EMALAHLENI – VULINDLELA BRIDGE – BASIC ASSESSMENT

ANNEXURE D AND F IN SUPPOR OF THE BASIC ASSESSMENT REPORT FOR THE PROPOSED VULINDLELA BRIDGE REPAIRS, IN OGIES, MPUMALANGA PROVINCE

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Environmental Management Programme report

(Volume 2 of 4)

VULINDLELA BRIDGE REPAIRS
ENVIRONMENTAL MANAGEMENT PROGRAMME

ENVIRONMENTAL MANAGEMENT PROGRAMME
SEPTEMBER 2019

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DATE : **September 2019**

APPLICANT : **Emalahleni Local Municipality**

PSP : **MDT Environmental (Pty) Ltd**

ENVIRONMENTAL MANAGEMENT PROGRAMME

Report prepared for

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ENVIRONMENTAL MANAGEMENT PROGRAMME

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ENVIRONMENTAL MANAGEMENT PROGRAMME

1. INTRODUCTION

1.1 *DETAILS OF THE ENVIRONMENAL ASSESSMENT PRACTITIONER*

The compilation of this Environmental Management Programme (EMPr) was prepared by Mr Deon Esterhuizen of MDT Environmental (Pty) Ltd) (MDTE). For a detailed description of expertise and previous project experience of the author please refer to **Annexure A** for the curriculum vitae of the Environmental Assessment Practitioner (EAP).

1.2 *PROJECT BACKGROUND*

Vulindlela Bridge works involve the rehabilitation of two bridge crossings. The water course has been affected by increasing and uncontrolled vegetation growth, as well as siltation caused by erosion, which has led to a reduction in river capacity, as well as altered water flow patterns. Consequently, during rainy seasons the river floods, hindering smooth traffic and pedestrian movement.

Siyandiza Consulting Engineers (Pty) Ltd were appointed to undertake designs for the bridge rehabilitation works. In addition, to comply with NEMA, as amended, and its regulations, Sasol has also appointed MDT Environmental (Pty) Ltd, as Environmental Assessment Practitioners (EAPs), to conduct environmental studies and apply for environmental authorisation for any listed activities that might be triggered through the execution of this project. The environmental studies will determine the potential significant environmental impacts that will emanate from the proposed project. In addition, the study will also recommend mitigation or management measures for these significant impacts

This document is the EMPr for the Vulindlela Bridge Repairs Project and is based on legislative requirements as per the National Environmental Management Act (No 107 of 1998) and in particular the Environmental Impact Assessment Regulations of 2014, as amended.

1.3 *NEED FOR THE PROJECT*

The project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd (Sasol Mining) and is part of the projects committed to in their social and labour plan. The project beneficiaries, and as such project applicants, are Emalahleni Local Municipality. The project entails rehabilitating two bridge crossings.

The Project objectives are to:

- establish mechanisms that will minimize sedimentation and debris accumulation at the bridge openings.
- rehabilitate and clean both bridges in order to improve safety status.
- improve storm water control measures
- undertake dredging methods that are well investigated to reduce impact on the ecosystem.
- achieve functional structures, which can be maintained in association with the asset management system for the Local Municipality.

1.4 *PROJECT LOCATION*

Property description:	The property consists of Erf 1057 and Erf 1058 in Phola within eMalahleni Local Municipality in Mpumalanga

(Farm name, portion, number and registration division or Erf number etc.) Where a large number of properties are involved (e.g. linear activities), please attach a full list to this application.

Current land-use zoning:	Erf 1058 falls within a water course.

In instances where there is more than one current land-use zoning, please attach a list of current land use zonings that also indicate which portions each use pertains to, to this application.

Property size (m^2) of all proposed sites:	The two properties, Erf 1057 and 1058 mainly consists of an open area that is dissected by a tributary of the Saalboom Spruitfalls. The Municipality has earmarked the site as a Park and the properties are zoned as open space.
Development footprint size (m^2):	The development footprint size for Erf 1057 is 77 330 m^2 and the development footprint size for Erf 1058 is 207 613 m^2. Thus, the total development footprint size is 284 943 m^2.

Project map:	A project map must be attached to this document. The map must accurately provide an indication of the project site position as well as the positions of the alternative sites, if any, and • Road names or numbers of all major roads as well as the roads that provide access to the site(s); • A north arrow; • Any sensitive geographic features (e.g. watercourses) *A project map, Photographic map, Site Layout Plan and Mpumalanga Biodiversity Sector Plan (MBSP) Terrestrial Critical Biodiversity Area (CBA) Map are attached as Appendix 3.1-1 to 3.1-4 of the Basic Assessment Report.*

Site co-ordinates:	Indicate the position of the activity using the latitude and longitude of the centre point of the preferred site alternative. The co-ordinates must be in degrees, minutes and seconds using the Hartebeesthoek94 WGS84 co-ordinate system.

Number of corner	**Latitude (S):**			**Longitude (E):**		
1	26°	00'	18.03"	29°	02'	18.13"
2	25°	59'	55.17"	29°	01'	56.67"

SG 21 Digit Code(s):	The Surveyor-General 21-digit codes for the site are listed under Appendix 3.1-1 of the Basic Assessment Report.

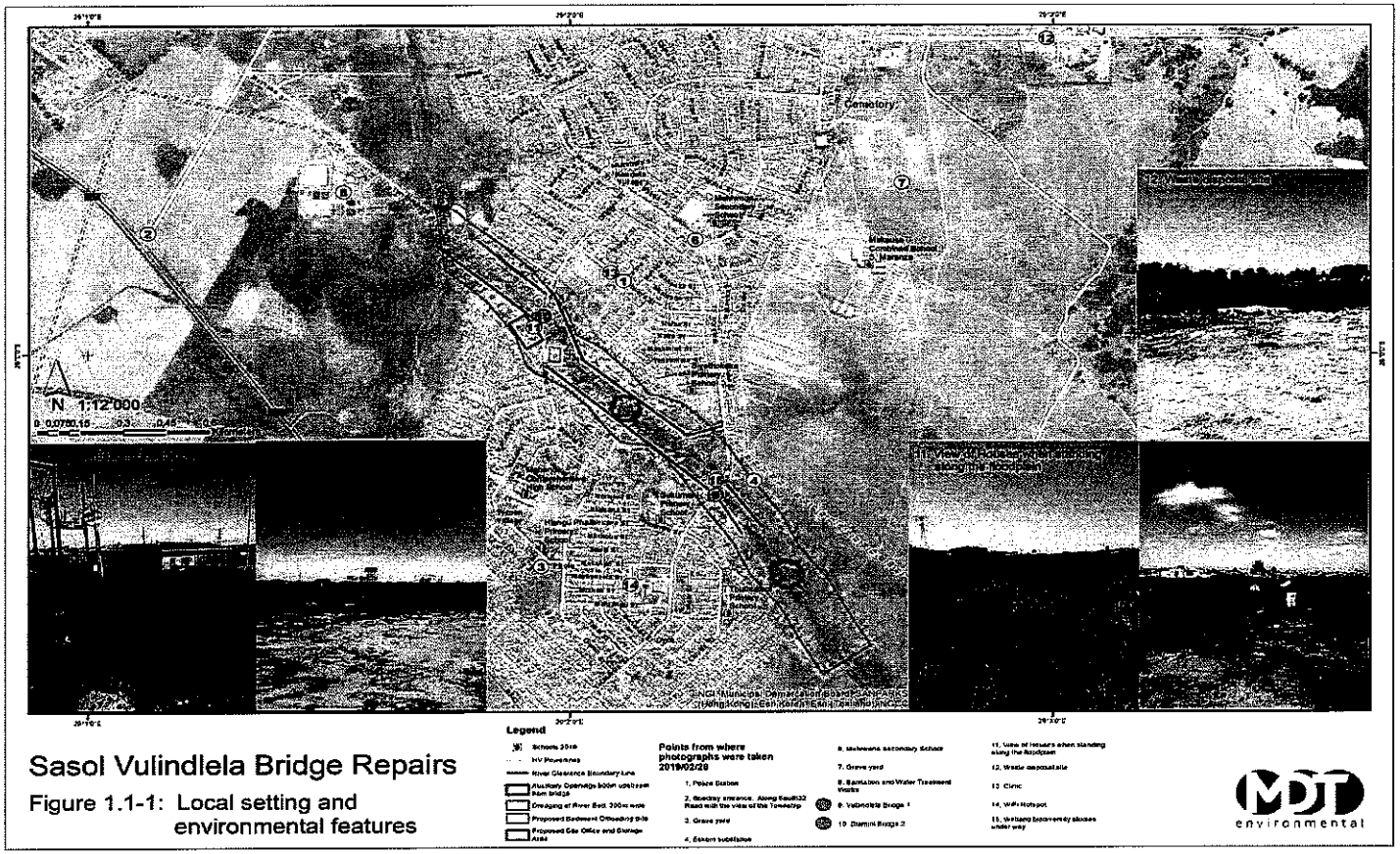


Figure 1-1: Vulindlela Bridge Repairs Locality

1.5 *SCOPE AND PURPOSE OF THE DOCUMENT*

This document is applicable to the Vulindlela Bridge Repairs Project. It is a management programme to be complied with by the developer and his contractor during the construction and rehabilitation phases of the Project and encompasses associated environmental aspects of the works.

The purpose of this document is to provide guidelines for the application of environmental best practice to Emalahleni Local Municipality and its appointed Contractor commissioned to construct the proposed project.

This document shall be seen as part of the contract with the appointed contractor. The EMPr together with appropriate enabling clauses will thus be part of the enquiry document to make recommendations and constraints, as set out in this document, enforceable under the general conditions of the contract. It must be ensured that relevant environmental management specifications as contained in the EMPr are incorporated into the tender and contract documentation. Relevant payment items must be incorporated into the bill of quantities. During the tender evaluations, the ability of the potential contractors to adequately manage the environmental issues must be assessed.

The EMPr has a long-term objective to ensure that:

- Environmental management considerations are implemented from the start of the project;
- Precautions against damage and claims arising from damage are taken timeously; and
- The completion date of the contract is not delayed due to avoidable environmental issues arising that could be mitigated through a well-structured EMPr.

2. LEGISLATIVE AND OTHER REQUIREMENTS

The management and mitigation of the environmental impacts experienced during construction is governed by environmental legislation. It is of utmost importance that this project is constructed in compliance with all relevant environmental legislation whether; National, Provincial and/or Local.

The environmental legislative framework and components for South Africa can best be unpacked and summarised as follows:

The Constitution of South Africa (Act No. 108 of 1996)

In accordance with the Constitution, the Government of South Africa has separate national, provincial and local levels that are mutually dependant and interconnected. All three areas of government have legislative and administrative functions and thus have responsibility for the management of the environment.

The Bill of Rights (Chapter 2 of the Constitution) is a fundamental cornerstone of environmental law in South Africa and makes provisions for environmental issues.

Section 24 of the Bill of Rights states that:

"Everyone has the right -

a. to an environment that is not harmful to their health or well-being; and
b. to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that -
   i.) prevent pollution and ecological degradation;
   ii.) promote conservation; and
   iii.) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

Common Law

South Africa's common law is composed of the foundational Roman-Dutch legal principles as modified and interpreted by judicial precedent.

National Legislation pertaining to this Project:

- National Environmental Management Act (No. 107 of 1998)
- National Environmental Management: Biodiversity Act (No. 10 of 2004)
- National Environmental Management: Waste Act (No. 59 of 2008)
- National Water Act (No. 36 of 1998)
- National Heritage Resources Act (No. 25 of 1999)
- National Road Traffic Act (No. 93 of 1996)
- Occupational Health and Safety Act (No. 85 of 1993)
- Hazardous Substances Act (No. 15 of 1973)
- Explosives Act (No. 26 of 1956)
- Basic Conditions of Employment Act (No. 75 of 1997)
- Promotion of Administrative Justice Act (No. 3 of 2000)
- Extension of Tenure Act (No. 62 0f 1997)
- Prevention of Illegal Eviction and Unlawful Occupation of Land Act (No. 19 of 1998)
- Development Facilitation Act (No. 67 of 1995)
- Municipal Structures Act (No. 117 of 1998)
- Traditional Leadership and Governance Framework Amendment Act (No. 23 of 2009)
- Local Government: Municipal Systems Act (No. 32 of 2000)

Provincial Legislation pertaining to this Project:

- North West Biodiversity Management Act (No. 4 of 2016)

2.1 *NATIONAL LEGISLATION*

2.1.1 National Environmental Management Act (No. 107 of 1998)

The National Environmental Management Act (No 107 of 1998) (NEMA) objectives include co-operative environmental governance, sustainable development, environmental justice and the "polluter pays" principle. NEMA Regulations incorporate requirements for environmental impact assessments which are approved or authorised in the form of Environmental Authorisations (EAs).

2.1.2 Environmental Impact Assessment Regulations, 2014, as amended

The Environmental Impact Assessment (EIA) Regulations of 2014, as amended are also published under NEMA. Section 19 of these EIA regulations requires the applicant to submit, within 90 days after receipt of the application by the competent authority, a basic assessment and EMPr.

Appendix 4 of the Regulations stipulates the required content of an EMPr. **Table 2-1** indicates these requirements and where it can be found within this EMPr.

Table 2-1: Content of an EMPr as per the EIA Regulations

No	Requirement	Reference in EMPr
1a	Details of i) The EAP who prepared the EMPr; and ii) The expertise of the EAP to prepare an EMPr, including a curriculum vitae;	Section 1.1 and Annexure A
1b	A detailed description of the aspects of the activity that are covered by the EMPr as identified by the project description.	Section 6
1c	A map at an appropriate scale which superimposes the proposed activity, its associated structures, and infrastructure on the environmental sensitivities of the preferred site, indicating any areas that should be avoided, including buffers.	Annexures B, C, and D
1d	A description of the impact management objectives, including management statements, identifying the impacts and risks that need to be avoided, managed and mitigated as identified through the environmental impact assessment process for all phases of the development, including: i) Planning and design; ii) Pre-construction activities;	Section 6 & 10

No	Requirement	Reference in EMPr
	iii) Construction activities; iv) Rehabilitation of the environment after construction and where applicable post closure; and v) Where relevant, operation activities.	
1e	A description and identification of impact management outcomes required for the aspects contemplated in 1d above.	Section 10
1f	A description of proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated in 1d and 1e above will be achieved.	Section 10
1g	The method of monitoring the implementation of the impact management actions contemplated in 1f above.	Section 5
1h	The frequency of monitoring the implementation of the impact management actions contemplated in 1f.	Section 5 & 10
1i	An indication of the persons who will be responsible for the implementation of the impact management actions.	Section 4
1j	The time periods within the impact management actions must be implemented.	Section 10
1k	The mechanism for monitoring compliance with the impact management actions.	Section 5
1l	A program for reporting on compliance, taking into account the requirements as prescribed by the Regulations.	Section 5 & 10
1m	An environmental awareness plan describing the manner in which i) The applicant intends to inform his or her employees of any environmental risk which may result from their work; and ii) Risks must be dealt with in order to avoid pollution or the degradation of the environment.	Section 7
1n	Any specific information that may be required by the competent authority.	N/A

2.1.3 National Environmental Management: Biodiversity Act (No. 10 of 2004)

Permit applications must be made to the relevant authority for the removal of any Red Data or Protected Species found in the proposed alignment and construction areas. These permit applications must be made in conjunction with requirements of the National Forests Act (No. 84 of 1998). The identified protected species are listed later in the report.

The Biodiversity Act also holds Emalahleni Local Municipality responsible for the eradication of any alien or invasive species which establish on site as a result of the construction activities

using methods which are appropriate to the species concerned and the environment in which it occurs.

2.1.4 National Environmental Management: Waste Act (No. 59 of 2008)

All wastes, both general and hazardous, generated during the construction of the Project and associated infrastructure must be disposed of at an appropriately licensed waste disposal site. Copies of the permits or licences must be obtained and kept on site before the commencement of construction.

2.1.5 National Water Act (No. 36 of 1998)

Emalahleni Local Municipality has completed a risk assessment in terms of the General Authorisations, Notice 509.

2.1.6 National Heritage Resources Act (No. 25 of 1999)

According to the NHRA archaeological and destruction permits are required for the removal of a structure or element of cultural significance as well as for the relocation of graves on site.

2.1.7 National Road Traffic Act (No. 93 of 1996))

Relevant provisions of the Road Traffic Act must be complied with pertaining to the correct licensing for all drivers on site as well as the ensuring that all vehicle and plant is road worthy.

2.1.8 Hazardous Substances Act (No. 15 of 1973)

Hazardous substances must be stored and handled in accordance with the appropriate legislation and standards, which may include the Hazardous Substances Act, the Occupation Health and Safety Act, relevant associated Regulations and applicable SANS and internal standards. The Implementer must ensure that all relevant Material Safety Data Sheets are present on site at all times.

2.1.9 Occupational Health and Safety Act (No. 85 of 1993)

All provisions of the Occupational Health and Safety Act must be complied with. The Act must not only provide for the health and safety of the persons connected to the construction but also the persons in the surrounding areas which are affected by the construction.

2.1.10 Explosives Act (No. 26 of 1956)

Blasting permits must be present on site before construction can commence. These permits must be acquired from the Department of Mineral Resources in accordance with the Explosives Act (Act No 26 of 1956).

2.1.11 Basic Conditions of Employment Act (No. 75 of 1997)

The Basic Conditions of Employment Act details employment conditions, applies to all workers and employers, and must be obeyed even if other agreements are different. It includes specifications regarding working time, leave, job information and payment, and termination of employment. The proponent and all its contractors must adhere to the requirements of this Act in the recruitment and employment of labour for construction.

3. PROJECT DESCRIPTION

3.1 *A DETAILED VIEW OF THE PROJECT WORKS*

The construction sites will be located on previously disturbed areas as all the areas identified are within a built-up environment. These areas will make provision for closed civil systems such as water tanks and conservancy tanks for sewerage containment. All waste products will be removed from the construction sites to an approved and licensed disposal site. Rehabilitation of the construction sites will be to the same level as to prior establishment. The construction site camp will be located above the 1:20 year flood line with hazard free accessibility from the main roads for delivery and access to the construction areas. Access to the respective construction sites would be possible via pre-existing roads. All additives to be used are to be non-poisonous and environmentally friendly. Batching of concrete for all purposes is to be done at the construction site camps in a regulated environmentally friendly way. No batching will be allowed to happen inside river servitude area of the 1:20 year flood line. All construction equipment and material also to be stored at the site camps and above the 1:20 year flood line where required. All material will be imported thus no quarries or borrow areas will be established in the vicinity. The identified areas are vulnerable and the risk of failure increases with every passing rainy season.

Cleaning of the riverbed

- Removal of material from the riverbed shall be end-hauled to safe, stable and licenced disposal sites.
- Environmental considerations pertaining to riparian ecosystem will be considered and a wetland and aquatic studies were undertaken.
- Excavation of excess material in the channel will be done to the original base level of the streambed, not below it, to avoid head cuts and / or water stagnation.
- Culvert cleaning may be done using horizontal drilling or jetting.

Structural health monitoring of the bridge

Assessment of the bridge structures will take into account the corrosion of the culvert reinforcement, cracks, abrasion extents and differential settlements if any are observed. The purpose of this exercise is to determine if there are any structural safety concerns that may require rehabilitation of the bridges themselves or their replacement (Note this is not the scope of this project, at this stage, repair work has been commissioned and the designs are looking at various feasible alternatives to achieve repair and leave stable, safe and operational structures).

Storm water management and Erosion control

- To minimize donga formation due to erosion and promote stabilization storm water control measures will be implemented
- Road kerbs and channel combination, with down-chutes will be used to drain the surface water from the road walkway enlargement will be done.

Walkways and road furniture

Due to high pedestrian movements, there are considerations for the refurbishment and construction of dedicated walkways on both sides of the bridges. The walkways are to have handrails on the outer edge and a barrier on the inner road edge to protect the pedestrians from vehicular traffic.

Proposed site office and storage areas:

The envisage infrastructure on site will entail:

- Site Office;
- Storage area;
- Containers;
- Parking area for plant;
- Fuelling point;
- 3 m high boundary fence with access;
- Gate facing main road;
- Security boom;
- Sediment offloading site; and
- Collection to take to spoiling or designated waste sites.

3.2 *DESCRIPTION OF THE AFFECTED AREA*

3.2.1 Hydrology

The study site is located in quaternary catchment B20G in the Olifants Water Management Area (WMA 2).

The Nkangala District Municipality Rural Development Plan (2017) illustrates that the District falls within the Inkomati and the Upper Olifants Water Management Areas (WMAs). The Inkomati WMA consists of the Komati West, Komati North, Crocodile and Sabie sub-WMAs, whilst the Olifants WMA consists of the Upper Olifants, Middle Olifants, Steelpoort and Lower Olifants sub-WMAs (Nkangala District Municipality Rural Development Plan, 2017).

The Olifants River acts as the main drainage system within the District, flowing in a northerly direction, bending gradually in an easterly direction to join the Limpopo River and further settles into the Indian Ocean. Approximately, 57% of the water in the Olifants WMA is utilised for irrigation purposes, simultaneously, the Olifants River drains the entire Steve Tshwete and Emalahleni mining regions and the areas north of Witbank and Middleburg form part of the Strategic Water Source Area (Nkangala District Municipality Rural Development Plan, 2017).

3.2.2 Wetlands

During the desktop investigation, one (1) possible area where wetlands could occur was identified on or in close proximity to the study site that would be affected by the proposed development activities. The NFEPA wetlands were also consulted and one wetland area was identified on or in close proximity to the study site that could be affected by the proposed activities.

The field investigations were undertaken during February 2019 to assess and confirm the delineated Wetland zones present on the survey area. The field investigations concluded that two (2) natural wetland systems (three wetland units) could be affected by the activities. Same is draining into the Saalboom Spruit.

Terrain unit indicator helps identify those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units:

- Crest;
- Midslope;
- Footslope; and
- Valley bottom.

Wetland classification

The hydrogeomorphic wetland units identified were also assessed in respect to its location in the landscape. The wetland units found:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

Soil Form and Soil Wetness Indicator

Soil erodibility in hydrologically transformed environments contributes to the difficulties to precisely determining wetland boundaries. This investigation focussed on the delineation of the wetland features based on soil hydro-morphology and landscape hydrology as observed in the catchment and on the study site.

Soils were found to be of a low clay content in general. Mostly sandy soils were present especially in the top 250 mm. The wetland seasonal and permanent zones reflected clayey soils.

The soils in the region are mostly derived from the geology of the region namely, predominantly shale, sandstone conglomerate and dolerite intrusions which feature prominently in the area. The soils are generally shallow with a dark brown colour (Zithole Consulting 2010).

The regional land capability is mostly class IV soils with limitations. This is evident in the large number of grazing land as opposed to cultivated lands found in the region. This is due to the fact that the effective soil depth is too shallow or too wet to cultivate, and livestock is grazed instead.

Vegetation type

The study area falls within the Grassland Biome (Biome 06), The Highveld Level -1 Ecoregion (Ecoregion 11) (Kleynhans *et al.*, 2005).

Close to 9% of the Districts ecosystems are endangered, some critically so; 9% of land is already degraded, 35.8% of land has been transformed, primarily within the grassland biome; and 33% of the river types are critically endangered (Nkangala District Municipality Rural Development Plan, 2017). The state of the environmental is mainly due to poor environmental management in the respective mining areas within the District which leads to excessive levels of water and air pollution (Emalahleni Local Municipality Spatial Development Framework, 2015; Nkangala District Municipality Rural Development Plan, 2017).

Upon the assessment of the area, the various wetland vegetation components were assessed and recorded. Dominant species were characterised as either wetland species or terrestrial species. Hydrophytic vegetation species were observed. Predominantly grass, rushes and sedge species were recorded. This unit was predominantly utilised to delineate the wetland.

3.2.3 Socio-Economic setting

The socio-economic overview of the Emalahleni Local Municipality has been compiled from the Emalahleni Local Municipality Integrated Development Plan (IDP) 2017- 2022, Emalahleni Spatial Development Framework (SDF) 2018, Nkangala District Municipality Integrated Development Plan (IDP) 2017-2022, Steve Tshwete Local Municipality Integrated Development Plan (IDP) 2017- 2022, Dr JS Moroka Local Municipality Integrated Development Plan (IDP) 2017- 2022, Thembisile Hani Local Municipality Integrated Development Plan (IDP) 2017- 2022, Victor Khanye Local Municipality Integrated Development Plan (IDP) 2017- 2022, Emakhazeni Local Municipality Integrated Development Plan (IDP) 2017- 2022. Documents from other surrounding Local Municipalities where used mainly for data comparison purposes since municipalities interact with each other. Also, data from Stats SA 2011 Census and Stats SA 2016 Community Survey Report and GIS maps for location, direction and distance purposes were consulted.

Nkangala District Municipality is the smallest, in land mass, of all the three District Municipalities in the Mpumalanga Province which also include Gert Sibande and Ehlanzeni. Nkangala District Municipality comprises of six local municipalities which are Emakhazeni, Steve Tshwete, Victor Khanye, Thembisile Hani, Dr JS Moroka and eMalahleni Local Municipality and Emalahleni Local Municipality (ELM) covers an area of approximately 2 677 km2 constituting about 16% of the total 18 812km2 of the Nkangala District Municipality. The local municipality is situated on the Western parts of the Nkangala District sitting on the Highveld region of Mpumalanga.

ELM shares a boarder with the Gauteng Province connected to the Province by N12 and N4 National transport corridors, (Spatial Development Framework, 2016). The hierarchy of roads consist of National (N4 and N12), Provincial (R555, R544, R545, R547, R104 and R580) and several local road networks. Also, the local municipality has an exceptional railway and road connection which include a rail line that connects Gauteng and Maputo running parallel to the N4 as well as roads and rail connection to the South of the municipality connecting Emalahleni to Richards Bay and Maputo Harbour. There are also road and railway networks within ELM. Thus, it is evident that when it comes to transport connections, ELM provides significant logistical opportunities.

The Emalahleni Spatial Development Framework (2016) state that ELM comprises of 34 wards. The area around town, eMalahleni Town, formerly Witbank, is divided into small wards which are so close to each other and the reminder of the area comprise of larger wards. Vulindlela bridges are located within three wards which are ward 28, 30 and 31 all situated around the watercourse.

Of the residential areas and settlement within ELM, eMalahleni town is the largest considered one of the major urban concentrations in the Nkangala District Municipality, and other medium sized towns and settlements include Phola, Ogies, Ga Nala, Thubelihe and several mining settlements in the south-eastern parts of the municipal area including Balmoral, Coalville, Kendal, Kriel, Matla, Minnaar, Rietspruit, Van Dyks Drif, Duvha, Wilge, and several rural settlements. Emalahleni Spatial Development Framework (2016) divides ELM into functional sections namely Emalahleni West, Emalahleni East, Phola, Ogies, Thubelihle, Ga-Nala and Emalahleni Rural. ELM is considered as the most industrialised municipality in Nkangala probably due to the fact that the local municipality has the largest concentration of power stations in South Africa. Vulindlela Bridge repairs will take place in the Phola–Ogies area located about 35km south west of Emalahleni town.

Figures from a census conducted in 2011 shows that ELM had a total population of 395 466 and a community survey conducted in 2016 shows that the population was 455 228 indicating a 3.2% growth rate between 2011 and 2016 (Statistics, South Africa, 2016). The Emalahleni Local Municipality Integrated Development Plan 2017/2018-2021/2022 state that in 2016, ELM had the third largest population in the Province taking 31.5% of the total population in Nkangala and making it the most populated Local Municipality within the district. Table 10.5-1 summarises the population figures in comparison to other local municipalities found within Nkangala District Municipality.

Despite being the most populated local municipality in Nkangala District Municipality, ELM had a 3.2 percentage population increase, 2011 to 2016, placing the local municipality on the second highest in the District, behind Steve Tshwete, which had the highest increase of 4.4 %. Considering the current growth rate, it is projected that by 2030 ELM will have a total population of 707 530 and this is expected to put pressure on infrastructure development, service delivery and employment opportunities.

High employment levels are an indication of a good economic environment in an area. The Emalahleni Integrated Development Plan 2017/2018-2021/2022 state that unemployment is still a challenge as is the case in many South African municipal areas. However, the local municipality has experienced a decrease in unemployment rates form 27.3% in 2011 to 23.2% in 2016 which is below the national unemployment rate of 26.6%. In Nkangala District Municipality, Emalahleni local municipality has the fourth highest unemployment rate with Dr JS Moroka Municipality having as high as 47.7% unemployment rate and Steve Tshwete with the least unemployment rate of 17.3%.

4. ROLES AND RESPONSIBILITY

Effective environmental management during the design and construction of the Vulindlela Bridge Repairs Project will be critically dependent on a number of project personnel. The purpose of this section is to define roles for personnel and to detail concomitant responsibilities in the execution of the EMPr. Before doing so it is also necessary to define the various parties that bear environmental management responsibilities for the Vulindlela Bridge Repairs Project, during design and construction.

4.1 *PROJECT OWNER – EMALAHLENI LOCAL MUNICIPALITY*

Emalahleni Local Municipality is the owner of the Vulindlela Bridge Repairs Project and is the independent decision-making authority and ultimately accountable and responsible with respect to implementation of the contract and compliance with this EMPr.

4.2 *CONTRACTOR (DESIGN AND CONSTRUCTION)*

Emalahleni Local Municipality will appoint a turnkey contractor through its normal procurement processes. The requirements of this EMPr will form part of the tender documents and Bill of Quantities to ensure that the turnkey contractor will price and fully comply with all environmental legislation and requirements.

The Environmental Manager will provide environmental management and oversight for all environmental issues that arise on a day-to-day basis. The Environmental Manager is the primary point of contact on environmental and social issues for the duration of the contract. The Environmental Manager will also assist the contractor in coordination with the Competent Authority.

4.3 *ENVIRONMENTAL MANAGEMENT STRUCTURE*

Within the above structure there will be a number of functional posts that will either directly or indirectly have an environmental management function as shown in **Figure 4-1** below and described later. Important to note, that although the functions area shown and described separately, these functions could be the responsibility of one post within the organisation, except for the Environmental Control Officer (ECO) post, which is an independent body reporting to the Competent Authority and the external auditor.

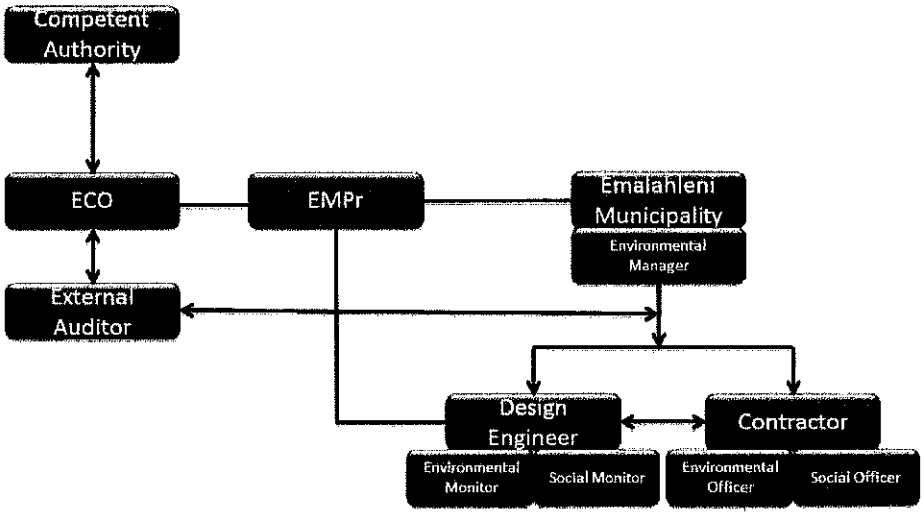


Figure 4-1: Environmental Management Structure

4.3.1 Project Owner

As the Project Owner part of Emalahleni's responsibilities is to oversee the overall implementation of the construction of the project as well as the compliance to the applicable legislation, the Environmental Authorisation and approved EMPr.

4.3.1.1 Environmental Manager

The Emalahleni Environmental Manager will focus on oversight and contractor compliance. The Environmental Manager reports to Emalahleni Local Municipality. The role of the Environmental Manager is to support the successful implementation of the EMPr through:

- Plan and direct the implementation of the EMPr.

- Ensure that the requirements of the EMPr are communicated, understood and enforced by personnel on site.
- Ensure that contractors on site develop, implement and monitor the required environmental management functions.
- Evaluate the applicability and accuracy of the EMPr and the Method Statements throughout the construction process.
- Ensure that all statutory requirements are met.
- Manage scheduled audits and inspections on contractor's performance on site.
- Manage all public and interested and affected party complaints, claims and recommendations.

4.3.1.2 External Auditor

Emalahleni Local Municipality will appoint an external auditor to undertake quarterly audits to ensure that the contractor is complying with the required construction phase management measures.

The main responsibility of the Environmental Auditor is to monitor and report on Emalahleni's compliance with the EMPr and other statutory obligations pertaining to environmental performance during construction of the project.

4.3.2 Design Engineer

The Design Engineer is responsible for the design of the chair lift and associated infrastructure. It will be the responsibility of the Engineer to ensure that the Contractor adheres to construction specifications, the Environmental Authorisation and EMPr. The Engineer has the authority to stop any construction activity which is in contravention of any of the specifications within the documents mentioned above after consultation with the ECO. All major decisions which may affect the programme or costs of the project with regards to the environmental procedure or protocols must be approved by the Employer via the Engineer.

4.3.2.1 Environmental Monitor

The Environmental Monitor (EM) is employed by the Engineer and is responsible for overseeing the daily implementation of the EMPr and relevant specifications for the duration

of the project. The EM should have a clear understanding of the project as well as all the environmental matters pertaining to the project and should have a good knowledge on the applicable environmental legislation and processes.

Responsibilities of the EM include:

- To advise and provide recommendations to the Environmental Officer (EO) on all environmental and related issues based on the requirements of the EMPr.
- To record and forward complaints received from the public to the Engineer and Employer.
- Resolve conflicts.
- Keep detailed and accurate records of the EMPr related activities on site.
- Report to the ECO on the monitoring of environmental issues.

4.3.2.2 Social Monitor

The Social Monitor will act on behalf of the Engineer in all social matters pertaining to the project. The Environmental and Social Monitor roles could be the responsibility of one individual.

Responsibilities of the Social Monitor are:

- Resolve conflicts.
- Ensure the implementation of the Social Monitoring Plan as well as social-related requirements in the EMPr.
- Monitor the progress, impact and sustainability of the project.
- Ensure that all community and land owner complaints are reported to the Engineer, recorded and dealt with in a timeous manner.

4.3.3 Contractor

In order to carry out the requirements of this EMPr, the Contractor must make sure that he has a clear understanding of all environmental matters relating to the project.

The responsibilities of the Contractor will include:

- The implementation of and adherence to the applicable environmental contract specifications in accordance with the requirements of the EMPr.

- The compliance to all national, provincial and local legislation related to the management of environmental aspects, including ensuring all applicable and required site specific permits, authorisations and licenses which are triggered by the Contractor's activities are applied for and obtained timeously. Examples of such permits include the removal of protected plant species and the storage of flammables and hazardous material.
- To ensure all Sub-contractors under his supervision adhere to the applicable environmental contract specifications in accordance with the requirements of the EMPr.
- Report any incident to the Engineer immediately and follow the initial notification with a flash report within 12 hours of the event occurring. The flash report will include details of the incident, which includes the extent, reasons, preventative actions and corrective actions taken.
- To ensure that all employees and Sub-contractors attend Environmental Awareness Training provided by the EM.
- To conduct any remedial work required in terms of this EMPr as a result of environmental negligence, mismanagement and/or non-compliance.

4.3.3.1 Environmental Officer

A suitably qualified senior employee of the Contractor shall be responsible for implementing the EMS, environmental monitoring and control. This position shall be designated the Environmental Officer (EO). The EO shall be responsible for:

- Aiding the Contractor to comply with all the project environmental requirements, objectives and targets;
- Facilitating environmental activities and environmental awareness training of all personnel on site, and
- Implementing an internal environmental management system.

4.3.3.2 Social Officer

The Social Officer (SO) functions could be included in the Environmental Officer roles and responsibilities.

The duties of the SO will include:

- Aiding of the Contractor with liaison with neighbours, land occupiers and other interested and affected parties,

- Facilitating the resolution of potential and actual challenges experienced during construction where these relate to land occupiers, staff, and guests and their special requirements, and
- Aiding the Contractor in keeping accurate records pertaining to issues, complaints and the associated corrective actions.

4.3.4 Environmental Control Officer

Emalahleni Local Municipality must appoint a suitably qualified and experienced independent Environmental Control Officer (ECO) who will be responsible for the monthly monitoring of the project compliance with the Environmental Authorisation, EMPr and applicable environmental legislation. The contract for the ECO will extend from the commencement of the Construction Phase to the handover of the site by the Contractor to Emalahleni Local Municipality.

The responsibilities of the ECO include but are not limited to:

- Undertaking a due diligence audit at least a month prior to the commencement of construction. The audit will include a site visit and a qualitative survey of the status of the area prior to construction.
- Review and analyse the monitoring data which will include but not be limited to water, dust and noise monitoring, complaints and pollution incidents and non-conformances against the limits that have been set in the environmental specifications and/or the Environmental Authorisation.
- Site inspections will be conducted in such a way that all the construction activities are covered in the month. The site inspection will include a physical visit to the construction sites. The ECO will inform Emalahleni Local Municipality of the visit and will commence the visit with an opening meeting on site to gather information regarding the level of operations and a closing meeting to provide feedback to the Design Engineer and Emalahleni Local Municipality. A report will be compiled to summarise the findings.
- Every month the ECO will also provide a monitoring report to the Competent Authority based on the data gathered by the Contractor and evaluate the information against the performance targets set out in the EMPr.

It is expected that the ECO will maintain open communications with Emalahleni Local Municipality to ensure that non-conformances are addressed as soon as possible on site.

5. MONITORING, AUDITING, & REPORTING

5.1 *INTRODUCTION*

The purpose of monitoring, auditing and reporting is to ensure that implementation in the design, construction and operations and maintenance phases of the life-cycle of the project is accomplished in such a manner that the organisations environmental policy, objectives and targets are met as outlined in this document.

Emalahleni Local Municipality has resolved to focus on environmental issues, with emphasis on attaining a high level of environmental conscience and as a responsible business take the lead in its field. The Resort recognises that every being has the right to an environment that is not harmful to their health or wellbeing and that the nature of its activities could impact on the environment. The Emalahleni Local Municipality Environmental Policy is included in **Appendix E**.

The philosophy that will be followed is based on the Deming Cycle, namely; Plan, Do Check, Act, that allows for continual improvement of all activities on site. The objectives are:

- Identify possible impacts that may emanate from its activities;
- Implement mitigation measures to prevent, reduce and minimize the impacts;
- Create an awareness among all employees;
- Incorporate environmental issues into the company's business strategy.

5.1.1 Plan

The planning is intended to ensure that all activities of the project are carried out in a methodical fashion that allows for a concise intervention that is in concurrent with environmental management principles.

5.1.2 Do

The implementation will be through the development of Management and Mitigation Plans for each significant construction activity and its aspects that may have an impact on the environment.

5.1.3 Check

This EMPr can only be effectively implemented if it is accompanied by monitoring, auditing and reporting on compliance with the management and mitigation plans. The monitoring programme

will be designed in a manner that ensures that all the components of the Project that have the potential to impact the environment are accurately monitored.

5.1.4 Act

Without acting on non-compliances and implementing corrective measures all actions on site will be fruitless. The Project will be subject to both internal monitoring, and external auditing to ensure compliance to relevant legislation and standards (including this EMPr).

The following basic elements will be included in establishing and maintaining procedures for investigating and correcting non-conformance:

- Identifying the cause of the non-conformance
- Identifying and implementing the necessary corrective action. Implementing or modifying controls necessary to avoid repetition of the non- conformance
- Recording any changes in written procedures resulting from the corrective action.

5.2 *ENVIRONMENTAL CONTROL DOCUMENTS*

5.2.1 Health and Safety Incidents and/or near Misses Reporting

The following actions will be followed / addressed during incidents, accidents and near misses:

- All accidents, incidents and near misses will be reported to the Emalahleni Local Municipality Environmental Manager
- Accidents will be addressed in terms of the Health and Safety Plan. If injured, workers will be taken to an appropriate health care facility for treatment. The accident will be documented, including the nature and cause of the accident and the subsequent measures to prevent a similar accident from recurring.
- The corrective actions will be discussed during the next day's toolbox discussion.
- A weekly incident report will be forwarded to the Employer or his representative.

The incident report will be kept on file and will be available for review during audits.

5.2.2 Environmental Monitoring and Community Complaints Records

Records are evidence of the ongoing activities of the operation. Typical records that will be kept may include:

- Declaration of understanding of Environmental Management Programme
- Environmental Incidence Register
- Environmental Incident Report

- Hazardous Waste Disposal Register
- Method Statement Proforma
- Method Statement Register
- Hazardous Substances Register
- Community / Guests / Staff Complaints Register
- Environmental Audit Report
- Environmental File Index
- Relevant Letters of Appointment
- Quarterly Environmental Report
- Environmental Induction
- Visitors Induction and Indemnity

The environmental records will be legible, identifiable, and traceable to the activity involved. Records will be maintained to demonstrate conformance to all requirements.

5.3 *ENVIRONMENTAL MONITORING*

The main objective of the monitoring programme with respect to project activities is as follows:

- To establish trends
- To ensure compliance with regulatory authorities requirements
- To asses effectiveness of the proposed mitigation measures
- To detect environmental contamination as early as possible

In order to fulfil the above mentioned objectives the monitoring programme will cover issues related to the following environmental components:

- Public health – noise, dust and construction traffic
- Protected fauna and flora species – search and rescue and destruction
- Heritage / grave protection and / or relocation

6. DESCRIPTION OF PROJECT RELATED ACTIVITIES AND ASPECTS

In order to oversee the successful construction of the chairlift and associated infrastructure, various construction activities as well as their associated aspects have been identified and listed. From the identified aspects it is possible to determine the associated environmental impacts and therefore set the base to formulate measures to manage and mitigate these environmental impacts on site.

6.1 *PRE – CONSTRUCTION ACTIVITIES*

Pre – Construction follows on from final project planning tender phase and leads up to the establishment of the appointed Contractor on site. Emalahleni Local Municipality will be responsible for overseeing the implementation of the project requirements.

The Pre-Construction activities that are going to be conducted involve, but are not limited to:

- Finalise Design Requirements of the chair lift;
- Access to site;
- The surveying of the chair lift alignment;
- Walk down of the alignment with the specialists and ECO, specifically to undertake search and rescue activities;
- Acquiring of all relevant permits and licences;
- Identified Cultural Heritage Resources and Graves rescue and relocation;
- Rescue and relocation of identified red data flora;
- Social aspects related to the employment of local labour;
- Development of construction Method Statements where applicable;
- Environmental Awareness Training; and
- Photographic record of areas prior to site establishment and construction.

6.2 *CONSTRUCTION ACTIVITIES AND ASPECTS*

Construction refers to the phase in the project during which the actual construction of the 900 m chairlift and associated infrastructure will take place.
The Construction Phase will be divided into the following activities:

- Site Establishment and Infrastructure.
- Site Operations and Construction Works.

The activities and associated aspects which have been identified for Site Establishment and Infrastructure are listed in **Table 6-1**.

Table 6-1: Site Establishment and Infrastructure activities and associated aspects

No.	Activity	Aspect
1	Clearing and Grubbing	• Dust generation • Loss of vegetation, habitat and soil fertility. • Increased level of noise generation
2	Access to Site	• Increased traffic volumes
3	Construction and use of Temporary Access Paths / Roads	• Dust generation • Loss of vegetation, habitat and soil fertility. • Increased potential for erosion. • Increase in vehicle movement in area. • Increased level of noise generation
4	Installation of parking bays for construction plant and vehicles	• Dust generation • Loss of vegetation, habitat and soil fertility • Increased level of noise generation
5	Installation of temporary warning signage	• Decrease in aesthetic quality of the environment • Lack of visibility of signage
6	Topsoil stripping and stockpiling	• Dust generation • Loss of vegetation, habitat and soil fertility. • Increased potential for erosion • Soil contamination • Encroachment and establishment of alien vegetation • Reduced productivity of subsistence farmland
7	Provision of sanitation systems	• Dust generation • Loss of vegetation, habitat and soil fertility • Ground water contamination
8	Demarcation, fencing and gates	• Loss of vegetation and habitat • Impede faunal movement • Impeded human movement and disrupted daily activities
9	Provision of flammable material and other material stores	• Dust generation • Loss of vegetation, habitat and soil fertility • Soil contamination

The activities and associated aspects which have been identified for Site Operations and Construction Works are listed in **Table 6-2**.

Table 6-2: Site Operations and Construction Work activities and associated aspects

No.	Activity	Aspect
1	Blasting of hard material	• Increased level of noise generation • Vibration • Dust generation • Safety
2	Refuelling of construction vehicles and plant	• Soil contamination • Water contamination
3	Spoil material generation and management	• Dust generation • Loss of vegetation, habitat and soil fertility • Decline in the aesthetic quality of the environment
4	Relocation of existing services	• Disruption in the provision of services
5	Domestic and construction waste collection, storage, handling and disposal	• Unpleasant odours • Increase in Waste generation • Decline in the aesthetic quality of the environment
6	Handling, storage, disposal of hazardous waste	• Unpleasant odours • Soil contamination • Water contamination
7	Consultation with affected parties	• Insufficient consultation
8	Operation and movement of construction vehicles and plant	• Dust generation • Increase in level of noise generation • Soil contamination • Safety • Vibration • Greenhouse gas emissions
9	Road upgrades	• Dust generation • Increased level of noise generation • Soil contamination • Safety
10	Slopes and slope stabilisation	• Dust generation • Increased potential for erosion • Water contamination • Decline in the aesthetic quality of the environment • Safety
11	Maintenance of sanitation systems	• Unpleasant odours • Mismanagement of sewerage
12	Transportation of hazardous waste	• Potential spillages of hazardous waste • Safety • Greenhouse gas emission

No.	Activity	Aspect
13	Transportation and storage of pylons, pipes and associated materials at the laydown area	• Increase in vehicle movement in area • Impact on the existing road conditions • Safety • Increase in the level of noise generation • Greenhouse gas emissions
14	Use of generators	• Increase in level of noise generation • Soil contamination
15	Protection of archaeological findings	• Destruction of graves and other sites of archaeological value
16	Welding	• Safety • Emission of noxious fumes
17	Cooking of food	• Fire hazard • Illegal wood harvesting
18	Employment of local labour	• Insufficient employment of local labour • Presence of construction workforce • Influx of job – seekers • Loss of farm labour to construction work
19	Security	• Trespassing
20	Fire Control	• Loss of vegetation, habitat and soil fertility
21	Water Use and Management	• Water contamination • Misuse of available water
22	Concrete mixing	• Soil contamination • Water contamination • Misuse of available water

6.3 *REHABILITATION*

Rehabilitation will run con-currently with the actual construction of the chairlift and associated infrastructure. Rehabilitation will consist of, but is not limited to, the following rehabilitation measures:

- Removal of temporary structures and infrastructures;
- Removal of inert waste and rubble;
- Hazardous waste and pollution control;
- Final shaping of disturbed areas;
- Topsoil replacement and soil amelioration;
- Ripping and scarifying;
- Planting;
- Grassing;

- Maintenance; and
- Management of alien vegetation.

Rehabilitation measures mentioned above are dealt with in more detail later.

7. COMMUNICATIONS, CONSULTATIONS, & TRAINING

7.1 *COMMUNICATION PROCEDURES ON SITE*

To ensure effective on-site communication and maintained environmental performance, copies of all documentation described in the EMPr must be maintained on site at all times and be available to both the Environmental Manager, Design Engineer, the EM and ECO, and will be provided on request to authorities or stakeholders for inspection.

7.1.1 Site Instruction Entries

The Site Instruction journal entries will be used for the recording of instructions as they relate to implementation of the EMPr. Entries could also include stoppage of work orders for the purposes of immediately halting any particular activities of the contractor.

7.1.2 ECO Diary Entries

The purpose of these entries will be to record the comments of the EM as they relate to activities on the site. Both the Site Instruction journal and EM Diary must be available on the site at all times. These documents will be made available to all relevant authorities for inspection if requested.

7.1.3 Site Meetings

Regular site meetings will be held between the Environmental Manager, Contractor and its EO, the Design Engineer and its EM, and the ECO (optional). The purposes of the meetings shall be:

- To establish the suitability of the Contractor's methods and machinery in an effort to lower the environmental, social and health risk involved;
- To discuss and resolve non-conformance to environmental legislation / policies or the EMPr;
- To assess the general state of the environment on site and discuss any environmental problems which may have arisen;
- To act as a forum for input into the nature and environmental performance of the construction works;

- To accommodate all stakeholders in the decision-making process regarding social and environmental issues on site.

7.1.4 Non-Conformance Reports

All supervisory staff including Foremen, Resident Engineers, and the ECO must be provided the means to be able to submit non-conformance reports to the EO and EM. The EO and EM may also report non-conformances. Non-conformance reports will describe, in detail, the cause, nature and effects of any environmental non-conformance by the Contractor. Records of penalties imposed may be required by the relevant authority.

The non-conformance report will be updated on completion of the corrective measures indicated on the finding sheet. The report must indicate that the remediation measures have been implemented timeously as well as the effectiveness of the remediation measure in order for the non-conformance to be closed-out at the satisfaction of the EM and ECO.

7.2 *COMMUNITY CONSULTATION*

Key stakeholders such as the Chiefs of the neighbouring areas and the representative community councillors should be informed on the progress with the implementation of the EMPr.

The stakeholders will be provided with an opportunity during construction to provide input into the project development process. The following consultation activities will be undertaken:

- Notify the Local Chiefs and the Local Community Councillors in the project area of the proposed construction start date and request them to notify their community members.
- The Community Councillors will be provided with the name of the appropriate project contact person that will deal with queries and complaints.
- Notify the community through the councillors of monitoring programmes and environmental audit results.
- Monthly meetings with the relevant councillors will be held to obtain feedback about the project from the communities.

7.3 *COMPLAINTS MANAGEMENT AND GRIEVANCE PROCEDURE*

A protocol to address complaints includes the following aspects:

- Name of complainant;
- Contact details of complainant;
- Date of complaint;

- Nature of complaint; health or environment or safety related;
- Details of complaint; location, severity, stakeholders involved, frequency; and
- Manner in which the complaint has been resolved and a description of how this was communicated back to the communities.

7.4 *ENVIRONMENTAL TRAINING*

All site staff of all levels, as well as visitors to the site, should be made aware of the environmental management requirements for the project. This should be achieved through training as part of their induction and regular refresher courses.

An Awareness Training Plan will be prepared, that provides for the various categories of persons on site and will cover at least:

- The role and responsibility of the ECO and of other key persons on site in relation to environmental management requirements
- The construction activities that will impact both the physical and social environments
- Mitigation measures that have been put in place to avoid or minimise the anticipated impacts
- The nature and appearance of cultural heritage resource sites that may be found during construction activities and the mandatory procedures to be followed for their mitigation
- Prevention and control of waste, litter, spillages and fire, and particularly veld fires
- An outline of specific environmental management measures, such as rehabilitation of disturbed areas, fire management, prevention of water pollution and dust management

Daily toolbox talks at the start of each day with all workers onsite should be held. At these sessions relevant environmental and communications requirements should be raised to alert workers to particular concerns associated with their tasks for that day or the area which they are working.

7.5 *SITE INDUCTION (SHE)*

The Contractor will provide all employees or other persons entering the site with health and safety induction training pertaining to the hazards prevalent on the site and with the necessary Personal Protective Equipment (PPE). All employees will also be informed of the relevant emergency procedures.

During the safety induction, the employees will be informed of all environmental, health and safety issues. All employees that underwent the safety induction will sign an attendance register that will be kept on file (records).

8. EMERGENCY PLANNING AND RESPONSE PROCEDURES

The Contractor shall develop plans for action to be taken in the cases of emergencies. These plans should specify the emergency procedures for fire, accidental leaks and spillages and medical emergencies and be in line with the Emalahleni Local Municipality's existing Standard Operating Procedures. An accident register should be compiled every month.

Emergency contact numbers should be displayed in prominent places which should include the Police, Fire Department and Ambulance Services.

A designated emergency meeting point should be established and all employees should be informed of the locality and procedures.

8.1 *FIRE CONTROL*

- The Engineer and relevant authorities should be advised of a fire as soon as one starts.
- It should be ensured that all employees are aware of the procedure to be followed in the event of a fire.
- 'No smoking' areas should be marked, including the workshop and fuel storage areas.
- It should be ensured that there is basic and adequate fire-fighting equipment available on site and on all plant.

8.2 *ACCIDENTAL LEAKS AND SPILLAGES*

The existing Emalahleni Local Municipality Service Provider should be used to undertake clean-up of accidental spills onsite.

The degree and nature of any spillage should be consulted and mutually agreed between the parties, to seek the best alternative clean-up method available. The MSDS should also be consulted to determine the method of clean-up and to realise optimal utilization.

The following preventative measures should be undertaken:

- All sensitive sites should be identified such as rivers and wetlands and procedures developed to ensure proper handling of oil/fuel or chemical spillages in these areas.
- It should be ensured that all employees are aware of the procedure to be followed in case of accidental spills and leaks.
- It should be ensured that the necessary materials and equipment for dealing with spills and leaks is available on site at all times.

- All employees should be trained to handle all accidental leaks and spillages onsite appropriately.

9. REHABILITATION

The landscaping and rehabilitation of disturbed areas shall occur as soon as practically possible following the completion of the work in a specific area. Therefore, the rehabilitation process will immediately be executed, per phase, upon the completion of the work within a specific area, utilising specified methods and species.

9.1 *REMOVAL OF STRUCTURES AND INFRASTRUCTURE*

- The removal of all construction facilities and materials from the construction camp will be required and rehabilitation will have to be carried out, including the removal of the following:
    - Removal of construction site and/or camp.
    - Clear and completely remove from site all construction plant, equipment, storage containers, temporary fencing, temporary services, fixtures, concrete and compact earth platforms, fuel storage tanks and bund areas, chemical toilets and any other temporary works.
    - Materials that will not be used again must be removed by the Contractor.
    - Ensure that all access roads utilised during construction (which are not earmarked for closure and rehabilitation) are returned to a usable state and/or a state no worse than prior to construction.
    - Ensure that all access roads earmarked for closure and rehabilitation are ripped and that all imported material is removed. Rehabilitation should follow the first out; last in principle (i.e. rehabilitation should occur as follows subsoil, topsoil, hydro seeding).

9.2 *INERT WASTE AND RUBBLE*

- Clear site of all inert waste and rubble, including surplus rock, foundations, batching plant aggregate and soil crete. After the material has been removed, the site shall be re-instated and rehabilitated.
- Load and haul excess spoil in borrow pits / dongas and inert rubble to dump sites and spoil areas as indicated / approved by the Environmental Manager.
- Remove from site all domestic waste and dispose of in the approved manner at a registered waste disposal site. Proof of this must be provided by the Contractor to the Engineer.

9.3 *HAZARDOUS WASTE AND POLLUTION CONTROL*

Remove from site all pollution containment structures such as temporary sanitary infrastructure, waste water disposal systems and oil separators. Take care to avoid leaks, overflows and spills and dispose of any waste in the approved manner.

A large quantity of silt has to be removed and disposed, and for this purpose the silt had to be analysed and classified. The silt from the river bed was analysed and classified according to the Waste Classification and Management Regulations, promulgated on 23 August 2013. These regulations require that waste generators classify their waste according to SANS 10234 and as stipulated in GN R634 and in cases where contaminated soil is considered the requirements from GN R331 regarding the classification of contaminated land and the quality of soil were applicable.

The classification focussed on the following criteria:

- Physical Hazard
- Explosiveness
- Flammability
- Oxidation / Corrosiveness
- Health Hazard
- Eye and skin irritation
- Mutagenicity; carcinogenicity; reproductive toxicity
- Environmental Hazards
- Toxicity to aquatic life

"The total concentration (TC) and leachable concentrations (LC) limits of the chemical substances in the waste weree compared to the threshold limits specified in Section 6 of the Norms and Standards for total concentrations (TCT limits) and leachable concentrations (LCT limits) of specific elements and chemical substances. Based on the TC and LC limits of the elements and chemical substances in the waste exceeding the corresponding TCT and LCT limits respectively, the specific type of waste for disposal to landfill was determined in terms of Section 7 of the Norms and Standards".

The classification and definitions within the legal framework were considered in terms of the following documents:

- National Environmental Management: Waste Act 59 of 2008 [Commencement Date: 1 July 2009] as amended
- National Environment Laws Amendment Act 14 of 2013 (with effect from 24 July 2013)
- National Environmental Management: Waste Amendment Act 26 of 2014 (with effect from 2 June 2014)
- Government Notice 635, National Environmental Management: Waste Act 59 of 2008: National Norms and Standards for the Assessment of Waste for Landfill Disposal
- Government Notice 636, National Environmental Management: Waste Act 59 of 2008: National Norms and Standards for Disposal of Waste to Landfill

The samples were analysed by an accredited laboratory.

An appropriate method of disposal and the type of facility to be used for the disposal of waste must be based on the results of the analysis and classification of the waste.

9.4 *FINAL SHAPING*

- Make sure all dangerous excavations are safe by backfilling and grading as required.
- In general, no slopes steeper than 1(V):3(H) are permitted, unless otherwise specified by the Environmental Manager, in consultation with the Engineer. Steeper slopes require protection.
- Programme the backfill of excavations so that subsoil is deposited first, followed by the topsoil. Compact in layers for best results.
- Additional fill may only be imported from approved borrow areas as indicated by the Environmental Manager.
- Monitor backfilled areas for subsidence (as the backfill settles) and fill depressions using available material.
- Shape all disturbed areas to blend in with the surrounding landscape.
- Ensure that no excavated material or stockpiles are left on site and that all material remaining after backfill is removed to a dedicated spoil area.

9.5 *TOPSOIL REPLACEMENT AND SOIL AMELIORATION*

- The principle of "progressive reinstatement" must be followed as determined by the EM and Contractor. This includes the reinstatement of disturbed areas on an on-going basis, immediately after the specified construction activities for that area are concluded.
- Execute top soiling activity prior to the rainy season or any expected wet weather conditions.
- Execute topsoil placement concurrently with construction where possible and as agreed by the Environmental Manager.
- Redistribute stockpiled topsoil. Replace herbaceous vegetation and reinstate grass in all areas cleared by the Contractor for the construction site, including temporary access routes and roads. Replace topsoil to the original depth.
- Place topsoil in the same area from where it was stripped. If there is insufficient topsoil available from a particular soil zone to produce the minimum specified depth, topsoil of similar quality may be brought from other areas of similar quality. Ensure that the soil brought in undergoes both physical and chemical tests and is to the satisfaction of the Landowner and Environmental Manager.
- The suitability of substitute material will be determined by means of a soil analysis addressing soil fraction, fertility, pH and drainage.
- Topsoil suspected to be contaminated with the seed of weeds must be sprayed with specified herbicides.
- Herbicides should be for selective broad-leafed weeds as approved by the Environmental Manager.
- Ensure that storm water run-off is not channelled parallel to the prevailing contours.
- After topsoil placement is complete, spread available stripped vegetation randomly by hand over the top-soiled area.

9.6 *RIPPING AND SCARIFYING*

- Rip and/or scarify all areas following the application of topsoil to facilitate mixing of the upper most layers. Whether ripping and/or scarifying is necessary will be based on the site conditions immediately before these works begin.
- All soil to be rehabilitated shall be ripped with a mechanical ripper to a depth of 300mm or as agreed by the Environmental Manager. No section of ground shall remain undisturbed after ripping.
- Rip and/or scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works.

- Rip and/or scarify along the contour to prevent the creation of down-slope channels.
- Do not rip and/or scarify areas under wet conditions, as the soil will not break up.

9.7 *PLANTING*

9.7.1 Transplanted plants

- All planting work is to be undertaken by suitably experienced personnel, making use of the appropriate equipment.
- Trees to be transplanted must be carefully removed from the soil so as to retain as large a root ball as practically possible. Use the tree's driplines as an indicator: the larger the tree the larger the root ball (and subsequently the planting hole).
- Minimise disturbance of the soil and the remaining roots in the root ball during the lifting, moving and or transportation of all species.
- Plant trees and shrubs so that their stems or trunks are at the same depth as in their original position.
- Orientate trees and shrubs in the same direction as in their original position.
- Plant aloes and bulbs in similar soil conditions and to the same depth as in their original position.
- The plant must be planted into the specified hole size with the approved soil, compost and fertiliser mix used to refill the plant hole and must cover all the roots and be well firmed down to a level equal to that of the surrounding in situ material, as per the rehabilitation specification.
- After planting, each plant must be well watered, adding more soil upon settlement if necessary.
- Place branches / brush packing on rehabilitated and seeded areas to protect new growth from grazing animals. This will also ensure the establishment of a seed bank.

9.8 *GRASSING*

- Suitably trained personnel must undertake grassing by making use of the appropriate equipment and using grass species as specified by the Environmental Manager pending availability.
- Trim areas to be grassed to the required level.
- Hydroseeding with a winter mix will only be specified where re-grassing is urgent, and cannot wait for the summer.

- Depending on soil texture and slope stability, it may be necessary to establish a temporary (annual) grass cover consisting of artificial composition to aid soil binding.

9.9 *MAINTENANCE*

- The Environmental Manager will monitor the re-growth of invasive vegetative material for one year.
- Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers (or other approved method). If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access.
- Re-vegetation must match the vegetation type, which previously existed.
- Base the new carrying capacity of rehabilitated land on the status quo rather than the regional estimate.
- Control invasive plant species and weeds by means of extraction, cutting or other approved methods before the plants flower and form seeds.
- For planted areas that have failed to establish, replace plants with the same species as originally specified.
- A minimum grass cover of 80% of the planted area sown, hydro-seeded or planted shall be covered with live plants of the specified species measured as basal cover, and that there shall not be any bare patches larger than 500 mm maximum in diameter.
- Individual plants must be strong and healthy growers at the end of the Defects Notification Period.
- The entire process of rehabilitation shall be meticulously documented so that the methods used on a specific part of the alignment can be replicated on other parts or even other future projects.

9.10 *ERADICATION OF WEEDS*

All weeds spread over the entire disturbed construction footprint must be removed prior to the plants flowering and forming seeds, irrespective of its existence prior to construction. Chemical removal shall be used in accordance with manufacturer's specification for weeds. All chemicals used must be approved by the ECO. Once the weeds have perished, they shall be removed mechanically by use of an offset disk plough thereby digging up the vegetation including the root ball.

9.11 *CONTROL OF WEEDS*

The remainder of the site including the re-vegetated areas shall be kept free of all weeds.

It is important that the entire process of rehabilitation shall be meticulously documented so that the methods used on a specific part of the alignment can be replicated (if necessary) on others parts or even other future projects.

10. MANAGEMENT AND MITIGATION PLANS

The management of environmental issues during the construction phase are dealt with through specific management and mitigation plans for each identified environmental component that requires management and mitigation.

The specific and detailed management and mitigation plans for construction follow as separate chapters.

11. ESTABLISHMENT OF CONSTRUCTION LAY DOWN AREA

11.1 *PURPOSE*

This activity includes the establishment of the site camp which includes, but is not limited to the site offices, ablutions, dedicated eating areas, material storage areas, and waste collection areas for the period that construction is to be undertaken.

During the construction phase one construction site / lay down area will be established.

The purpose of this management and mitigation plan defines the establishment and management of the construction site during the construction phase to prevent or minimise environmental impacts these might cause.

11.2 *OBJECTIVE*

The objectives are to:

- Minimise impacts associated with the establishment and operation of construction site lay down area.
- Ensure access to the construction laydown area is properly controlled.
- Ensure that the handling and disposal of contaminated water is done within the framework of applicable legislation.
- Ensure that water washing and toilet facilities are supplied complying to norms and standards.
- Ensure that the potential for communicable diseases to increase, as a result of the project, is managed and mitigated effectively.
- Ensure that hazardous materials storage is effective and compliant to norms and standards.
- Ensure that vehicle, plant and equipment refuelling is practiced in such a manner that no secondary pollution or emergency situation is created.
- Ensure that lighting pollution is controlled at construction sites ensuring that neighbours are not negatively affected.

11.3 *TARGETS*

- No complaints regarding the construction camp from residents.
- No unauthorised access to the construction laydown area.
- No discharge of polluting elements to any stormwater drain, stream or river.

- Sufficient ablution facilities supplied at all construction sites.
- Percentage of medical examinations of all construction workers by the Contractor.
- No construction workers to stay on site.
- Hazardous substances storage shall comply with regulatory requirements at all times.
- Storage of flammable material shall be done according to prescribed standards at all times.
- Refuelling of vehicles, plant and equipment shall be done according to prescribed standards at all times.
- No complaints regarding lighting impacts on neighbours, residents, visitors and staff.
- No runoff shall be allowed from any wash facility.

11.4 *MANAGEMENT AND MITIGATION PLAN*

Establishment of construction sites

- A plan showing the construction layout, including the positions of all buildings, fuel storage areas and other infrastructure should be prepared. The plan should detail all pollution control measures. The site has to be demarcated by means of a security fence.
- Access to the site should be limited to authorised persons and should be security controlled. Identification cards should be issued to all workers and visitors to site.
- The placement of buildings and equipment should be done to minimise the footprint and visual impact of the sites.
- Downlighting should be used and it should be ensured that lighting on site does not interfere with road traffic or cause a reasonably avoidable disturbance to the surrounding hotel guests, staff or other users of the area.
- Vehicles, plant and equipment should be subject to prestart checks and regular maintenance to identify and remedy fuel and oil leaks.
- Workers should be instructed not to dispose of cigarette butts.

Demarcation and access control

- The construction site should be properly identified and demarcated.
- The materials and soil stockpile areas, fuels and chemical storage areas, and concrete mixing areas must be selected to ensure that they are located away from environmentally sensitive areas and protected from stormwater runoff, fire and access by unauthorised persons.
- The access roads, temporary loading and packing areas and turning circles should be clearly indicated on a drawing.

Handling and disposal of contaminated water

- No discharge of pollutants such as cement, concrete, chemicals, fuels or oils should be allowed into any water resource.
- The areas around fuel tanks should be bunded in accordance with SANS 1089:1999: Part 1.
- Only above ground temporary storage tanks should be allowed on site.
- Contaminated or potentially contaminated water should be kept separated from unpolluted stormwater.
- No wash areas should be erected.

Water washing, toilets and sewage

- Ablution facilities provided should include shelter, toilets and hand washing facilities.
- Toilets should be provided at the preferred ratio of 1 toilet per 15 workers, and should be shown on a lay down drawing.
- Sanitation facilities shall be located within 100m of any point of work, but not closer than 50m from any water body.
- All temporary/portable toilets should be secured to the ground to prevent them toppling due to wind or any other cause.
- Entrances to toilets should be adequately screened from public view.
- Ablution facilities provided should be maintained in a hygienic state and serviced regularly to ensure proper operation.
- Toilet paper should be supplied at ablutions.
- No spillage shall be allowed when the toilets are cleaned or serviced.
- The contents of chemical toilets should be removed to an approved disposal site.
- The toilets should be serviced and cleaned on the last construction day before the builder's holiday.

Communicable diseases

- No accommodation at the construction site should be allowed. Workers should not be allowed to stay overnight in the construction site.
- Access control through appropriate fences and 24 hour gate control should be enforced.
- Ongoing training should be provided regarding communicable diseases.
- No alcoholic beverages should be allowed onsite.

Hazardous materials storage

- Materials storage areas should not be allowed in close proximity to ecologically and archaeological sensitive areas.
- Materials storage areas should be sited outside the 1:50 year flood line of watercourses.
- Hazardous chemicals or potentially hazardous chemicals used during construction should be stored in secondary containers and all relevant Material Safety Data Sheets (MSDSs) should be available on site.
- The relevant emergency procedures relevant to particular chemicals used on site, as per the MSDSs and suppliers guidelines, should be followed in the event of an emergency.

Vehicle, Plant and equipment re-fuelling

- All liquid fuels and oils should be stored in suitable above ground storage tanks or in tanks with lids, which should be kept firmly shut and under lock and key at all times.
- Above ground fuel tanks should be at least 3,5 m from buildings, boundaries and any other combustible or flammable materials.
- Empty but externally dirty tanks should be sealed and stored where the ground has been protected.
- Any electrical or petrol-driven pumps should be equipped with a drip tray and positioned so as not to cause any danger of ignition of the product.
- Fuel dispensed from 210 l drums should be done with proper dispensing equipment to minimise spill potential.
- Under no circumstances should drums be tipped to dispense fuel.
- The siting of the installation should be done within the following guidelines:
    - The fall of ground in relation to residential areas and other risk areas that could be exposed in the event of accidental large scale spillages.
    - Access to facilities to and around the site.
    - Drainage systems.
    - Available water supplies.
    - Fire protection, security, and general service facilities in the area, including the fire services response time.
    - Population densities around the premises.
    - Good housekeeping e.g. the removal of flammable materials such as rubbish, dry vegetation and oil soaked soil.
- Bunding at these facilities should comply to the following guidelines:
    - A slope of at least 1:100 away from the tank is provided for at least 15m.
    - The volumetric capacity of the bunded area is a minimum of 110% of the volume of the largest tank.

- The wall of the bunded area is of concrete, and has been designed to be liquid tight and to withstand a full hydrostatic head of water.
- The wall height of the bunded area has been restricted to 1.8m.

Lighting

- Working hours should generally be restricted to daylight hours.
- If working hours are required outside of daylight hours, notification should be provided to relevant neighbours.
- Security lights are directed from the perimeter wall towards the centre of the camp with a down angle.

Materials / Goods on site

- The store man should be responsible for stacking and storage of material.
- Bricks, sandstone blocks, building sand, plaster sand and stone will be stored "open" on site but with special care that materials are not contaminated i.e. that different types of sand are not mixed.
- Cement should be stored in a lockable and water proof container and should be stacked not more than 13 bags high. Cement should be used, as far as possible, on a first-in first-out basis.
- Reinforcing bars should be stored in the open but should be placed on timber poles to avoid "contamination" by mud or soil.
- Paint will be stored in a ventilated lockable store.

11.5 *MONITORING & REPORTING*

Daily inspections should be carried out by the EO and record findings on a weekly checklist. Monthly audits will be undertaken by the ECO and a monthly audit report prepared.

12. EROSION CONTROL

12.1 *PURPOSE*

The purpose of this management and mitigation plan is to ensure that erosion is minimized that could occur as a result of construction activities.

12.2 *OBJECTIVE*

The objective is to avoid soil erosion of areas within and downstream of the construction activities.

12.3 *TARGETS*

- No formation of small erosion channels and sheet erosion.
- No flooding as a result of stormwater control measures.
- No erosion as a result of stormwater control measures.
- No silt pollution as a result of flooding and/ or stormwater control measures.

12.4 *MANAGEMENT AND MITIGATION PLAN*

Identified areas where erosion could occur should be appropriately protected by installing the necessary temporary and/or permanent drainage works as soon as possible and by taking other appropriate measures to prevent water from being concentrated in rivers/streams and from scouring slopes, banks or other areas.

Any erosion channels which develop during the construction period should be suitably backfilled, compacted and restored to a proper condition (i.e. vegetated etc.).

Where excavation takes place, the affected area should be properly stabilised and revegetated to minimise erosion risk.

Stormwater control measures should consider and provide for the following:

- Use of siltscreens.
- Use of straw bales as filters, which are placed across the flow of overland stormwater flows.
- Channelling stormwater run-off through natural grassland buffer areas.
- Silting of stormwater pipes in adjoining developments as a result of run-off from the project area will not be allowed.

- Gabions or stormwater control structures should be used to disperse stormwater flows and/or prevent and control erosion where necessary.
- All erosion protection measures should be maintained on a continual basis
- Corrective actions should be taken as and when required to stop any signs of erosion.
- Regular inspections by competent personnel should be undertaken at especially:
  - inlet and outlet points of drainage structures
  - stormwater release points, and
  - along sections where drainage structures are laid on steep slopes.
- Where possible, stormwater should be released in grassy areas which act as a natural filter and to reduce the erosion potential of the water.
- The stabilization of headcuts during the construction phase to prevent erosion and sedimentation should be undertaken through various methods to limit or eliminate erosion and sedimentation i.e. gabions, rock packing, vegetation establishment, bales and poles, and vegetation sausages.

12.5 *MONITORING & REPORTING*

Weekly visual inspections of erosion sensitive areas and daily inspections after rainfall events will be undertaken. Recording and reporting will be through inspections notes and monthly monitoring report.

13. WETLAND MANAGEMENT

13.1 *PURPOSE*

The purpose of this management and mitigation plan is to ensure that the identified sensitive wetlands are protected through the implementation of active mitigation measures.

13.2 *OBJECTIVE*

The objective is to avoid wetland degradation as a result of construction activities.

13.3 *TARGETS*

- Effective stormwater management during the construction phase.
- Effective rehabilitation of the construction footprint.
- Achieve the recommended ecological Category C, within one season after construction has been completed.

13.4 *MANAGEMENT AND MITIGATION PLAN*

The Hydrogeomorphic wetlands were identified, namely a channelled valley bottom wetland and two hill slope seepage wetlands. The overall wetland was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred, however some of the natural habitat remains intact to some extent. Therefore, the Present Ecological Status is a Category D.

The overall wetland is considered to be ecologically important and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. The ecological importance and sensitivity for this system is thus considered to be moderate.

Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. The recommended ecological category is therefore set at Category C.

13.5 *MONITORING & REPORTING*

The following monitoring and reporting requirements must be implemented:

- Water quality monitoring during the construction phase as required by the General Authorisations.
- Quarterly wetland monitoring after the completion of all construction activities by a qualified and registered professional.

14. FLORA AND FAUNA MANAGEMENT

14.1 *PURPOSE*

The purpose of this management and mitigation plan is to ensure vegetation clearing is undertaken in such a manner that protected species as detailed in this report are rescued or protected.

14.2 *OBJECTIVE*

- To ensure that the existing roads will be used to access the project area.
- To ensure that the impact to habitat is restricted only to the footprint area and that protected plant and fauna species are not affected through construction and weed invasion does not take place as a result of development.
- To successfully rescue or protect species of conservation value.
- To revegetate disturbed areas after construction, inclusive of construction areas, temporary accesses, stockpile areas, and construction camps.
- The objective of management measures is to ensure that littering does not take place and faunal disturbance is kept to a minimum.
- To ensure that no bird collisions take place.

14.3 *TARGETS*

- All protected plant species rescued.
- No evidence of erosion.
- No invasive species in areas that have been disturbed by construction activities.
- No bird collisions with pylons.

14.4 *MANAGEMENT AND MITIGATION PLAN*

- The footprint area should be kept as small as possible and therefore no additional areas will be cleared except for the immediate work areas.
- An Alien Invasive Plant Species (AIPs) Management Plan should be implemented, whereby the disturbed site is monitored quarterly for at least two years to ensure that AIPs does not take place.
- As seedlings emerge, they will be removed bi-annually as part of an AIPs Management Plan.

- Rehabilitation of the disturbed area should take place after construction, whereby a mixture of native grass species harvested from climax *Themeda* grassland and native grass species (such as *Cynodon dactylon*) are planted immediately to prevent erosion.
- Signage should be erected to indicate any expected plant and animal species, and that no disturbance of these are allowed.

14.5 *MONITORING & REPORTING*

Wherever rehabilitation is required, a detailed record will be kept of the land area that has been rehabilitated compared to the land area still to be rehabilitated. Photographic or video records should also be used to supplement this information.

The percentage rehabilitation completed will be recorded for the construction site and reported on a weekly basis.

After a slope has been vegetated it will be inspected daily for the first week. Thereafter visual inspections will be undertaken once per week until the slope is deemed to be well enough vegetated to ensure further slope stability. Specific reports on erosion or slumping and sliding will be investigated on a case by case basis, the condition of the slope recorded together with the remedial action implemented.

AIP monitoring and implementation of control/ eradication measures should take place. Monitoring, eradication and control should be initiated after constructed and should take place annually for two years to ensure that AIPs area completely removed.

Signage will be erected to indicate an expected plant and animal species, and that no disturbance of these will be allowed.

15. AIR QUALITY MANAGEMENT

15.1 *PURPOSE*

The earthworks proposed during the construction phase have the potential to create a short-term dust nuisance unless properly managed. This may impact surrounding residents, construction workers and nearby vegetation. Dust may be generated from the following activities:

- earthworks associated with the development
- spillage or storage of soil and other materials
- vehicle movements along paved and unpaved roads

The impact of dust is likely to cause problems such as unpleasant visual amenity, dust on washing and dust entering houses. A potential exists for a public health impact if elevated levels persist in residential areas, however this is unlikely due to the stage nature of the project. Potential impacts on workers health and amenity will be addressed through induction and the issue of personal protective equipment.

15.2 *OBJECTIVE*

To ensure that dust emissions from construction activities do not result in adverse health or other negative effects.

15.3 *TARGETS*

- Dust fallout values shall conform to the relevant values of levels of nuisance dust against the National Environmental Management: Air Quality Act (NEMAQA) National Dust Control Regulations (GNR 827) on the boundary of the residential areas adjacent to the construction site
- Dust from construction sites not to exceed 600mg/m^2/day
- No complaints regarding dust.

15.4 *METHOD STATEMENT*

Areas susceptible to dust generation include re-vegetated areas and areas in need of rehabilitation. Vegetation cover must preferably be maintained e.g. removal of vegetation should be avoided until such time as soil stripping is required. Excavation, handling and transport of erodible materials should be avoided during periods of excessive wind. Location and management of stockpiles is of importance.

Dust control measures from traffic and other construction activities:

- Dust generation as a result of construction activities will be minimised through all reasonable measures.
- Removal of vegetation will be avoided until actual topsoil stripping is required.
- Excavation handling and transport of erodible materials will be avoided under high wind conditions or when a visible dust plume is present.
- Soil stockpiles will as far as possible be located in sheltered areas where they will not be exposed to erosive winds.
- Appropriate dust-suppression techniques will be implemented where dust generation is unavoidable through wet suppression.
- Strict measures will apply where materials in powder form, such as cement, concrete additives, etc. are stored, handled or used, and for the proper disposal of packaging of any such materials.
- In excessive windy conditions, the dust generating activities will be stopped until wind speed drops to an acceptable level.
- All exposed surfaces will be stabilised, resurfaced or re-vegetated as soon as is practically possible.

15.5 *MONITORING & REPORTING*

Daily visual observations of dust and nuisance levels. Recording and reporting will be through inspections notes and monthly monitoring report.

16. GENERAL SOLID & HAZARDOUS WASTE MANAGEMENT

16.1 *PURPOSE*

The inappropriate handling and disposal of solid waste materials can impact on both human safety and risk contamination of the natural environment. Two waste stream categories will be generated during the construction phase. These are hazardous waste and general waste. The purpose of this method statement is to manage these waste streams such that all potential negative impacts are prevented.

General waste would typically include building rubble generated during site clearance, vegetation, waste steel, wire and electrical cable off-cuts, waste wood and waste concrete.

Hazardous wastes typically include sanitary waste and used oil, oil rags, empty oil and grease containers, paint containers, degreasers, bitumen, herbicides, resins and curing agents.

16.2 *OBJECTIVE*

The objective is to avoid or minimize negative impacts on surrounding environment (soil, surface and groundwater) resulting from inappropriate waste disposal.

16.3 *TARGETS*

- Waste recycled and or reused shall be 10% of all waste generated.
- No littering on construction sites.
- Adequate containers are supplied and are easily accessible.
- Waste bins are removed and cleaned daily by the responsible Contractor.

16.4 *METHOD STATEMENT*

- Disposal instructions will be obtained from the supplier of pollutants or hazardous substances.
- An approved waste disposal company will be contracted to remove and dispose of hazardous substances. A certificate of safe disposal will be obtained from them and kept on record.
- No maintenance of vehicles will take place onsite. If used oil accumulates onsite these will be fetched by a company who recycle the oil e.g. Oilkol. Used oil will be stored in an enclosed area. The storage area will have an impervious surface to prevent oil contamination.

- Old containers of paint, oil, thinners, acids, poisons etc., will be disposed as per clients waste disposal procedures.
- Construction workers will be trained and informed about waste minimisation. The person dealing or who may potentially be exposed to hazardous chemical substances will be provided with a well-defined list of duties.
- Where feasible, waste materials will be recycled and the following will apply:
  - Glass, papers and cardboard, metals (other than aluminium), aluminium, organic waste and plastic could be recycled and will be separated into different containers at the construction site.
  - These containers will be suitably marked and stored in a covered and enclosed area to protect it from the elements and scavengers.
  - Recycling will be done by staff wearing suitable PPE such as gloves and dust masks.
  - Clear signs and separation areas for waste material will be provided.
- Appropriate records will be kept of volumes of hazardous chemical substances generated and disposed. These will include safe disposal certificates.
- Littering will not be allowed on site or at the laydown camp.
- Adequate containers or bins for litter removal will be supplied on site.
- The containers or bins will be emptied on a regular basis as required.
- Bins or containers used at the construction areas will be waterproof.
- Waste collected from these bins and containers will then be stored on site in a larger, scavenger proof and waterproof container for later disposal - disposal will be done at least once a week at the closest appropriate waste disposal site - records of proper disposal will be kept.
- If required, chicken runs will be conducted on site and at the camps to keep it litter free. This will be done at least once a week but as often as required to ensure a litter-free site.
- Care will be taken not to dispose of hazardous materials with the domestic waste - hazardous materials will be disposed of at a hazardous waste disposal site.
- Where waste is to be transported by truck, it will be covered and labelled appropriately

16.5 *MONITORING & REPORTING*

A register will be kept of all quantities of non-aqueous waste that is generated and removed for disposal from all the construction sites. The waste will be characterized as follows:

- Domestic/general waste.
- Building rubble.
- Waste timber.
- Scrap metal.

- Hazardous chemical substances.

The disposal of these different waste types will also be recorded and tracked with waste disposal certificates.

17. TRAFFIC MANAGEMENT

17.1 *PURPOSE*

The management of traffic will be essential during the construction phase and will require specific mitigation measures as described below to ensure that the impact on residents, businesses and road users are kept to a minimum.

17.2 *OBJECTIVE*

- To ensure that traffic impacts as a result of construction activities are minimised.
- To ensure that pedestrians are accommodated safely at all times where existing pedestrian walkways are affected by the construction activities.
- To use existing road infrastructure to access construction sites.

17.3 *TARGETS*

- No construction vehicles exceeding defined speed limits.
- No fines for construction vehicles committing traffic offences.
- No construction vehicles on the roads during peak traffic times.
- No replacement walkways for pedestrians that are directly exposed to vehicle movements.
- Use of existing roads must be maximised.
- Cleaning of public roads used for construction vehicles access twice a week.

17.4 *METHOD STATEMENT*

- A speed limit of 30 km/h for heavy vehicles; and 50 km/h for other construction vehicles will be strictly enforced. On public roads the specified speed limit would be applicable.
- Where possible, construction traffic should be scheduled in off-peak traffic times.
- Appropriate traffic safety signage should be provided to warn the public of construction traffic and flagmen will be on duty where traffic merges with normal road traffic.
- Regular route monitoring on all routes utilised by construction traffic will be done by construction foreman to ensure that any material that has fallen from construction vehicles be removed immediately to prevent traffic congestion and safety hazards.
- Construction vehicles shall be limited on any road in the vicinity between 7:00 to 18:00, Monday to Friday.
- Existing sidewalks should be used as walkways as far as possible. Where existing sidewalks are affected, alternate pedestrian walkways will be provided.
- Pedestrians should not be allowed to cross construction areas.

- Construction of temporary access roads will be minimised. Roads used will be cleared regularly of any dust and mud resulting from the use by construction vehicles. Dust and noise will be minimised and accident risk reduced by strict monitoring of speed limits.
- All gravel access roads will be watered regularly to control dust pollution.

17.5 *MONITORING & REPORTING*

Random checks will be done on the routes that construction vehicles follow to ensure that these vehicles only drive on the agreed roads. This should be done by following a vehicle from the construction site to its destination and vice-versa.

The routes followed must be checked at least once a month for all construction sites. The registration plate of truck, route followed and time and day will be recorded.

APPENDIX A: CURRICULUM VITAE OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

Name of firm: **MDT Environmental (Pty) Ltd**

Name of Staff: **Deon Esterhuizen**

Profession: Environmental Scientist

Date of Birth: 6 June 1968

Nationality: South African

Professional Natural Scientist (RN: 400154/09)

Membership in Professional Societies:

Registered with the South African Council for Natural Scientific Professions: Professional Natural Scientist - Environmental Science (RN: 400154/09).

Member of the International Association for Impact Assessors South Africa.

Member of the Groundwater Division of South Africa.

KEY QUALIFICATIONS:

Deon has a MSc in Environmental Ecology with 27 years of experience in water related projects, which include water resource management, water quality management, water use registration and licencing of water users, including project management of multi-disciplinary studies. He also has extensive experience in a wide-range of environmentally related projects, processes and applications for private, commercial and industrial clients, in addition to local, provincial and national government departments.

He has gained experience through his involvement in a number of water resources related projects, including ensuring the protection, development, conservation, management, use and control of the water resources in the Gauteng Region's area of responsibility in a sustainable manner as well as co-ordinating the management of the quality of the water resources of a specific catchment on an ongoing basis to achieve water resource objectives during his employment at the Department of Water and Sanitation. Specific focus areas included:

- Catchment Management Strategies & Plans
- Water Quality Management Plans
- Registration and Licensing of water users
- Assessing water requirements for basic human needs and riverine ecology
- Determining stream-flow assimilative capacity for pollution loads
- Water quality guidelines
- Industrial wastewater treatment and disposal

He has gained experience through environmental related projects as a consultant at ILISO Consulting (Pty) Ltd and BKS (Pty) Ltd in the fields listed below:

- Integrated Environmental Management (IEM) in general
- Environmental Impact Assessments (EIAs)
- Environmental Management Plans (EMPs)
- Environmental monitoring and auditing

He has been the project leader and coordinator on a number of large, strategically important and multi-disciplinary projects for various clients, including international (Africa) projects as well as fulfilling the role of an external reviewer for the Department of Water and Sanitation as well as other consulting firms.

He has gained operational knowledge and experience of applying the IFC Social and Environmental Performance Standards, specifically on the Olifants Water Resources Development Project. He developed and implemented environmental and social mitigation and management plans that have been approved by the relevant environmental authorities.

EDUCATION:

M.Sc (Environmental Ecology) University of Pretoria 2003
B.Sc (Honours), Rand Afrikaans University 1991
B.Sc (Botany & Zoology), Rand Afrikaans University 1990

ADDITONAL COURSES:

Environmental Water Quality Monitoring 2011
River hydraulics, stormwater & flood management, Stellenbosch University 2009
Environmental Risk and Impact Assessment, Rhodes University 2006
Reserve Determinations and Procedures, DWAF 2000
Project Management, Compu-Tutor 2000

EXPERIENCE RECORD:
ILISO Consulting (Pty) Ltd
August 2005 to present
Technical Director.

- Environmental and Social Lead of the Olifants River Water Resources Development Project - Sub-Phases 2C. Responsible and accountable for the management of all environmental and social related tasks performed by two Environmental Monitors, two Social Monitors, and a Land Acquisition Team. This team was responsible to ensure that the Contractor executes the project within the guidelines of legislation, the environmental authorisation, the environmental management plan, and project specifications. Trans Caledon Tunnel Authority. January 2011 - Current.

- Environmental and Social Lead of the Olifants River Water Resources Development Project - Sub-Phases 2B, C, D, E, & F. Responsible and accountable for the management of all environmental, social and land acquisition tasks and reports directly to the Project Manager / Engineer. Numerous design related activities were completed, including the development of project environmental compliance specifications, environmental management system, stakeholder relations strategy, and resettlement action plan. Trans Caledon Tunnel Authority. December 2009 - Current.
- Compilation of an application for exemption from minimum emission standards and extension of the minimum emission standard timeframes for Eskom's Power Stations, including supporting studies. Eskom (Pty) Ltd. Preparation of the surface water specialist report. 2013 - 2014.
- Application for the rectification in terms of section 24G for the unlawful construction of facilities and infrastructure for the return of service of the Eskom Komati Power Station. 2012.
- Application for the rectification in terms of section 24G for the unlawful construction of facilities and infrastructure for the Eskom Kusile Power Station. 2012.
- Application for an integrated environmental authorisation and waste management licence in terms of the National Environmental Management Act and the Waste Act for activities on the Eskom Kusile Power Station construction site. 2012 - current.
- Mafutha Environmental Impact Assessment for Sasol (Pty) Ltd. Responsible for the Surface water specialist study and water balance development. June 2010 - June 2011.
- Feasibility study for the construction of bridges linking Okahandja to Ovitoto communal area. Ministry of Works and Transport. Undertake an environmental screening in terms of the Environmental Management Act (2007) (EMA) that was promulgated in December 2007. 2010.
- Design and construction of Botsabelo Complex - Lesotho blood transfusion services centre, National Reference Laboratory, student accommodation at the National Health Training College. The Government of the Kingdom of Lesotho Millenium Challenge Account. Development of an Environmental Protection Plan for implementation during construction. The development of method statements for key environmental construction activities. 2010.
- Stormwater Audit at Namibian Custom Smelters in Tsumeb, Namibia. Namibian Custom Smelters (Pty) Ltd. 2012.
- Braamhoek Integrated Water Use Licence Application: Peer review of the draft Integrated Water Use Licence application for the proposed Braamhoek Pump Storage Scheme. 2005.
- Integrated Stormwater Management: Boepenspruit: Environmental Impact Assessment - Scoping for a record of decision application in terms of the Environmental Conservation Act. 2005.
- Gautrain Rapid Rail Link: Part of the ISAA Joint Venture compiling the Initial Works Environmental Management Plan and Draft Final Environmental Management Plan as required by the Record of Decision issued by the Gauteng Department of Agriculture, Conservation and Environment. 2005.
- Gautrain Rapid Rail Link: Preparing the surface water specialist report in support of the variant alignment environmental impact assessment study. 2006
- Department of Water Affairs & Forestry: Mpumalanga Region. Task Leader of a multi disciplinary team to assist the Mpumalanga Regional Office: Water Quality Management with line function work. 2006.
- Gauteng Region Office Technical and Administrative Support project. Project Manager of a multi disciplinary team to assist the DWAF Gauteng Regional Office with specific technical tasks. 2006 – 2009.
- Task Leader for preparing the Water Use Licence application for the Tshwane Metro Zeekoegat Waste Water Treatment Works. 2007 – 2010.
- Environmental specialist for a 42 month construction period of the Thune Dam in Botswana. 2007 –

current.

- Preparation of an Environmental Management Plan for the Groot Letaba proposed storage dam. Department of Water Affairs and Forestry. 2007 – 2009.
- Project Manager of a multi disciplinary team to develop a National Groundwater Strategy for the Department of Water Affairs and Forestry. 2007 – 2010.
- Preparation of the surface water specialist report for the proposed Nelspruit Ring Road. 2007.
- Preparation of the surface water specialist report for the proposed expansion of ArcelorMittal in New Castle. 2008.

BKS (Pty) Ltd, Pretoria
January 2000 to July 2005
Director.

- Olifants River Catchment Ecological Water Requirement Assessment (Mpumalanga): Determination of the ecological reserve of the river (Management Consultant) Responsible for project co-ordination and administration. 2000-2002.
- Olifants / Doring River Rapid Reserve Assessment (Western Cape): Conducting a rapid reserve assessment of three sites in the Olifants and Doring Rivers for the provincial Department of Agriculture in the Western Cape. 2000-2002.
- Olifants / Doring River Basin Study (Western Cape): Determination of the ecological reserve of the river (Management Consultant) Responsible for project co-ordination and administration. 2000-2002.
- Assessment of Domestic Water Supplies, Volume 5: Management Guide. Development of a management guide, which forms part of a series, which is intended to provide water supply agencies, water resource managers, workers in health related fields, as well as communities throughout South Africa with guidance on domestic water quality with regard to planning a new domestic water supply scheme, implementation of a domestic supply scheme, and the management of an exiting domestic supply scheme. 2001-2002.
- DWAF, RDM-Office structure. Preparation of a strategy and plan to determine the Ecological Reserve for each significant resource, within the constraints of human and financial resources. Two components were developed namely, a structure / framework for the RDM-Office and the implementation of a control auditing system.
- Nylstroom Municipality Waste Water Treatment Plant. Licence application. Evaluation of the licence application in terms of the National Water Act. 2001.
- Thaba Chweu Municipality Waste Water Treatment Plant Licence application in terms of the National Water Act. 2002.
- Olifants River (Mpumalanga). Assisting the DWAF with the registration of all water uses in the catchment. 2001-2002.
- Leboeng Community Safety Centre. Registration of the waste water treatment facility in terms of the National Water Act. 2001.
- Mhlathuze Water. The completion of a licence application in terms of the National Water Act for two sea outfall pipelines into the Indian ocean. 2001-2002.
- Lower Spekboom Irrigation Board. Motivation on behalf of the Board to the DWAF requesting funds from their reserve fund for the rehabilitation of their canal system. 2002.
- Modder and Riet Rivers Catchment. Development of a Catchment Management Strategy and

determination of an intermediate ecological Reserve. 2002-current.

- Water Quality Performance Assessment System. Development and implementation of a water quality performance assessment system for the DWAF Water Quality Management Directorate and the Gauteng Regional Office: Upper Vaal Water Management Area. 2002-current.
- Rietfontein WwTW (Madibeng Local Authority) Waste Water Treatment Plant Licence application in terms of the National Water Act. 2003.
- Rietfontein WwTW (Madibeng Local Authority) Waste Water Treatment Plant Environmental Impact Assessment - Scoping for a record of decision application in terms of the Environmental Conservation Act. 2003.
- Da Gama Textiles Licence application in terms of the National Water Act. 2003.
- De Beers Kimberley Mines. The redrafting of the De Beers Kimberley Mines EMPR to consolidate all the relevant information into one document, to align the mine activities and EMPR with new anticipated legal requirements, and to align the EMPR to the Kimberley Mines Environmental Management System. 2003.
- Department of Water Affairs & Forestry. Project Manager of a project to develop a Water Quality Management Plan for the Waterval River catchment, DWAF Gauteng Regional Office. 2003.
- Department of Water Affairs & Forestry. Project Manager of a multi disciplinary team to assist the Gauteng Regional Office: Water Quality Management with line function work. 2003.
- ERPM Gold Mine Water Management Plan development and licence application in terms of the National Water Act. 2003.
- Olifants River Water Resources Development Project. Task Leader to assist the project co-ordinator on the management of the environmental and public participation tasks within this multi-disciplinary project. 2004
- Republic of Botswana. Ministry of Minerals, Energy and Water Affairs: Department of Water Affairs. EIA study in respect of detailed design of Lower Shashe Dam. Final EIA report. Review of issues identified and addressed in EIA report. 2004
- East-West highway Jamahiriya toll road feasibility study. Libya. Environmental Impact Assessment. 2005.

Department of Water Affairs and Forestry, Pretoria
1991 to 1999
Assistant Director.

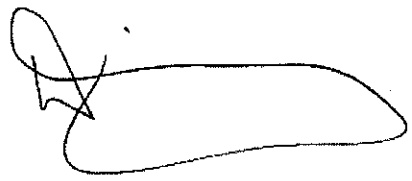
- He was responsible for the management in an integrated manner all water resource related issues within the Mooi River, Taai and Leeu Spruit, Vaal Barrage and Liebenbergsvlei catchments. With his knowledge gained throughout the years he lectured all new Water Quality Managers appointed at the DWAF during the internally developed orientation course for water quality managers.

LANGUAGES:

	Speak	**Read**	**Write**
English	Excellent	Excellent	Excellent
Afrikaans	Excellent	Excellent	Excellent

CERTIFICATION:

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and my experience.



Deon Esterhuizen

Aquatic Resources Assessment report

(Volume 3 of 4)

AQUATIC RESOURCES ASSESSMENT

WETLAND -PES, EIS, REC

DIATOM ANALYSIS

IN SITU WATER QUALITY

Vulindlela Bridge Maintenance & Rehabilitation

Volume 3 of 4

Report Compiled by:

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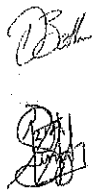
APPROVAL PAGE

Project Name	**Vulindlela Bridge Maintenance & Rehabilitation**
Report Title	Aquatic Resources Assessment
Authority Reference Number	Pending
Report Status	Final

Applicant Name	**Emalahleni Local Municipality**

	Name	Signature	Date
Document Compilation	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat.		2019/03/
Field Assessment	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat. **Mr. P. Singh** (M.Sc. Aquatic Health) Aquatic Specialist | Pr.Sci.Nat.		2019/02/19
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Document Signoff	**Mr. D. Botha** (M.A. Env.Man.) (PHED) Wetland Specialist | Pr.Sci.Nat.		2019/04/11

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Amendments on Document

Date	Report Reference Number		Description of Amendment
201/04/11	21901_AQU_D001	21901_AQU_1	Minor updates made; Report finalised

DECLARATION OF INDEPENDENCE

Specialist Name	Mr. D. Botha
Declaration of Independence	I declare, as a specialist appointed in terms of the National Environmental Management Act (Act No 108 of 1998) and the associated 2014 Environmental Impact Assessment (EIA) Regulations, that: • I act as the independent specialist in this application; • I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant; • I declare that there are no circumstances that may compromise my objectivity in performing such work; • I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity; • I will comply with the Act, Regulations and all other applicable legislation; • I have no, and will not engage in, conflicting interests in the undertaking of the activity; • I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority; • All the particulars furnished by me in this form are true and correct; and • I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.
Signature	
Date	2019/04/11

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The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and Prism Environmental Management Services and its staff reserve the right to modify aspects of the report including the recommendations if and when new information becomes available from ongoing research or further work in this field, or pertaining to this investigation.

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EXECUTIVE SUMMARY

Prism Environmental Management Services was requested by **MDT Environmental (Pty) Ltd** to undertake an aquatic resources assessment to delineate the riparian zone and wetland, conduct a diatom analysis and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the Vulindlela bridges maintenance and associated rehabilitation. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

Sasol South Africa (Pty) Ltd (Sasol) proposes to undertake maintenance activities at Vulindlela on behalf of **Emalahleni Local Municipality**. The project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd (Sasol Mining) and is part of the projects committed to in their social and labour plan. The project beneficiaries, and as such project applicants, are Emalahleni Local Municipality.

This project will entail the removal of sediment in the Saalboom / Saalklap Spruit between two existing bridge structures. Further activities will include the construction and rehabilitation of wing and side walls and the installation of sub-soil drainage pipes and coffer dams where required. The work at the bridge crossings is required to minimise sedimentation and debris accumulation of the openings and minimise soil erosion at the river beds and to improve the safety thereof. Upon conclusion, these structures should be maintainable in association with the asset management system of the Local Municipality.

The Vulindlela bridges is located at S26°0'18.03": E29°2'18.13" and S25°59'55.17": E29°1'56.67" in the Phola Township within the Emalahleni Local Municipality, Mpumalanga Province (here after referred to as the study site/s). The study site is located in quaternary catchment B20G in the Olifants Water Management Area (WMA 2). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al.*, 2005).

The field investigations concluded that two (2) natural wetland systems (*three wetland units*) could be affected by the activities. Same is draining into the Saalboom Spruit.

The following Hydrogeomorphic wetland units were identified during the site evaluation:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

The wetlands recorded were assessed and the following results were attained:

- The wetland attained a low overall PES (Present Ecological State)
    - The overall wetland system, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota have occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit
- The wetland attained a Low Ecological Importance and Sensitivity (EIS) score.
    - The overall wetland system is considered to be of moderate ecologically importance and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate.
- The wetland Recommended Ecological Classification (REC) was rated as:
    - The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:
        - Category C for the overall wetland system

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium-low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

Concluded from the results presented in this document, the construction activities will impact on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources. Hence the actioning of this remediation project.

The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the bridge construction, it is important to ensure that the required erosion protection measures linked to the crossing sections be carefully designed and installed.

The project can be supported should all the mitigation measures be implemented and monitored against.

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1 INTRODUCTION

Prism Environmental Management Services was requested by **MDT Environmental (Pty) Ltd** to undertake an aquatic resources assessment to delineate the wetland, conduct a diatom analysis and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the Vulindlela bridges maintenance and associated rehabilitation. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

1.1 Project Description

Sasol South Africa (Pty) Ltd (Sasol) proposes to undertake maintenance activities at Vulindlela on behalf of **Emalahleni Local Municipality**. The project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd (Sasol Mining) and is part of the projects committed to in their social and labour plan. The project beneficiaries, and as such project applicants, are Emalahleni Local Municipality.

This project will entail the removal of sediment in the Saalboom / Saalklap Spruit between two existing bridge structures. Further activities will include the construction and rehabilitation of wing and side walls and the installation of sub-soil drainage pipes and coffer dams where required. The work at the bridge crossings is required to minimise sedimentation and debris accumulation of the openings and minimise soil erosion at the river beds and to improve the safety thereof. Upon conclusion, these structures should be maintainable in association with the asset management system of the Local Municipality.

Siyandiza Consulting Engineers (Pty) Ltd were appointed to undertake designs for the bridge rehabilitation works. The main objective of the proposed activities is to maintain the Vulindlela Bridge crossings and various inherent objectives will be realised as part this project. The key objectives of the project are:

- To establish mechanisms that will minimise sedimentation and debris accumulation at the bridge openings;
- To rehabilitate and clean both bridges in order to improve safety status;
- To improve stormwater control measures;
- To undertake dredging methods that are well investigated to reduce impact on the ecosystem;
- Achieve functional structures, which can be maintained in association with the asset management system for the Local Municipality.

1.1.1 Study Site Location

The Vulindlela bridges (Bridge 1 and Bridge 2)are located at S26°0'18.03": E29°2'18.13" and S25°59'55.17": E29°1'56.67", respectively in the Phola Township within the Emalahleni Local Municipality, Mpumalanga

Province *(here after referred to as the study site/s)* Figure 1-1, Figure 1-2 and Figure 1-4. The study site is located in quaternary catchment B20G in the Olifants Water Management Area (WMA 2) (Figure 1-4). The study area falls within the Grassland Biome (Biome 06), the Highveld Level-1 Ecoregion (Ecoregion 11) (Kleynhans *et al.*, 2005) (Figure 1-5).

1.1.2 Alternatives

The alternatives that were investigated are alternatives for erosion control mechanisms.

After investigations and 2D modelling of various flood events routed through the compiled model of the river course way, fifteen areas were identified that were erosion prone and where severe flooding could occur during, specifically a 1 in 20-year flood event. Conceptual erosion protection measures were then designed for these locations and the model re-run to ensure the preservation and protection of the identified areas and to ensure the surrounding properties are not negatively affected during a 1 in 20-year storm event.

Three typical designs were considered as erosion protection structures and would be implemented based on space constraints and practicality.

There are three proposed typical erosion protection structures considered, namely,

(a) **Typical protection structure 1 (Riprap & vegetated berm):** Wide floodplains: Berm with 1:2.5 side slope on both sides, Riprap protection on one side face to river, riprap toe below 1:20 year flood erosion level
(b) **Typical protection structure 2 (Riprap & vertical wall):** Limited space and deep alluvial material: Concrete wall with 1:2.5 bank slope and Riprap protection on one side, riprap toe below 1:50 year flood erosion level
(c) **Typical protection structure 3 (Vertical wall):** Limited space and shallow bedrock: Concrete wall without side slope, toe below 1:50 year flood erosion level or to bedrock.

The activities that will be undertaken as part of these planned alternatives for erosion protection measures are provided in the table below..

Table 1-1: Proposed Erosion Protection Structures

(a) Typical protection structure 1 (Riprap and vegetated berm)	(b) Typical protection structure 2 (Riprap & vertical wall)	(d) Concrete stilling basin (site 2)
1. Site Clearance and establishment. 2. All necessary traffic accommodation and construction warning signage will be erected as necessary. 3. River diversion and dewatering where required. [To be avoided] 4. Surveying and setting out. 5. Removal of failed gabion structures and other debris down to the founding rock embankment 6. Importing and placement of appropriate fill material. 7. Preparation and compaction of the river bank. 8. Riprap Installation: a. Ensure correct gradient. b. Provide specified fabric. c. Fabric should be thoroughly stapled to the ground. d. Provide the specified type and size of riprap. e. A rock bucket should be used during the installation of the riprap. f. Place riprap according to engineering specifications and guidelines provided during detailed design. 9. Berm: a. Provide enough material to construct berm to required height. b. Place and compact material according to engineering specifications and guidelines provided during detailed design. c. Ensure that the berm ties in with the riprap to form one structure. 10. Landscaping, shaping of ground, planting of vegetation where required and consideration of green engineering around all structures. 11. Rehabilitation and site de-establishment and Maintenance of the rehabilitated areas	Same as (a) with the exception that a vertical wall is provided **(c) Typical protection structure 3 (Vertical wall)** Same as (a) and (b) with the exception that there is no riprap installation activities.	1. Site Clearance and establishment. 2. All necessary traffic accommodation and construction warning signage will be erected as necessary. 3. River diversion and dewatering where required. 4. Surveying and setting out. 5. All existing failed gabion structures and other debris will be removed down to the founding rock embankment with the use of an excavator where possible or by hand. 6. Importing and placement of appropriate fill material. 7. Preparation and stabilisation of the river banks. 8. Concrete stilling basin: a. Excavation into river bank up to bedrock. b. Prepare base with proper compaction of the soil and to the correct level. c. Erect formwork and steel fixing. d. Tie into existing upstream culverts and downstream canal. e. Cast concrete. f. Curing. g. Stripping of shutters. h. Backfill and compact where necessary. 9. Landscaping, shaping of ground, planting of vegetation where required and consideration of green engineering around all structures. 10. Rehabilitation and site de-establishment including the removal of all debris and waste products off the site to an approved and licensed disposal site. 11. Maintenance of the rehabilitated areas

1.2 Scope and Purpose

The aim of this study was to undertake an aquatic resources assessment including a diatom analysis and a wetland assessment to delineate the wetland and to determine the Present Ecological State (PES), the Ecological Importance and Sensitivity (EIS) and the Recommended Ecological Classification (REC) for the proposed development. This, specifically to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities.

1.3 Overview of Specialist

Prism EMS has conducted the required aquatic resources specialist assessment on site to inform the Environmental Impact Assessment (EIA) (Basic Assessment Process) and Water Use Registration for the proposed activities. The team under lead of Mr. D. Botha has conducted the assessment. The details of the team are tabularised in Table 1-2.

Table 1-2: Details of Specialist

Specialist	Mr. D. Botha – Wetland Specialist			
Company:	Prism EMS			
Qualifications:	M.A. Environmental Management B.A. Hons. Geography & Environmental Management, B.A. Humanities Post Higher Education Diploma Wetland and Wetland Delineation *(DWAF Accredited Short Course)* Soil Classification and Wetland Delineation – Short Course – *Terrasoil Science* Tools for Wetland Assessment – *Rhodes University* SASS5 Aquatic Biomonitoring Training – *Department of Water Affairs, Ground Truth* Wetland Plant Taxonomy – *Water Research Commission* Hydropedology and Wetland Functioning – *Water Business Academy / Terra Soil Science*			
Experience:	16 Years			
Affiliation/ Registration	SACNASP Registered Scientist – Pr.Sci.Nat. (119979) Founder Member of Environmental Assessment Practitioners Association of South Africa (EAPASA) Member of the International Association for Impact Assessors (IAIAsa) (1653) Member of the Gauteng Wetland Forum Member of the South African Wetland Society			
Address:	No 17 Coldstream Office Park, Coldstream Street, Little Falls			
Tel:	087 985 0951			
Fax:	086 601 4800			
Email:	dewet@prismems.co.za			
Designation	**Name**	**Qualification**	**Professional Registration**	**Role**
		Specialist Team		
Aquatic Specialist	Mr. P. Singh	MSc Aquatic Health (Cum Laude) BSc.Hons (Biodiversity & Conservation) BSc (Bot & Zoo) Rand Water Water Purification of Drinking Water – *Rand Water Vereeniging* Ecotoxicity Test Methods and Validation - *Golder Associates Research Laboratory* *Wetland Management Course: Ecology, Hydrology, Biodiversity, Legislation, Delineation and Management (University of the Free State)* SASS5 Accredited Practitioner *(DWS and WRC)* 6 Years' Experience	Pr.Sci.Nat. (116822)	Water Quality Analysis Wetland Assessment
Diatomologist	Ms. M Gomes	MSc (Ecology) Wits'15		Diatom Analysis
Aquatic Ecologist	Mr. M Alexandre	M.Sc. (Aquatic Health)	Pr. Sci. Nat. (400079/13)	Diatom Analysis Review

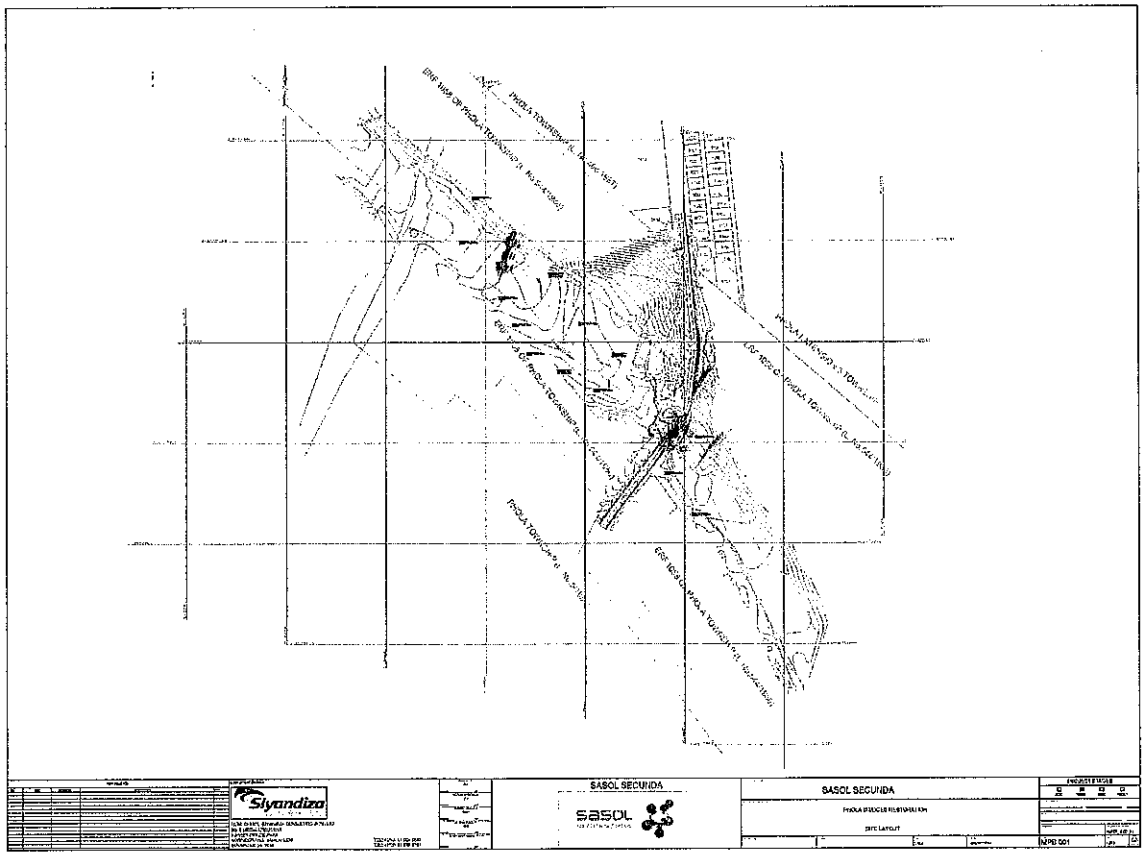

Figure 1-1: Proposed Activities

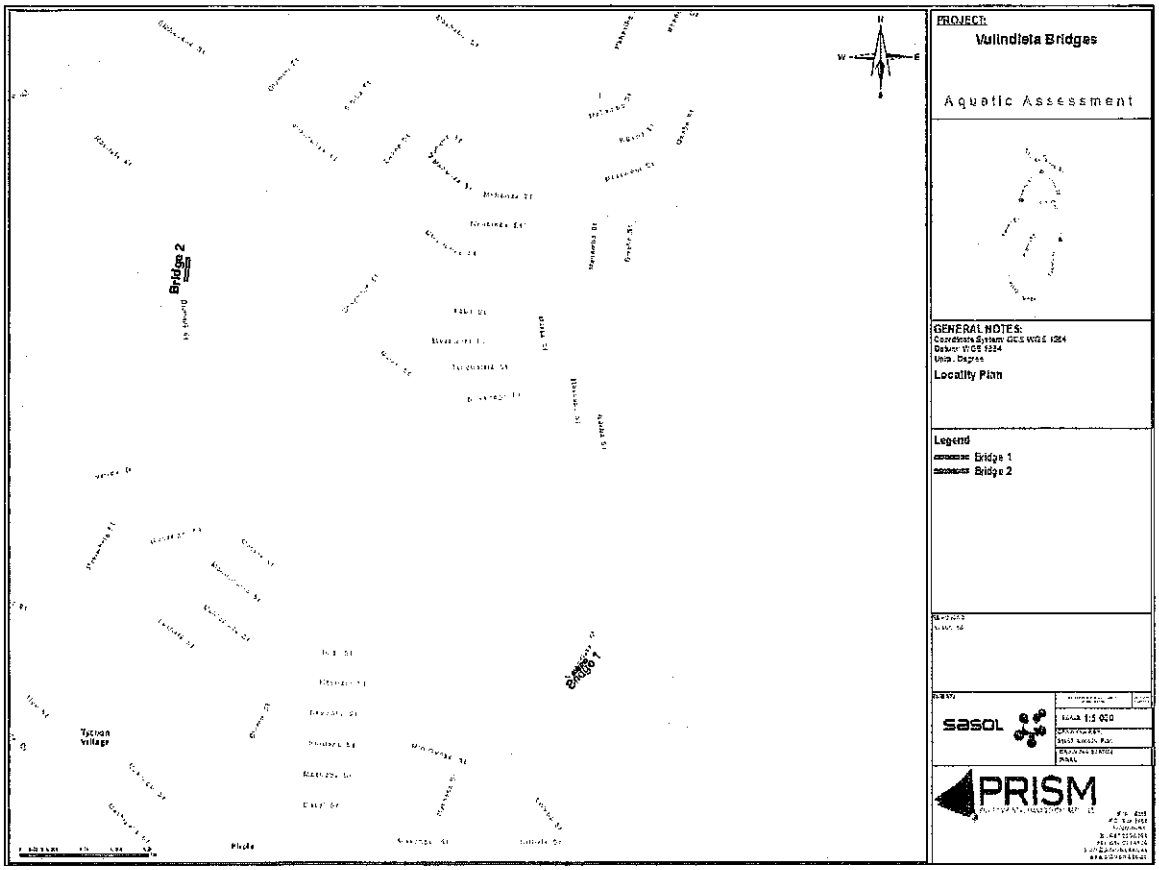

Figure 1-2: Locality Plan

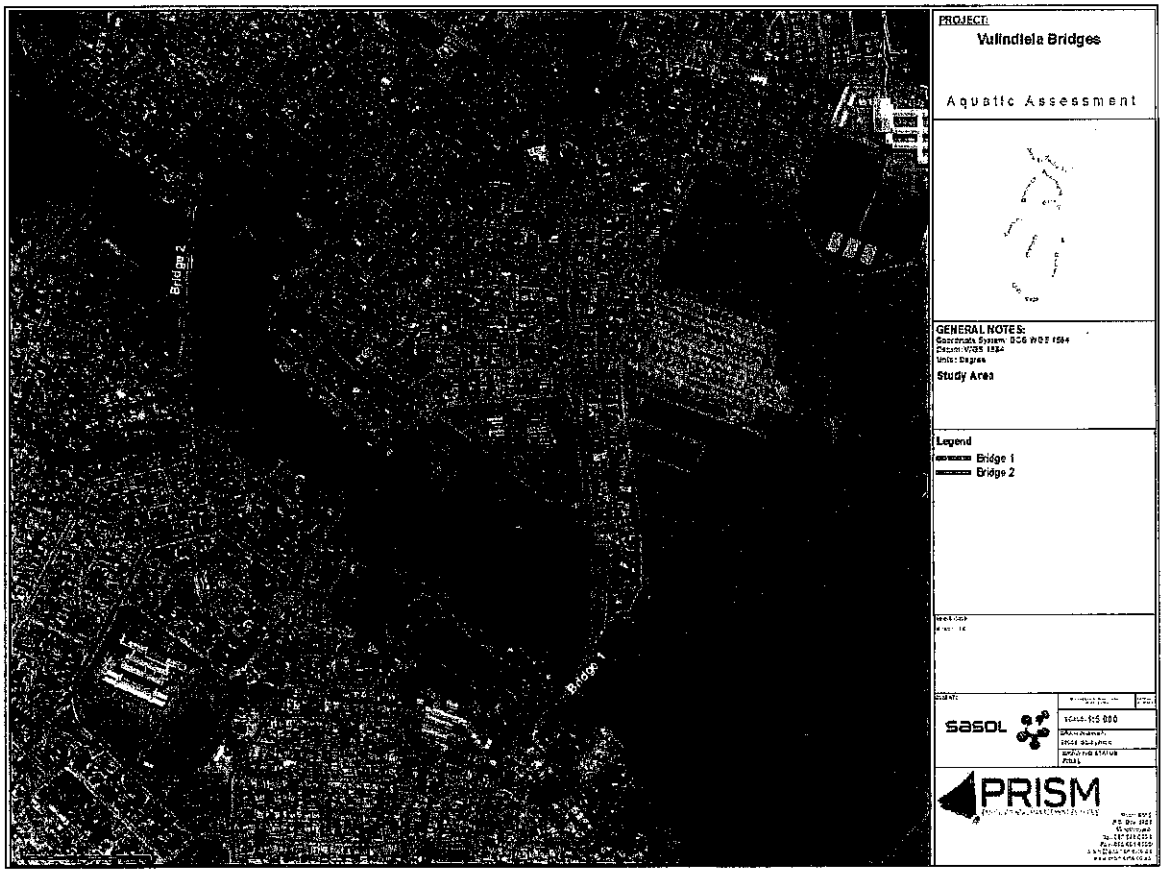

Figure 1-3: Aerial Photograph of Study Area

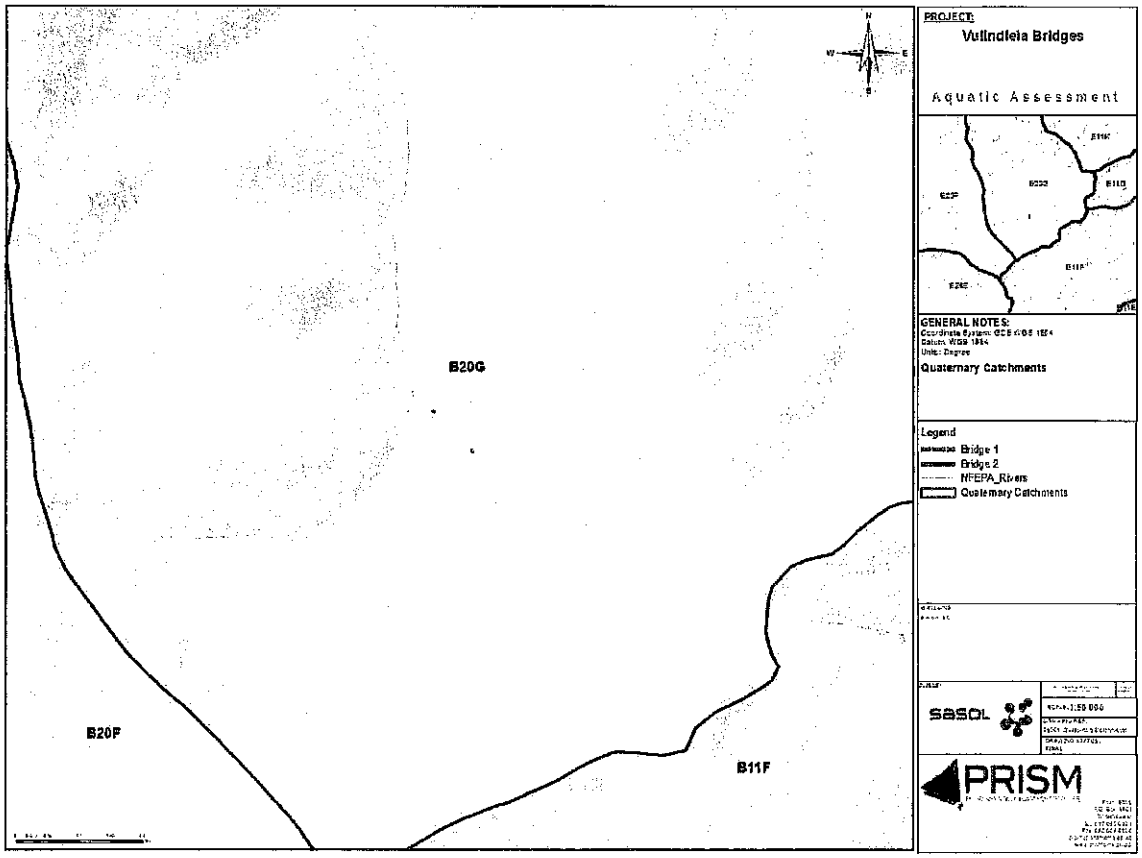

Figure 1-4: Map of the Catchment Areas

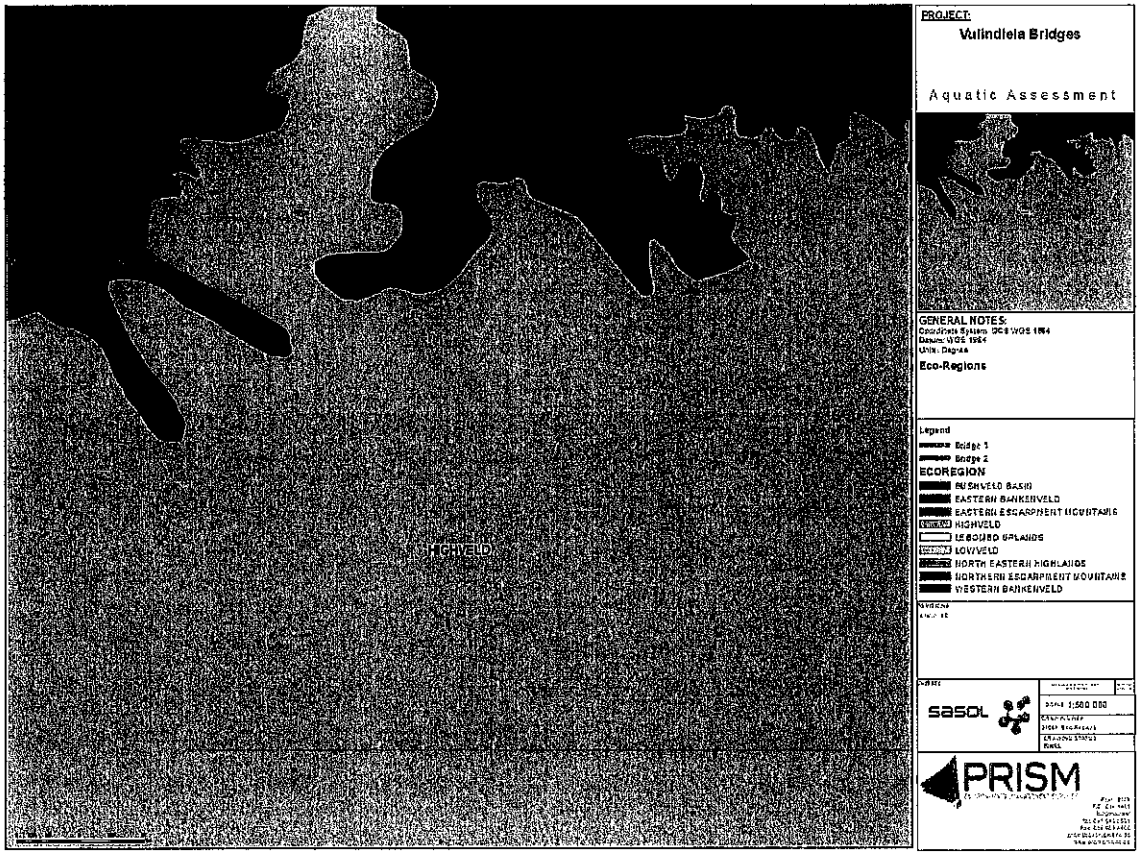

Figure 1-5: Map of the study sites Eco-Regions (DWAF; 2005)

2 REPORT OUTLINE

Appendix 6 of GN 982 of 4 December 2014 provides the requirements for specialist reports undertaken as part of the environmental authorisation process. In line with this, Table 2-1 provides an overview of Appendix 6 together with information on how these requirements have been met.

Table 2-1. Specialist Report Requirements

Requirement from Appendix 6 of GN 982 of 4 December 2014 [as amended]	Chapter
(a) Details of - (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae	Chapter 1.3
(b) Declaration that the specialist is independent in a form as may be specified by the competent authority	*Declaration of Independence*
(c) Indication of the scope of, and the purpose for which, the report was prepared	Chapter 1.2
(cA) an indication of the quality and age of base data used for the specialist report;	Chapter 6
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Chapter 7
(d) The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	Chapter 4
(e) Description of the methodology adopted in preparing the report or carrying out the specialised process, inclusive of equipment and modelling used.	Chapter 4
(f) Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives.	Chapter 6
(g) Identification of any areas to be avoided, including buffers	Chapter 6
(h) Map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Chapter 6
(I) Description of any assumptions made and any uncertainties or gaps in knowledge	Chapter 5
(j) Description of the findings and potential implications of such findings on the impact of the proposed activity, or activities.	Chapter 6 Chapter 7
(k) Mitigation measures for inclusion in the EMPr	Chapter 8.1
(l) Conditions for inclusion in the environmental authorisation	Chapter 8 Chapter 9
(m) Monitoring requirements for inclusion in the EMPr or environmental authorisation	Chapter 8

Requirement from Appendix 6 of GN 982 of 4 December 2014 [as amended]	Chapter
(n) Reasoned opinion - (i) whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and (ii)if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Chapter 8
(o) Description of any consultation process that was undertaken during the course of preparing the specialist report	Chapter 0
(p) A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q) Any other information requested by the competent authority	N/A

3 LEGISLATION AND GUIDELINES

The generic term 'wetland' is used worldwide and includes specific ecosystems such as bogs, coastal lakes, estuaries, fens, floodplains, mangroves, marshes, mires, moors, pans, peatlands, seeps, sloughs, springs, swamps, vlei and wet meadows (Mays, 1996; DWAF, 2005). Regardless of the local name given to wetlands, the driving force of all wetlands is the interplay between land and water, and the consequent characteristics that reflect both (Cowan, 1999). Any part of the landscape where water accumulates for long enough and often enough to influence the plants, animals and soils occurring in that area, is referred to as a wetland (DWAF, 2005). Wetlands comprise approximately 6% (8.5 km^2 x 103) of the world's land surface and are found in every climate from the tropics to the frozen tundra (Mays, 1996).

Several definitions for wetland and wetland areas exist. Two of the most common wetland definitions used in South Africa is the National Water Act (NWA) (Act 36 of 1998) and the Ramsar definition are provided below:

National Water Act, Act No 36 of 1998:

> *"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

South Africa, being a contracting party to Ramsar, also uses the definition accepted by the convention. Article 1.1 of the convention defines wetlands as (Cowan, 1999; Koester, 1989):

> *"Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters."*

Wetlands are defined as those areas that have water on the surface or within the root zone for long enough periods throughout the year to allow for the development of anaerobic conditions. These conditions create unique soil conditions (hydric soils) and support vegetation adapted to these flood conditions.

Hydric soils develop a grey or sometimes greenish or blue-grey colour, as a result of the chemical reduction of iron (gleying). Hydric soils that are seasonally flooded are characterised by the formation of mottles, which are relatively insoluble, enabling them to remain in the soil long after it has been drained. Consequently, it is possible to identify wetland areas on the basis of soil colour, using a standard colour chart, as matrix hue and chroma decrease, while mottle hue and chroma initially increase and then decrease the more saturated the soils become Table 3-1.

Table 3-1: Relationship between degree of wetness (wetland zone), soil-physiochemistry and vegetation (Kotze *et al.*, 1994)

	Degree of wetness		
	Temporary	Seasonal	Permanent / Semi-permanent
Soil Depth (0cm – 10cm)	Matrix chroma: 1-3 Few / no mottles Low / intermediate OM Non-sulphuric	Matrix chroma: 0-2 Many mottles Intermediate OM Seldom sulphuric	Matrix chroma: 0-1 Few / no mottles High OM Often sulphuric
Soil Depth (40cm – 50cm)	Few / many mottles Matrix chroma: 0-2	Many mottles Matrix chroma: 0-2	No / few mottles Matrix chroma: 0-1
Vegetation	Predominantly grass species	Predominantly sedges and grasses	Predominantly reeds and sedges

Vegetation distribution within wetlands is related to the flooding regime. Terrestrial plants are not tolerant of flooding within the root zone for periods long enough to cause anaerobic conditions and are thus found on drier soil conditions. The distribution of wetland plants is related to their tolerance of different flooding conditions, and their distribution within a system can be used as an indication of the wetness of an area.

Typically, indicators of soil wetness based on soil morphology correspond closely with vegetation distribution, since hydrology affects soils and vegetation in systematic and predictable ways. However, in systems where the hydrological regime has been modified due to human activities, vegetation distribution will not vary systematically with soil morphology. The response of vegetation to alteration of hydrological conditions is rapid (months / years), whereas the response of soil morphology to such alteration is slow (centuries). Therefore, lowering of the water table or reduction of surface flows, may lead to rapid establishment of terrestrial vegetation, whereas the soil morphology will retain indicators of wetness for a lengthy period. Soil morphology forms the basis of wetland delineation nationally, following international protocols, mainly because it provides a long-term indication of the "natural" hydrological regime. However, soil morphology cannot be considered to necessarily reflect the current hydrological conditions of the site where the hydrological regime has been altered, and in

such circumstances, vegetation provides the best indication of the distribution of wetlands as it best reflects current hydrological conditions (Figure 3-1).

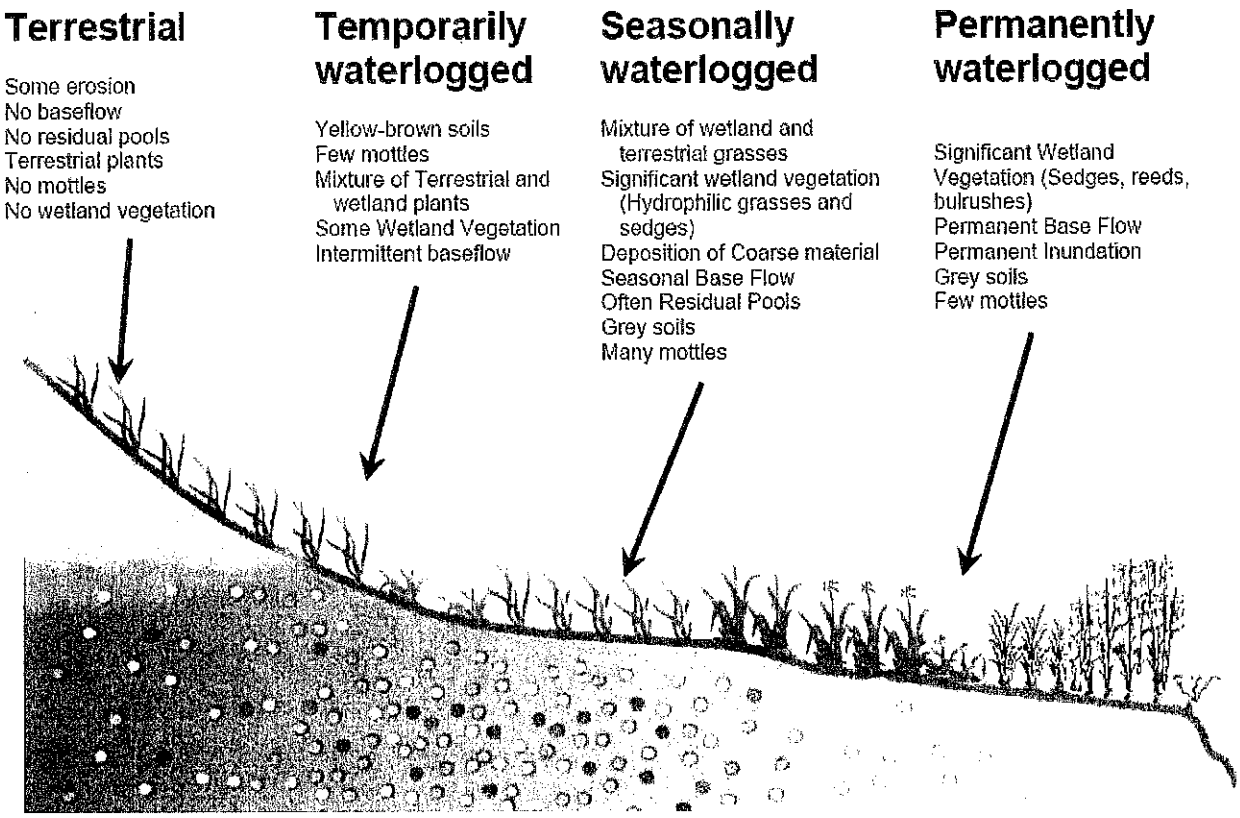

Figure 3-1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change along a gradient of decreasing wetness, from the middle to the edge of the wetland. (Reproduced by Sivest from Kotze (1996), DWAF Guidelines)

Wetland vegetation is adapted to shallow water table conditions. Due to water availability and rich alluvial soils, wetland areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses and wildflowers.

3.1 EIA Applicable Legislation

3.1.1 National Environmental Management Act (Act No. 107 of 1998) (NEMA)

The proposed development triggers a number of activities in terms of NEMA. These are listed in Table 3-2.

Table 3-2: Listed Activities in terms of NEMA

Government Notice Number	Activity and Listing Number	Description
GN 983 of 4 December 2014 as amended	Activity 12 Listing Notice 1	The development of— (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs— (a) within a watercourse;
GN 983 of 4 December 2014 as amended	Activity 19, Listing Notice 1	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse;
GN 985 of 4 December 2014 as amended	Activity 12, Listing Notice 3	The clearance of an area of 300 square metres or more of indigenous vegetation. f. Mpumalanga i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans; or

An Environmental Impact Assessment (EIA) [Basic Assessment Process] will be undertaken.

3.2 Water Use Applicable Legislation

3.2.1 National Water Act (Act No 36 of 1998) (NWA)

The NWA is the primary regulatory legislation; controlling and managing the use of water resources as well as the pollution thereof and is implemented and enforced by the Department of Water and Sanitation (DWS[1]).

[1] Previously referred to as the Department of Water Affairs

Section 21 of the NWA lists water uses that must be licensed unless it is listed in the schedule (existing lawful use) and/or is permissible under a general authorisation, or if a responsible authority waives the need for a Water Use Licence.

The following listed water uses according to Section 21 of the NWA are triggered for the proposed project:

- Section 21(c): impeding or diverting the flow of water in a watercourse
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse.

These water uses are permissible under a general authorisation and therefore, requires registration with DWS.

4 METHODOLOGY

4.1 Wetland Assessment

4.1.1 Desktop Assessment

A preliminary delineation of the Wetland boundary was undertaken using aerial photograph interpretation. Historical records and reports were consulted. The Department of Water and Sanitation (DWS) database was also consulted to obtain historical data for the study area. The Wetland Freshwater Priority Areas (FEPAs) as presented by South African National Biodiversity Institute (SANBI) was also scrutinised (Nel *et al*, 2011). Historical data and official approvals were also consulted during the assessment.

4.1.2 Field Investigation

The field investigation was undertaken during February 2019 to assess and corroborate the delineated Wetland zones present on the survey area.

The field procedure for the wetland delineation was conducted according to the Guidelines for delineating the boundaries of a wetland set out by the Department of Water Affairs and Forestry (DWAF 2005/8). Due to the transitional nature of wetland boundaries, the different wetland zones are often not clearly apparent. However, the wetland edge can be determined accurately. The delineations are based on scientifically defensible criteria and are aimed at providing a tool to facilitate the decision-making process regarding the assessment of the significance of impacts that may be associated with the proposed developments.

The wetlands were delineated by considering the following wetland indicators (DWAF 2005/8):

- Terrain unit indicator helps identifying those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope, and valley bottom;
- Soil wetness indicator identifies the morphological signatures developed in the soil profile as a result of prolonged and frequent saturation; and
- The vegetation indicator identifies hydrophytic vegetation associated with frequently saturated soils.

The following procedure was followed during the delineation of the wetland boundaries and zones:

- A desktop delineation of the larger wetland area was undertaken using satellite imagery of the study site;
- Areas for verification were identified; and
- Identified areas were then assessed in the field with boundaries being recorded using a GPS.

4.1.3 Mapping

Mapping of the wetland boundaries was done by computerised processing utilising GPS tools and GIS modelling.

4.2 Wetland Classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit.

Table 4-1: Wetland classification level 1 - 4

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
Connectivity to open ocean	Ecoregion	Landscape setting	HGM type	Longitudinal zonation / landform	Drainage - outflow	Drainage - inflow
			A	B	C	D
INLAND	DWAF Level 1 Ecoregions	SLOPE	Channel (river)	Mountain headwater stream	Not applicable	Not applicable
				Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
			Hillslope seep	Not applicable	With channel outflow	Not applicable
					Without channel outflow	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
		VALLEY FLOOR	Channel (river)	Mountain stream	Not applicable	Not applicable
				Transitional river	Not applicable	Not applicable
				Rejuvenated bedrock fall	Not applicable	Not applicable
				Upper foothill river	Not applicable	Not applicable
				Lower foothill river	Not applicable	Not applicable

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
				Lowland river	Not applicable	Not applicable
				Rejuvenated foothill river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Channelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
					dammed	With channel inflow
						Without channel inflow
			Valleyhead seep	Not applicable	Not applicable	Not applicable
		PLAIN	Channel (river)	Lowland river	Not applicable	Not applicable
				Upland floodplain river	Not applicable	Not applicable
			Floodplain wetland	Floodplain depression	Not applicable	Not applicable
				Floodplain flat	Not applicable	Not applicable
			Unchannelled valley-bottom wetland	Valley-bottom depression	Not applicable	Not applicable
				Valley-bottom flat	Not applicable	Not applicable
			Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
			Flat	Not applicable	Not applicable	Not applicable

Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit			
		BENCH (Hilltop/saddle/shelf)	Depression	Not applicable	Exorheic	With channel inflow
						Without channel inflow
					Endorheic	With channel inflow
						Without channel inflow
			Flat	Not applicable	Not applicable	Not applicable

The Hydrogeomorphic wetland units identified will be describe individually as per Marneweck and Batchelor (Marneweck & Batchelor; 2002).

4.3 Wetland Present Ecological Status (PES) assessment

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland for purposes of Ecological Reserve determination in terms of the National Water Act, and for environmental impact assessments WET-Health (Macfarlane *et al*, 2008). A level 1 wetland assessment was undertaken to determine the PES of the wetland system.

The PES assessment is concluded by following a 5-step process:

1. Divide the wetland into HGM units;
2. Assess hydrological health of the wetland;
3. Assess geomorphological health;
4. Assess vegetation health of the wetland;
5. Represent the health scores for the overall wetland.

Table 4-2: Outline of steps involved in the Level 1 assessment (Macfarlane *et al*, 2008)

Step 1	**Divide the wetland into HGM units**
↓	
Step 2	**Assess hydrological health of the wetland**
• Step 2A	Evaluate changes to water input characteristics from the catchment
• Step 2B	Evaluate changes to water distribution and retention patterns with the wetland
• Step 2C	Determine the hydrological State of the wetland based on integrating scores from individual HGM Units
• Step 2D	Determine the overall Present Hydrological State of the wetland based on integrating scores from individual HGM Units
• Step 2E	Assess the anticipated trajectory of change of the wetland hydrology
↓	
Step 3	**Assess geomorphological health**
• Step 3A	Determine the Present Geomorphic State of the Individual HGM units
• Step 3B	Determine the overall Present Geomorphic State of the wetland based on integrating scores from individual HGM Units
• Step 3C	Assess the anticipated trajectory of change of the geomorphology of the overall wetland
↓	
Step 4	**Assess vegetation health of the wetland**
• Step 4A	Familiarisation with the general structure and composition of wetland vegetation in the area
• Step 4B	Identify and estimate the extent of disturbance classes
• Step 4C	Assess the changes to vegetation composition in each class, and integrate these for the overall HGM Unit
• Step 4D	Determine the overall Present Vegetation State based on integrating scores from individual HGM Units
• Step 4E	Assess the anticipated trajectory of change of wetland vegetation
↓	
Step 5	**Represent the health scores for the overall wetland**

The Present Ecological State (PES) categories are given in Table 4-3.

Table 4-3: PES categories (Macfarlane *et al*, 2008)

Description of Ecological Category	Combined impact score	PES Category
Unmodified / Natural	0-0.9	
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	

The determination of the probable Trajectory of Change of the wetland is also evaluated. This is rated and presented as indicated in Table 4-4.

Table 4-4: Trajectory of Change classes, scores and symbols used to represent anticipated changes to wetland integrity (Macfarlane *et al*, 2008)

Trajectory class	Description	Change score	Class Range	Symbol
Improve markedly	Condition is likely to improve substantially over the next five years	2	1.1 to 2.0	↑↑
Improve	Condition is likely to improve over the next 5 years	1	0.3 to 1.0	↑
Remain stable	Condition is likely to remain stable over the next 5 years	0	-0.2 to +0.2	→
Deterioration slight	Condition is likely to deteriorate slightly over the next 5 years	-1	-0.3 to -1.0	↓
Deterioration substantial	Condition is likely to deteriorate substantially over the next 5 years	-2	-1.1 to -2.0	↓↓

4.4 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999), refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

In the method outlined by DWAF (1999) a series of determinants for EIS are assessed for the wetlands on a scale of 0 to 4 (Table 4-5), where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to determine the EIS and EMC of the wetland unit (Table 4-6).

Table 4-5: Score sheet for the determination of ecological importance and sensitivity (DWAF, 1999)

Determinant	Score	Confidence
Primary determinants		
Rare and endangered species		
Species / taxon richness		
Diversity of Habitat types or features		
Migration route / breeding and feeding site for wetland species		
Sensitivity to changes in the natural hydrological regime		
Sensitivity to water quality changes		
Flood storage, energy dissipation and particulate / element removal		
Modifying determinants		
Protected status		
Ecological integrity		

Score guideline: 4 = Very High; 3 = High; 2 = Moderate; 1 = Marginal / Low; 0 = None. Confidence rating: 4 = Very High Confidence; 3 = High Confidence; 2 = Moderate Confidence; 1 = Marginal / Low Confidence.

Table 4-6: Ecological Importance and Sensitivity (EIS) categories and the interpretation of median scores for biotic and habitat determinants (DWAF, 1999)

Range of Median	EIS Category	Category Description	Ecological Management Class
>3 and ≤4	Very High	Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	
>2 and ≤3	High	Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water in major rivers.	
>1 and ≤2	Moderate	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	C
>0 and ≤1	Low/ Marginal	Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	D

4.5 Wetland Recommended Ecological Category (REC)

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure." (DWAF, 1999).

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A system may receive the same class for the PES, as the REC if the system is deemed to be in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the riparian system (Table 4-7).

Table 4-7: Recommended Ecological Category (REC) classes

Class (% of total)	Description
A	Unmodified, natural.
B	Largely natural with few modifications.
C	Moderately modified.
D	Largely modified.

4.6 Diatom Analysis (Response Indicators)

Diatoms are the unicellular algal group most widely used as indicators of river and wetland health as they provide a rapid response to specific physico-chemical conditions in water and are often the first indication of change. The presence or absence of indicator taxa can be used to detect specific changes in environmental conditions such as eutrophication, organic enrichment, salinization and changes in pH. They are therefore useful in providing an overall picture of trends within an aquatic system as they show an ecological memory of water quality over a period of time.

4.6.1 Laboratory Procedures

Diatom laboratory procedures were carried out according to the methodology described by Taylor *et al.* (2005). Diatom samples were prepared for microscopy by using the hot hydrochloric acid and potassium permanganate method. Approximately 300 to 400 diatom valves were identified and counted to produce semi-quantitative data for analysis. Prygiel *et al.* (2002) found that diatom counts of 300 valves and above were necessary to make correct environmental inferences. The taxonomic guide by Taylor *et al.* (2007b) and Cantonati *et al.* (2017) was consulted for identification purposes. Where necessary, Krammer & Lange-Bertalot (1986, 1988, 1991 a, b) were used for identification and confirmation of species identification. Environmental preferences were inferred from Taylor *et al.* (2007b) and Cantonati *et al.* (2017) and various other literature sources as indicated in the discussion section to describe the environmental water quality at each site.

4.6.2 Diatom-based Water Quality Indices

There are different diatom-based water quality indices that are used globally and are based on the specific water quality tolerances of diatoms. Most of the indices are based on a weighted average equation by Zelinka and Marvan (1961). Two values are assigned to each diatom species used in the calculations of the indices that reflects the tolerance or affinity of the diatom species to a certain water quality (good or bad); and indicates how strong (or weak) the relationship is (Taylor 2004). These values are then weighted by the abundance of the diatom species in the sample (Lavoie *et al.* 2006; Taylor 2004; Besse 2007). The main difference between indices is in the indicator sets (number of indicators and list of taxa) used in calculations (Eloranta & Soininen

2002). These indices underpin the computer software packages used to estimate biological water quality. One such software package commonly used and approved by the European Union is OMNIDIA (Lecointe *et al.* 1993). The program is a taxonomic and ecological database of 7 500 diatom species, and it contains indicator values and degrees of sensitivity for given species. It allows rapid calculations of indices of general pollution, saprobity and trophic state, indices of species diversity, as well as of ecological systems (Szczepocka, 2007).

4.6.3 The Specific Pollution Sensitivity Index (SPI)

The SPI was used in this diatom assessment (Table 2-1) and is an inclusive index and takes factors such as salinity, eutrophication and organic pollution into account (CEMAGREF, 1982). This index comprises 2035 taxa (Taylor, 2004) and is recognised as the broadest species base of any index currently in use and has been adapted to include taxa endemic to and commonly found in South Africa, thus increasing the accuracy of diatom-based water quality assessments and is known as the South African Diatom Index (SADI) (Harding and Taylor, 2011). The limit values and associated ecological water quality classes adapted from Eloranta and Soininen (2002), in conjunction with the new adjusted class limits that are provided in (Taylor & Koekemoer, in press), were used for interpretation of the SPI scores. The SPI index is based on a score between 0 – 20, where a score of 20 indicates no pollution and a score of zero indicates an increasing level of pollution or eutrophication.

Table 4-8: Adjusted class limit boundaries for the Specific Pollution Index in the evaluation of water quality applied in this study *(adapted from Eloranta & Soininen, 2002; Taylor & Koekemoer, in press)*
Interpretation of Index Scores

Ecological Category (EC)	Class	Index Score (SPI Score)
A	High quality	18 - 20
A/B		17 - 18
B	Good quality	15 - 17
		14 - 15
	Moderate quality	12 - 14
		10 - 12
	Poor quality	8 - 10
D/E		6 - 8
E	Bad quality	5 - 6
		4 - 5
		< 4

4.6.4 The Percentage Pollution Tolerant Valves (%PTV)

The %PTV is part of the UK Trophic Diatom Index (TDI) (Kelly and Whitton, 1995) and was developed for monitoring organic pollution (sewage outfall- orthophosphate-phosphorus concentrations), and not general stream quality Table 4-9. The %PTV has a maximum score of 100, where a score above 0 indicates no organic pollution and a score of 100 indicates definite and severe organic pollution. The presence of more than 20% PTVs shows organic impact. All calculations were computed using OMNIDIA ver. 4.2 program (Lecointe *et al.*, 1993).

Table 4-9: Interpretation of the percentage Pollution Tolerant Valves scores (adapted from Kelly, 1998)

%PTV	Interpretation
<20	Site free from organic pollution.
20 to <40	There is some evidence of organic pollution.
>60	Organic pollution likely to contribute significantly to eutrophication.
	Site is heavily contaminated with organic pollution.

4.7 Water Quality Analysis (Stressor Indicators)

Instream water quality guidelines for aquatic ecosystems were developed by the South African Department of Water Affairs and Forestry (DWAF), now known as the Department of Water and Sanitation (DWS). The guidelines were developed to protect and conserve the health of aquatic ecosystems. The term *water quality* is used to describe the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses including protection of the health and integrity of aquatic ecosystems. Many of these properties are controlled or influenced by constituents that are either dissolved or suspended in water. In the DWAF guidelines (DWAF, 1996), the Target Water Quality Range (TWQR) was used for this study, but not as a water quality criterion but rather as a management objective which has been derived from quantitative and qualitative criteria. This is the range of concentrations or levels within which no measurable adverse effects are expected on the health of aquatic ecosystems, and should therefore ensure their protection.

Physico-chemical properties of the water samples such as Turbidity were analysed at a SANAS accredited laboratory. During the *in-situ* water quality assessment, the following field instruments were used to measure the water quality parameters:

- Dissolved Oxygen (*EXTECH® ExStik® DO600*);
- Electrical Conductivity (*EXTECH® ExStik® EC500*);
- pH (*EXTECH® ExStik® EC500*); and
- Temperature (EXTECH® ExStik® EC500)

The velocity / flow of the aquatic resource was measured using a *Ground Truth Transparent Velocity Head Rod* (TVHR). The clarity of the aquatic resource was measured using a *Ground Truth Water Clarity Tube*. The South African River Health Program utilises the clarity tube and TVHR to monitor South African rivers.

The instream aquatic assessment was conducted at four (4) sites along the Channelled Valley Bottom Wetland (VBR_CVB1), upstream and downstream of each bridge location. The GPS coordinates are presented in Table 15 below. *In situ* water quality parameters were measured and recorded in the field by means of portable field instruments. The parameters recorded were Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), water temperature, water velocity, turbidity and clarity.

Table 10: GPS coordinates of monitoring points (19 February 2019).

Site Name	GPS Coordinates	Site Description
B1-UP	26° 0'17.53"S 29° 2'18.93"E	Located upstream of Bridge 1.
B1-DS	26° 0'15.97"S 29° 2'18.37"E	Located downstream of Bridge 1.
B2-UP	25°59'55.54"S 29° 1'57.03"E	Located upstream of Bridge 2.
B2-DS	25°59'54.90"S 29° 1'56.47"E	Located downstream of Bridge 2

Water temperature plays a significant role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms. Temperature affects the rate of development, reproductive periods, and emergence time of organisms. Temperature varies with season and the life cycles of many aquatic macroinvertebrates are cued to temperature.

For surface water, pH values typically range between 4 and 11. The relative proportions of the major ions, and in consequence the pH, of natural waters, are determined by geological and atmospheric influences. Most fresh waters, in South Africa, are relatively well buffered and neutral, with pH ranging between 6 and 8 (DWAF, 1996).

Electrical Conductivity (EC) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium, and magnesium in the water, all of which carry an electrical charge. Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently do not affect the EC. EC is a rapid and useful surrogate measure of the Total Dissolved Solids (TDS) concentration of waters with a low organic content.

Industrial activities generally cause acidification rather than alkalinisation of rivers. Acidification is normally the result of three distinct types of pollution, namely:

- low-pH point-source effluents from industries, such as pulp and paper and tanning and leather industries;
- mine drainage, which is nearly always acid, leading to the pH of receiving streams dropping to below 2; and
- acid precipitation resulting largely from atmospheric pollution caused by the burning of coal (and subsequent production of sulphur dioxide) and the exhausts of combustion engines (nitrogen oxides). When acid rain falls on a catchment, the strong acids leach calcium and magnesium from the soil and interfere with nutrient availability.

Elevated pH values can be caused by increased biological activity in eutrophic systems. The pH values fluctuate widely from below 6 to above 10 over a 24-hour period because of changing rates of photosynthesis and respiration.

The maintenance of adequate dissolved oxygen (DO) is critical for the functioning of aquatic ecosystems, as it is required for the respiration of all aerobic organisms (DWAF, 1996). The DO can either be measured either as milligrams per litre (mg/ℓ) or as percentage of oxygen saturation concentration (%). The median guideline for DO as set by (Kempster, Hattingh, & Van Vliet, 1980) for the protection of aquatic biota is > 5 mg/ℓ. According to DWAF (1996), concentrations of less than 100% saturation indicate that dissolved oxygen has been depleted from the theoretical equilibrium concentration. Continuous exposure to oxygen concentrations levels of less than 80% will cause physiological stress to the aquatic organisms.

Turbidity is a measure of the light-scattering ability of water and is indicative of the concentration of suspended matter in water. Micro-organisms are often associated with turbidity; hence low turbidity reduces the potential for transmission of infectious diseases. Suspended matter usually consists of a mixture of inorganic matter such as clay and soil particles, and organic matter such as living and / or non-living matter. Sewage and other types of waste discharge can contribute significantly to the turbidity of a water source (DWAF, 1996).

The clarity of a water body refers to the depth to which light can penetrate. It is for this reason that clarity is frequently associated with turbidity. There is also a possible health risk associated with turbid water due to the presence of micro-organisms which may be associated with suspended particulate matter. Clays, organic particles from decomposing plant and animal matter, fibrous particles and suspended soils and sediments constitute most of the particulate matter that contributes to high turbidity and low clarity. Sewage and other wastes may contribute significantly to reduced water clarity.

4.8 Impact Assessment Methodology

As standardised impact assessment methodology was utilised to determine the impacts associated with the proposed installation. A summary of this methodology is provided below.

The **significance** of an impact is defined as the combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The nature and type of impact may be direct or indirect and may also be positive or negative, refer to Table 4-11: below for the specific definitions.

Table 4-11: Nature and type of impact

Nature and Type of Impact:		
Direct	Impacts that are caused directly by the activity and generally occur at the same time and place as the activity	✓/*
Indirect	Indirect or induced changes that may occur as a result of the activity. These include all impacts that do not manifest immediately when the activity is undertaken, or which occur at a different place as a result of the activity	✓/*
Cumulative	Those impacts associated with the activity which add to, or interact synergistically with existing impacts of past or existing activities, and include direct or indirect impacts which accumulate over time and space	✓/*
Positive	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will benefit significantly, and includes neutral impacts (those that are not considered to be negative	✓
Negative	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes will be comprised	*

Table 4-12 presents the defined criteria used to determine the **consequence** of the impact occurring which incorporates the extent, duration and intensity (severity) of the impact.

Table 4-12: Consequence of the Impact occurring

Extent of Impact:	
Site	Impact is limited to the site and immediate surroundings, within the study site boundary or property (immobile impacts)
Neighbouring	Impact extends across the site boundary to adjacent properties (mobile impacts)
Local	Impact occurs within a 5km radius of the site
Regional	Impact occurs within a provincial boundary
National	Impact occurs across one or more provincial boundaries
Duration of Impact:	
Incidental	The impact will cease almost immediately (within weeks) if the activity is stopped, or may occur during isolated or sporadic incidences
Short-term	The impact is limited to the construction phase, or the impact will cease within 1 - 2 years if the activity is stopped
Medium-term	The impact will cease within 5 years if the activity is stopped
Long-term	The impact will cease after the operational life of the activity, either by natural processes or by human intervention
Permanent	Where mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient
Intensity or Severity of Impact:	
Low	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are not affected
Low-Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are modified insignificantly
Medium	Impacts affect the environment in such a way that natural, cultural and/or social functions and processes are altered
Medium-High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes are severely altered
High	Impacts affect the environment in such a way that natural, cultural and / or social functions and processes will permanently cease

The probability of the impact occurring is the likelihood of the impacts actually occurring and is determined based on the classification provided in Table 4-13.

Table 4-13: Probability and confidence of impact prediction

Probability of Potential Impact Occurrence:	
Improbable	The possibility of the impact materialising is very low either because of design or historic experience
Possible	The possibility of the impact materialising is low either because of design or historic experience
Likely	There is a possibility that the impact will occur
Highly Likely	There is a distinct possibility that the impact will occur
Definite	The impact will occur regardless of any prevention measures

The significance of the impact is determined by considering the consequence and probability without taking into account any mitigation or management measures and is then ranked according to the ratings listed in Table 4-14.

Table 4-14: Significance rating of the impact

Significance Ratings:	
Low	Neither environmental nor social and cultural receptors will be adversely affected by the impact. Management measures are usually not provided for low impacts
Low-Medium	Management measures are usually encouraged to ensure that the impacts remain of Low-Medium significance. Management measures may be proposed to ensure that the significance ranking remains low-medium
Medium	Natural, cultural and/or social functions and processes are altered by the activities, and management measures must be provided to reduce the significance rating
Medium-High	Natural, cultural and/or social functions and processes are altered significantly by the activities, although management measures may still be feasible
High	Natural, cultural, and/or social functions and processes are adversely affected by the activities. The precautionary approach will be adopted for all high significant impacts and all possible measures must be taken to reduce the impact

The level of confidence associated with the impact prediction is also considered as low, medium or high (Table 4-15:).

Table 4-15: Level of confidence of the impact prediction

Level of Confidence in the Impact Prediction:	
Low	Less than 40% sure of impact prediction due to gaps in specialist knowledge and/or availability of information
Medium	Between 40 and 70% sure of impact prediction due to limited specialist knowledge and/or availability of information
High	Greater than 70% sure of impact prediction due to outcome of specialist knowledge and/or availability of information

Once significance rating has been determined for each impact, management and mitigation measures must be determined for all impacts that have a significance ranking of Medium and higher in order to attempt to reduce the level of significance that the impact may reflect.

The EIA Regulations, 2014 specifically require a description is provided of the degree to which these impacts:

- can be reversed;
- may cause irreplaceable loss of resources; and
- can be avoided, managed or mitigated.

Based on the proposed mitigation measures, the mitigation efficiency is also determined (Table 4-16) whereby the initial significance is re-evaluated and ranked again to effect a significance that incorporates the mitigation based on its effectiveness. The overall significance is then re-ranked and a final significance rating is determined.

Table 4-16: Mitigation efficiency

Mitigation Efficiency	
None	Not applicable
Very Low	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact. Positive impacts will remain the same
Low	Where the significance rating reduces by one level, after mitigation
Medium	Where the significance rating reduces by two levels, after mitigation
High	Where the significance rating reduces by three levels, after mitigation
Very High	Where the significance rating reduces by more than three levels, after mitigation

The reversibility is directly proportional to the "Loss of Resource" where no loss of resource is experienced, the impact is completely reversible; where a substantial "Loss of resource" is experienced there is a medium degree of reversibility; and an irreversible impact relates to a complete loss of resources, i.e. irreplaceable (Table 4-17).

Table 4-17: Degree of reversibility and loss of resources

Loss of Resources:	
No Loss	No loss of social, cultural and/or ecological resource(s) are experienced. Positive impacts will not experience resource loss
Partial	The activity results in an insignificant or partial loss of social, cultural and/or ecological resource(s)
Substantial	The activity results in a significant loss of social, cultural and/or ecological resource(s)
Irreplaceable	The activity results in the complete and irreplaceable social, cultural and/or ecological loss of resource(s)
Reversibility:	
Irreversible	Impacts on natural, cultural and/or social functions and processes are irreversible to the pre-impacted state in such a way that the application of resources will not cause any degree of reversibility
Medium Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if less than 50% resources are applied
High Degree	Impacts on natural, cultural and/or social functions and processes are partially reversible to the pre-impacted state if more than 50% resources are applied
Reversible	Impacts on natural, cultural and/or social functions and processes are fully reversible to the pre-impacted state if adequate resources are applied

4.9 Consultation Process

Consultation as part of the overall environmental authorisation process is being undertaken by MDT Environmental (Pty) Ltd (EAP). Prism EMS, aquatic resources specialist consulted with:

- The EAP;

5 ASSUMPTIONS, GAPS AND LIMITATIONS

The study was limited to a snapshot view during one site assessment. The field investigation was undertaken on 19 February 2019 to assess and confirm the delineated Wetland zones present on the survey area. Weather conditions during the survey were favourable for recordings. The delineations were recorded by hand held GPS.

It must be noted that, during the process of converting spatial data to final output drawings, several steps are followed that may affect the accuracy of areas delineated. Due care has been taken to preserve accuracy. Printing or other forms of reproduction may also distort the scale indicated in maps. It is therefore suggested that the wetland areas identified in this report be pegged in the field in collaboration with the surveyor for precise boundaries.

A total assessment of all probable scenarios or circumstances that may exist on the study site was not undertaken. No assumptions should be made unless opinions are specifically indicated and provided. Data presented in this document may not elucidate all possible conditions that may exist given the limited nature of the enquiry.

It is unlikely that more surveys would alter the outcome of this study radically.

6 RESULTS AND FINDINGS

6.1 Wetland Delineation

6.1.1 Desktop Assessment

During the desktop investigation, one (1) possible area where wetlands could occur was identified on or in close proximity to the study site that would be affected by the proposed development activities. The NFEPA wetlands were also consulted and one wetland area was identified on or in close proximity to the study site that could be affected by the proposed activities.

6.1.2 Field Assessment

The field investigations were undertaken on the 19th February 2019 to assess and confirm the delineated Wetland zones present on the survey area.

The field investigations concluded that two (2) natural wetland systems (three wetland units) could be affected by the activities. Same is draining into the Saalboom Spruit.

6.1.2.1 Wetland Indicators

6.1.2.1.1 Terrain Unit Indicator

Terrain unit indicator helps identify those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units:

- Crest;
- midslope;
- footslope; and
- valley bottom.

The hydrogeomorphic wetland units identified were also assessed in respect to its location in the landscape. The wetland units found:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

Refer to Table 6-1 and section 4.2 Wetland Classification for the classification of the terrain unit.

Table 6-1: Wetland Classification

Identified Wetland	Level 1: System	Level 2: Regional setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
	Connectivity to open ocean	Ecoregion	Landscape setting	HGM type	Longitudinal zonation / landform
				A	B
VBR_CVB1	INLAND	DWAF Level 1 Ecoregions	VALLEY FLOOR	Channelled valley-bottom wetland	Valley-bottom flat
VBR_HSS1	INLAND	DWAF Level 1 Ecoregions	SLOPE	Hillslope seep	
VBR_HSS2	INLAND	DWAF Level 1 Ecoregions	SLOPE	Hillslope seep	

6.1.2.1.2 Soil Form and Soil Wetness Indicator

Soil erodibility in hydrologically transformed environments contributes to the difficulties to precisely determine wetland boundaries. This investigation focussed on the delineation of the wetland features based on soil hydro-morphology and landscape hydrology as observed in the catchment and on the study site.

Soils were found to be of a low clay content in general. Mostly sandy soils were present especially in the top 250mm. The wetland seasonal and permanent zones reflected clayey soils. (Figure 6-1).

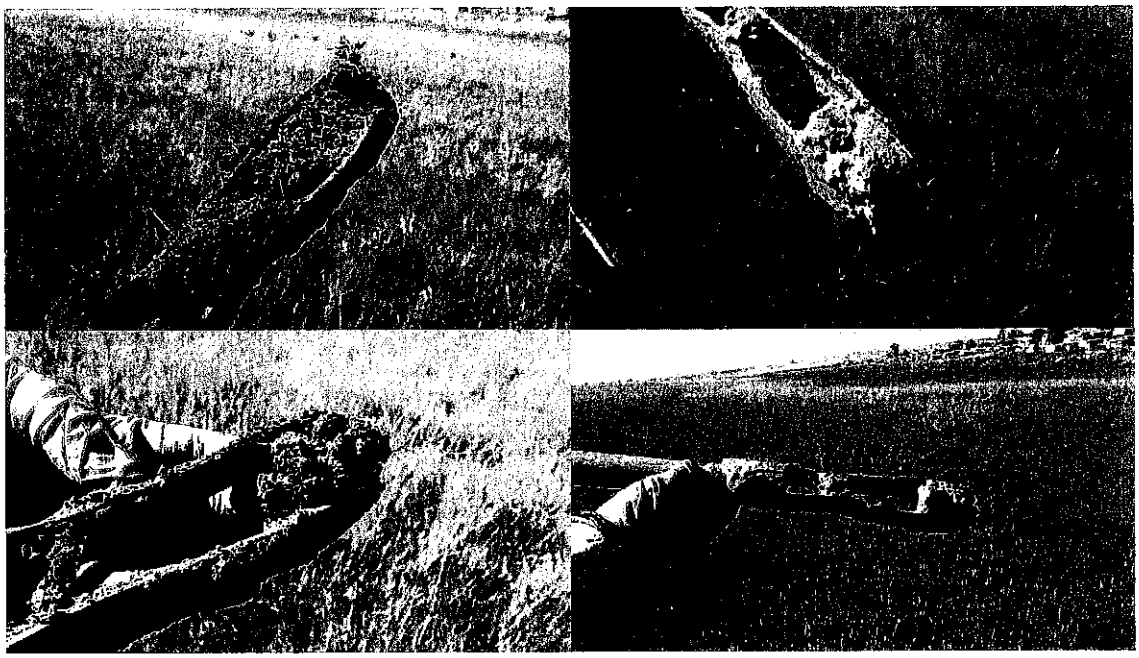

Figure 6-1: Soil samples

6.1.2.1.3 Vegetation Indicator

Upon the assessment of the area, the various wetland vegetation components were assessed and recorded. Dominant species were characterised as either wetland species or terrestrial species. Hydrophytic vegetation species were observed. Predominantly grass, rushes and sedge species were recorded. This unit was predominantly utilised to delineate the wetland (Figure 6-2).

Figure 6-2: Wetland vegetation

Table 6-2: Wetland indicator species noted during the assessment

Riparian / Wetland vegetation
Typha species
Paspalum species
Cyperus species
Juncus species
Andropogan species
Berkheya radula

**Not all species listed, only most common indicators*

6.1.3 Mapping

Figure 6-3 indicates the National Freshwater Ecosystem Priority Areas (NFEPA) Wetlands. No NFEPA wetlands are indicated on the Geographic Information Systems (GIS) layers that are in close proximity to the study site.

Figure 6-4 serves to conceptually present the location of the wetlands that could be affected by the proposed remediation activities on the site.

Figure 6-5 presents the wetland buffer zones that are applicable and should be considered during the development to ensure appropriate mitigation and management of the activities.

A 32m buffer was applied to VBR_CVB1 and VBR_HSS2 wetlands and a 100m buffer area to the VBR_HSS1 wetland that is in line with the National Environmental Management Act (NEMA) listed activities and the bio-diversity and mapping requirements. These VBR_CVB1 and VBR_HSS2 wetlands are fairly disturbed due to historical impacts (mostly upstream) and are of low ecological importance. VBR_HSS1 wetland is more sensitive and of medium-high ecological importance and must be protected, hence the extended buffer area. Rehabilitation of the buffer area is required. This conservation buffer should be utilised as the control area and will be adequate to assist with management and mitigation during the construction and operation phase.

Also, refer to the associated digital files presenting the wetland boundaries.

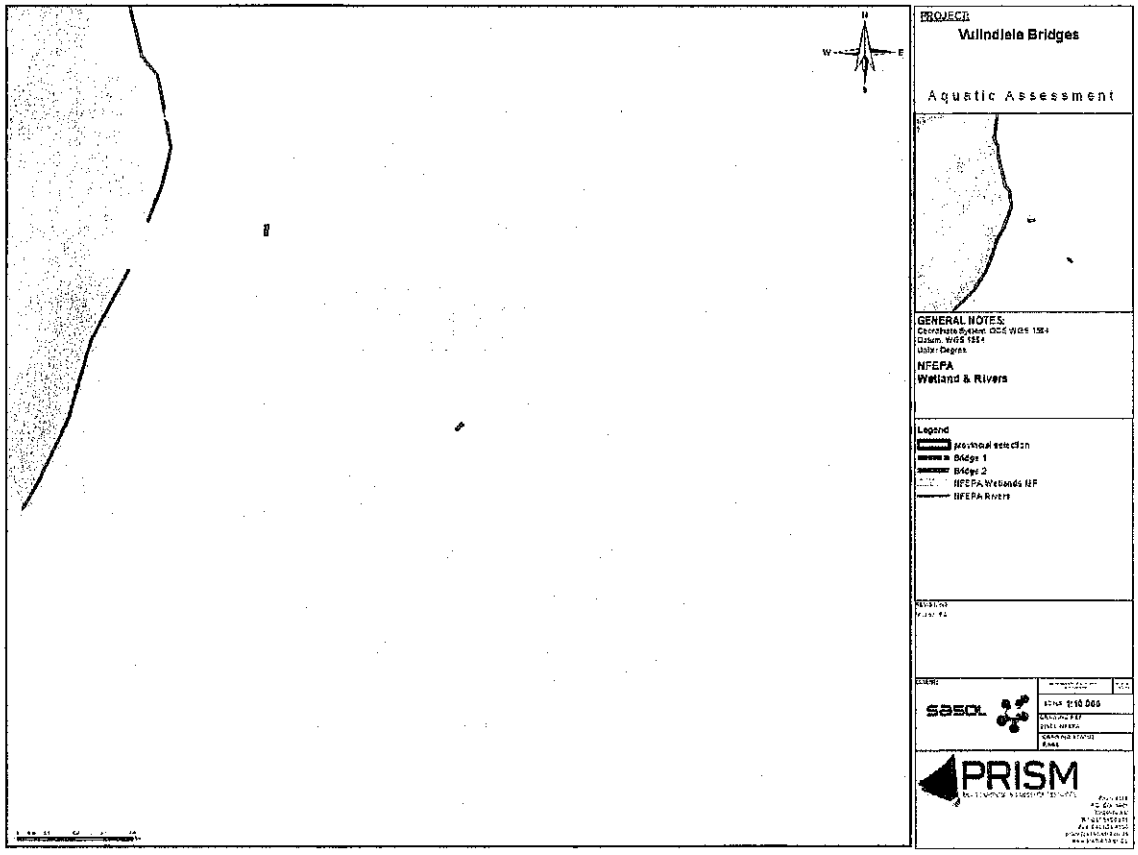

Figure 6-3: NFEPA Wetlands (Nel, 2011)

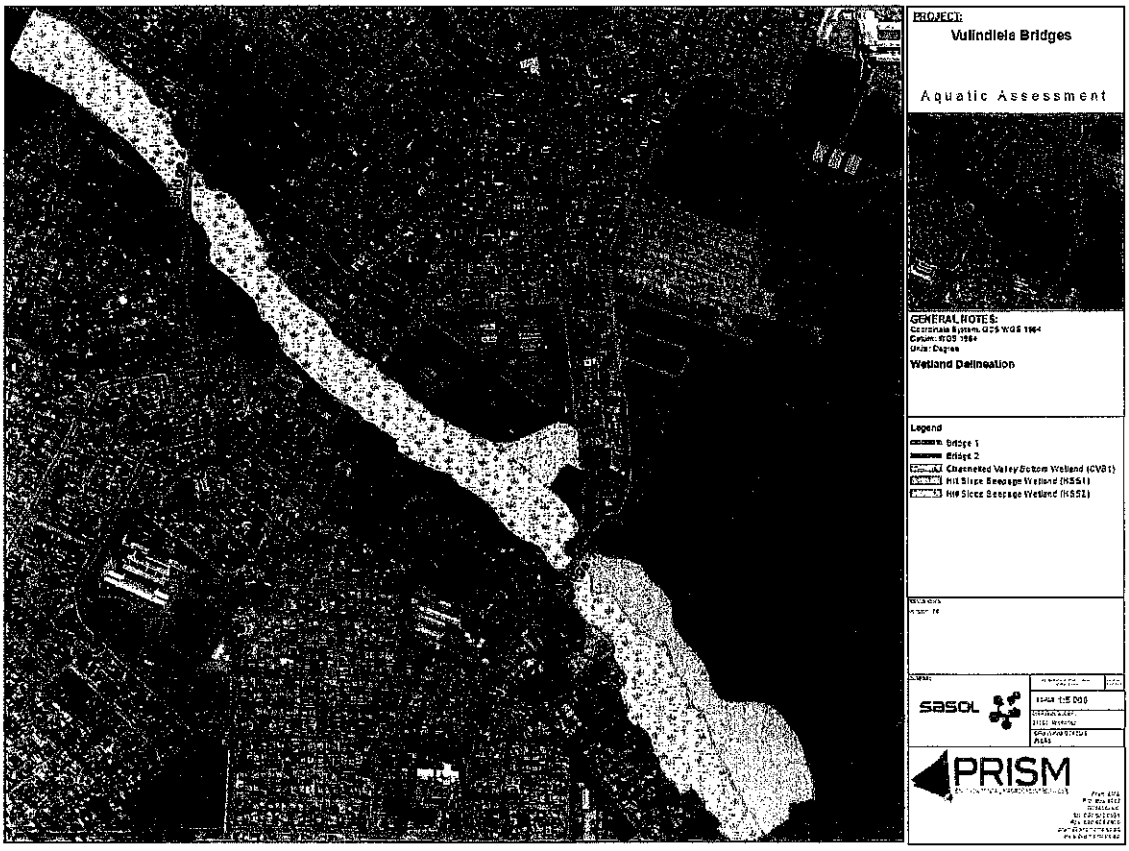

Figure 6-4: Aquatic Resource Delineation

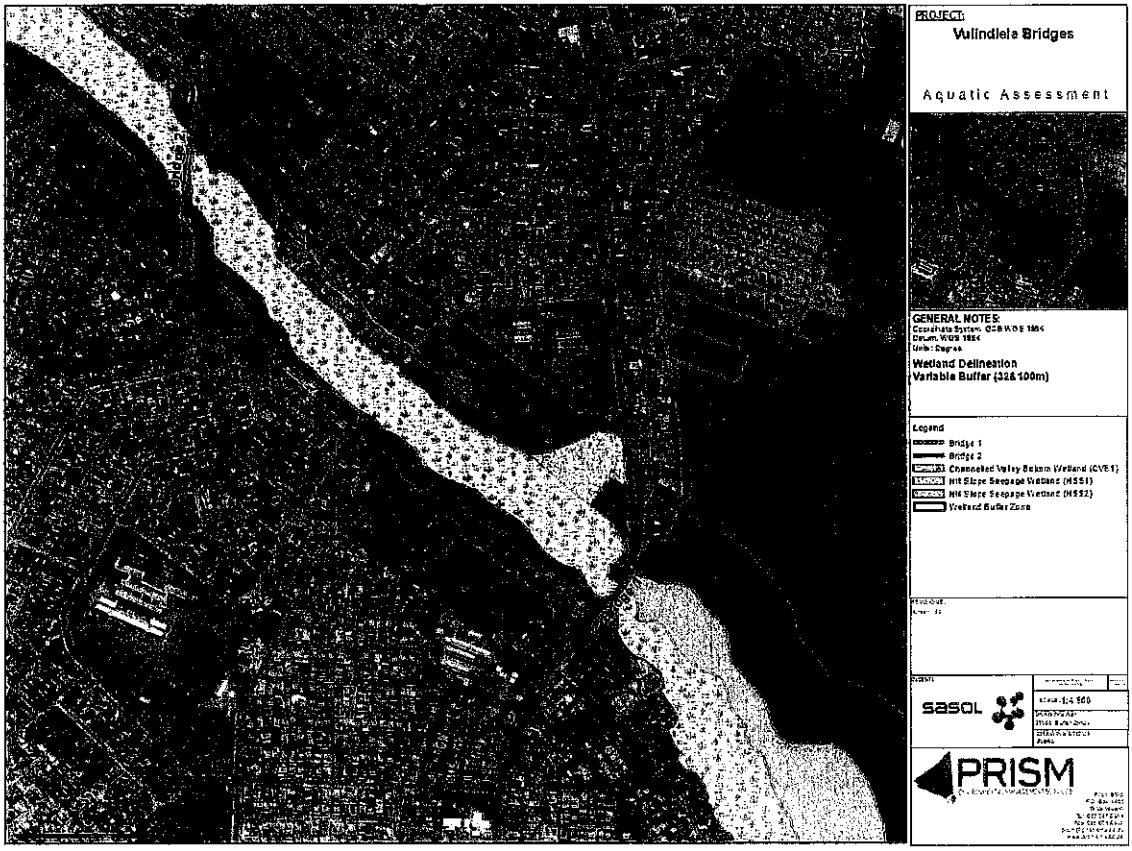

Figure 6-5: Aquatic Resource Buffer Zones

6.2 Wetland Classification

SANBI's classification for wetlands was used to classify the wetland units within the study area (SANBI, 2009). The wetland units were classified up to level four, which includes the system, regional setting, landscape unit and Hydrogeomorphic (HGM) unit. Figure 6-6 conceptually present the HGM units (Marneweck and Batchelor, 2002).

Three natural wetland entities were identified during the field investigation.

The following Hydrogeomorphic wetlands were identified during the site evaluation:

- VBR_CVB1 –Channelled Valley Bottom Wetland
- VBR_HSS1 – Hill Slope Seepage Wetland
- VBR_HSS2 – Hill Slope Seepage Wetland

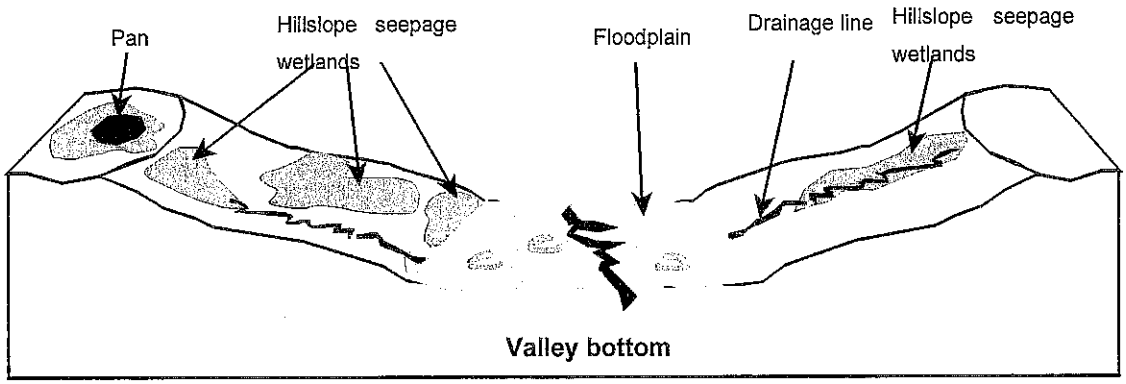

Figure 6-6: Wetland hydrogeomorphic (HGM) classification (Marneweck and Batchelor, 2002)

6.2.1 Channelled Valley Bottom Wetland

One Channelled Valley Bottom Wetland Unit was identified (VBR_CVB1) in the study area. Figure 6-7 diagrammatically illustrates the HGM unit.

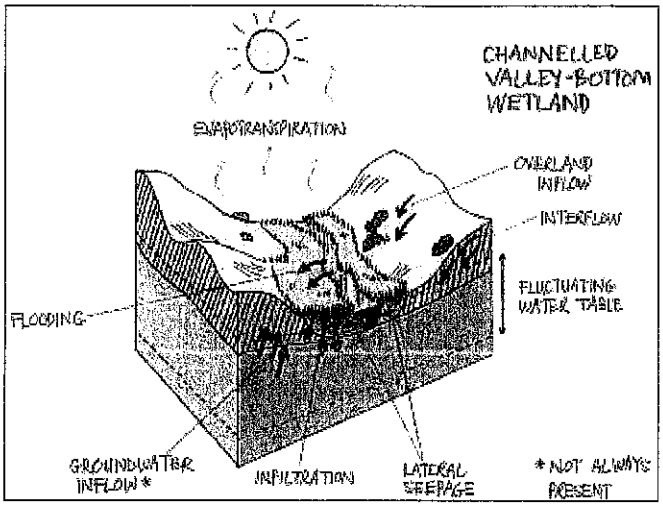

Figure 6-7: Channelled Valley Bottom Wetland (SANBI; 2013)

6.2.2 Hillslope Seepage Wetland

Two (2) Hillslope Seepage Wetland Units were identified (VBR_HSS1&2) in the study area. Figure 6-8 diagrammatically illustrates the HGM unit.

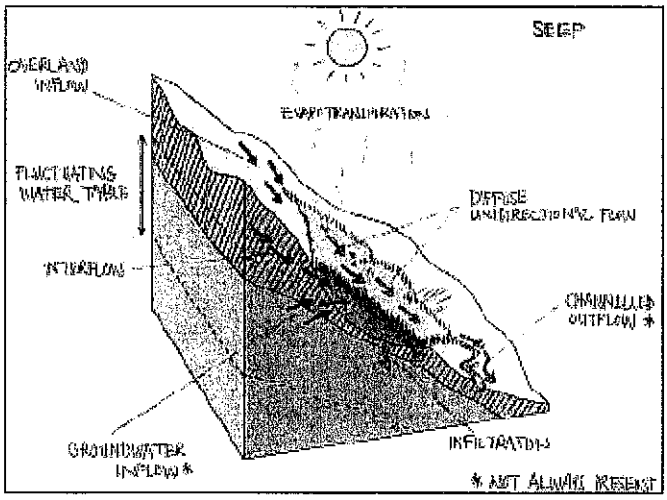

Figure 6-8: Hillslope Seepage Wetland (SANBI; 2013)

6.2.3 Wetland Unit classification

SANBI's "Further development of a proposed National Classification System for South Africa" was used to verify the classification of the wetlands within the study area (SANBI, 2009). The wetlands were classified up to level four, which includes the system, regional setting, landscape unit and hydrogeomorphic unit (Table 4-1).

The wetlands were classified as per Table 6-3.

Table 6-3: Wetland Units classification

Unit	System	Regional setting	Landscape unit	Hydrogeomorphic unit
VBR_CVB1	Inland	Highveld	Valley Floor	Channelled Valley-bottom Wetland
VBR_HSS1	Inland	Highveld	Slope	Hillslope Seepage Wetland
VBR_HSS2	Inland	Highveld	Slope	Hillslope Seepage Wetland

6.3 Wetland Present Ecological Status (PES)

A level 1 WET-health wetland assessment was undertaken to determine the PES of the wetland system.

6.3.1 Overall wetland

The overall wetland, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. (Table 6-4). This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit. The trajectory of change of the wetland ecological status is predicted to decline over the next 5 years without major intervention (Table 6-5).

Table 6-4: Overall Wetland PES

Description	Combined impact score	PES Category
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	5.2 (range 4.5-5.9)	D (low)

*HSS1 – PES = B

Table 6-5: Trajectory of change of the Overall Wetland

Trajectory class	Description	Change score	Class Range	Symbol
Deterioration substantial	Condition is likely to deteriorate substantially over the next 5 years	-1,2	-0.2 to +0.2	↓↓

6.4 Wetland Ecological Importance and Sensitivity (EIS)

The ecological importance and sensitivity assessment were conducted according to the guidelines as discussed by DWAF (1999). DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999), refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) analysis provides a guideline for the determination of the Ecological Management Class (EMC).

6.4.1 Overall Wetland Ecological Importance and Sensitivity

The Overall Wetland is considered to be ecologically important and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate (Refer to Table 6-6).

Table 6-6: Overall Wetland EIS

Score	EIS Category	Category Description	Ecological Management Class
Score =1,5 ***Range (>1 and <=2)***	**Moderate**	Wetlands that are to be considered ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	**C**

**HSS1 – EIS = B*

6.5 Wetland Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) is determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity (EIS) of the aquatic resource. This is then followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

6.5.1 Overall – REC

The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements

associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:

- Category C for the overall wetland (Table 6-7).

Table 6-7: REC

Wetland	Class (% of total)	Description
Overall Wetland	**C**	Moderately modified.

**HSS1 – REC = B*

6.6 Diatom Results and Discussion

6.6.1 Diatom Assessment

The diatom assessment is divided into two sub-sections: (i) Discussion of the ecological classification of water quality for each site according to the diatom assemblage during this assessment. (ii) Analyses and discussion of the dominant species and their ecological preference at each site. Thus, allowing spatial variation analyses of ecological water quality between sites.

6.6.2 Ecological Classification for Water Quality

The ecological classification for water quality according to Van Dam *et al.* (1994) and Taylor *et al.* (2007), includes the preferences of 948 freshwater and brackish water diatom species in terms of pH, nitrogen, oxygen, salinity, humidity, saprobity and trophic state as provided by OMNIDIA (Le Cointe *et al.*, 1993) (Table 6-8). The overall diatom assemblages comprised of species with a preference for:

- Fresh brackish (<500 µS/cm), circumneutral (pH 6.5- 7.5) to alkaline (pH >7) waters and eutrophic conditions.
- The nitrogen requirements for both sites ranged from N-Autotrophic tolerant indicating a tolerance for elevated concentrations of organically bound nitrogen to N-Heterotrophic facultative indicating a requirement of periodically elevated concentrations of organically bound nitrogen.
- The dissolved oxygen saturation requirements were low (<30%) for all the sites.
- The pollution levels indicated that there was some form of pollution evident at all the sites (α- meso-polysaprobic- heavily polluted waters).

Table 6-8: Ecological descriptors for the sites based on the diatom community (Van Dam *et al.*, 1994 and Taylor *et al.*, 2007)

Site	pH	Salinity	Organic Nitrogen uptake	Oxygen Levels	Pollution Levels	Trophic State
BS-US	Alkaline	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
BP-DS	Circumneutral	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
B1-US	Circumneutral	Fresh-brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
B1-DS	Alkaline	Fresh-brackish	N-Autotrophic tolerant	Low	α-meso-polysaprobic	Eutrophic

6.6.3 Diatom Spatial Analysis

A total of 23 diatom species were recorded at the four sites and the dominant species recorded included, *Nitzschia sp.* and *Gomphonema parvulum* (Table 6-9). These species are cosmopolitan in nature and have wide ecological amplitudes. Thus, caution must be taken when analysing the predominance of these species at specific sites and it is important to consider the diatom assemblage in conjunction with focusing on the dominant species. The occurrence of *Nitzschia sp.* indicated α- mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The occurrence of *G. parvulum* indicated oligosaprobic and mesosaprobic, oligo- to eutrophic freshwater and points to impacts associated with agricultural run-off. *G parvulum* is adapted to withstand physical disturbance and benefits from organic enrichment.

Additional information is provided for the sub-dominant species in order to make ecological inferences for the four (4) sites assessed (Taylor *et al.*, 2007, Cantonati *et al.*, 2017):

- **Site B1-US**: This site was dominated by *G. parvulum* which indicated oligo- to eutrophic freshwater and pointed to impacts associated with agricultural run-off and organic enrichment. The subdominance of *Nitzschia sp.* indicated α-mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The presence of *Ulnaria ulna* pointed to slightly alkaline, medium conductivity, oligosaprobic, and moderately eutrophic conditions. The presence of *Navicula erifuga* pointed to brackish waters and electrolyte-rich freshwaters habitats.
    - The results indicated by the diatom assemblage suggested that this site has been impacted and disturbed to some extent and that the ecological water quality was characterized as eutrophic freshwater with high electrolyte content. The %PTV score was high indicating that there was an impact associated with organic enrichment/anthropogenic pollution which was possibly associated with distal

upstream point source pollution or runoff from the surrounding land-use. The overall ecological water quality was considered *Poor* (Table 6-10)

- **Site B1-DS:** The dominance of *Nitzschia sp.* indicated α-mesosaprobic to polysaprobic freshwater and is commonly found in untreated waste water and in habitats that are strongly impacted by industrial sewerage. The subdominance of *Achnanthidium sp.*, which is cosmopolitan in nature, can be found in both clean and polluted waters and species from this genus are usually the first colonisers in electrolyte-poor conditions after acidification pulses. However, it is absent from strongly-acidic environments. The presence of *C. minusculoides* pointed to eu- to polytrophic, electrolyte-rich to salinized waters. The presence of *G. parvulum* indicated potential agricultural run-off and organic enrichment. The presence of *Hippodonta capitata* pointed to eutrophic to polytrophic freshwater and this taxon is tolerant to polluted conditions.
    - The results indicated by the diatom assemblage indicated that the ecological water quality was α-mesosaprobic to polysaprobic freshwater suggesting that this site was impacted and disturbed by some form of pollution. This impact may be associated with either distal upstream point source pollution or runoff from the surrounding land-use. The %PTV score was relatively low suggesting that some other source of pollution aside from organic enrichment was impacting this site. The overall ecological water quality was considered *Poor* (Table 6-10).
- **Site B2-US:** This site was dominated by *G. parvulum* which indicated impacts associated with agricultural run-off and organic enrichment. The subdominance of *Nitzschia sp.* indicated untreated waste water and industrial sewerage. The presence of *Craticula accomoda* pointed to strongly saprobically-impacted running waters, in particular waste water of sewage works. The presence of *C. minusculoides* pointed to eu- to polytrophic, electrolyte-rich to salinized waters. The presence of *P. frequentissimum* suggested alkaline, polysaprobic freshwaters with no acidic conditions.
    - The results indicated by the diatom assemblage suggested that this site has been impacted and that the ecological water quality was characterized as eutrophic, polysaprobic freshwater with high electrolyte content. The %PTV score was high indicating that there was an impact associated with organic enrichment/anthropogenic pollution which was possibly associated with distal upstream point source pollution or runoff from the surrounding land-use. The overall ecological water quality was considered *Poor* (Table 6-10).
- **Site B2-DS:** The dominance of *G. parvulum* pointed to impacts associated with agricultural run-off and organic enrichment. The subdominance of *Navicula sp.* suggested electrolyte-rich eutrophic freshwaters habitats. Species from this genus is often dominant in industrial waste water and polluted conditions. The presence of *Nitzschia sp.* pointed to α-mesosaprobic to polysaprobic freshwater and species from this genus is commonly found in untreated waste water and habitats that are strongly impacted by industrial sewage. The presence of *Craticula accomoda* and *C. minusculoides* pointed to strongly saprobically-impacted running waters, in particular waste water of sewage works and electrolyte-rich waters.

- The results indicated by the diatom assemblage indicated that the ecological water quality was α-mesosaprobic to polysaprobic freshwater, suggesting that this site was impacted by organic/anthropogenic pollution. This impact may be associated with upstream point or non-point source pollution. This notion is further supported by the very high %PTV score for this site. The overall ecological water quality was considered *Poor* (Table 6-10).

In conclusion, all the sites appeared to be impacted to some degree by organic enrichment/anthropogenic pollution, which may be associated with distal upstream point source pollution or runoff from the surrounding land-use. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected Poor conditions.

Table 6-9: Species and their abundances for the Vulindlela bridge repair sites.

Taxa	B1-US	B1-DS	B2-US	B2-DS
Achnanthidium exiguum (Grunow) Czarnecki		18	23	
Achnanthidium sp.	5	100	26	3
Amphora veneta		4		
Craticula accomoda (Hustedt) Mann			50	50
Craticula minusculoides (Hustedt) Lange-Bertalot	12	94	40	33
Cyclotella meneghiniana Kützing			22	
Frustulia crassinervia (Breb.) Lange-Bertalot et Krammer	3			
Gomphonema parvulum (Kützing)	160	50	135	155
Gomphonema species	15	8	25	6
Gyrosigma acuminatum (Kützing)Rabenhorst		4		
Hippodonta capitata (Ehr.) Lange-Bert Metzeltin & Witkowski	8	48	26	13
Navicula erifuga Lange-Bertalot	53		25	7
Navicula rostellata Kützing	55	30		6
Navicula sp.	45	24		95
Nitzschia palea (Kützing) W.Smith				68
Nitzschia sp.1	74	110	75	26
Pinnularia gibba Ehrenberg	2			25
Planothidium frequentissimum (Lange-Bertalot) Lange-Bertalot		3	26	
Planothidium rostratum (Oestrup) Lange-Bertalot				10
Pseudostaurosira brevistriata (Grun.in Van Heurck) Williams & Round				3
Sellaphora mutatoides Lange-Bertalot & Metzeltin	3			
Sellaphora pupula (Kützing) Mereschkowksy	20	3	27	
Ulnaria ulna (Nitzsch.) Compere	45	4		
Total	500	500	500	500
Nutrients				
Organics				
Salinity				
Other dominant				

Table 6-10: Diatom index scores for the study sites indicating the ecological water quality

Site	%PTV	SPI	Ecological Category (EC)	Class
B1-US	32	7.6	D/E	Poor
B1-DS	10	9.2		Poor
B2-US	27	6.3	D/E	Poor
B2-DS	44.6	6.3	D/E	Poor

6.7 Water Quality Results and Discussion

6.7.1 Water Quality Results

The instream aquatic assessment was conducted at four (4) sites along the Channelled Valley Bottom Wetland (VBR_CVB1), upstream and downstream of each bridge location. The results from the February 2019 survey are presented in Table 6-11. Although only a 'snapshot' of what the water quality is, results obtained are still an important consideration as water quality has a direct influence on aquatic life. Data will be compared to the Target Water Quality Range (TWQR) guidelines for aquatic ecosystems (DWAF, 1996b), allowable concentrations to support aquatic life (Chapman & Kimstach, 1996), and the recommended values to support diverse aquatic life (Behar, 1996).

Table 6-11: *In situ* water quality recorded during February 2019.

Site	DO (mg/ℓ)	DO (%)	pH	EC (µS/cm)	Temperature (°C)	Flow (m/s)	Clarity (cm)	Turbidity (NTU)
	5.0-9.5[a]	80-120	6.0 - 9.0[a]	150 – 500[b]	5 - 30	-	-	
B1-UP	4.70	49.64	7.82	607	17.2	0.41	50	6.8
B1-DS	5.40	57.04	7.87	602	17.2	0.41	51	7.1
B2-UP	6.00	63.37	7.79	602	18.7	0.41	57	8.3
B2-DS	5.70	60.2	7.87	602	18.5	0.41	47	7.2

Target Water Quality Range ; [a] *Chapman and Kimstach* (1996); [b] *Behar* (1996)
DO – *Dissolved Oxygen;* EC – *Electrical Conductivity*

6.7.2 Dissolved Oxygen

The maintenance of adequate dissolved oxygen (DO) is critical for the survival and functioning of aquatic ecosystems as it is required for the respiration of all aerobic organisms (DWAF, 1996). Therefore, the DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO as set by Kempster *et al.* (1980) for the protection of aquatic biota is > 5 mg/ℓ. Repeated exposure to reduced concentrations may lead to physiological and behavioural stress (DWAF, 1996).

The TWQR for the DO saturation in aquatic ecosystems is 80% to 120% under ideal conditions, with sub-lethal effects to aquatic biota occurring below 60% and lethal effects below 40%. During the February 2019 survey, none of the percentage oxygen observations met the TWQR for dissolved oxygen. Fish and invertebrate species may show varying sensitivities to changes in DO concentrations depending on their life stages (eggs, larvae or adult) and state of behaviour (feeding and/or reproduction). Juvenile stages are more sensitive to oxygen depletion showing physiological stress leading to increased vulnerability to predation and disease. All aquatic biota will, where possible, avoid oxygen depleted zones to better their chances of survival (DWAF, 1996). The oxygen concentration at all sites downstream of the Bridge 1 met the allowable limit requirements (> 5 mg/ℓ) and may therefore not have a limiting effect on aquatic biota, whilst the oxygen concentration at B1-UP was slightly below the limit. Based on the percentage oxygen observations, the water in this channelled valley bottom wetland may have a slight limiting effect on aquatic organisms depended on dissolved oxygen.

6.7.3 pH

Most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6.5 to 8.5, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (Barbour, *et al.*, 1996). The pH target for fish health ranges between 6.5 and 9.0 (Alabaster & Lloyd, 1982). The DWAF (1996) guidelines state that pH values should not be allowed to vary from the range of the background pH values for a specific site and time of day, by > 0.5 of a pH unit. The difference between the two sites was <0.5 pH units, therefore meeting this requirement. An optimal range of 6.0 - 9.0 is prescribed by Chapman and Kimstach (1996).

The pH at all four (4) sites met this requirement, within the optimal range according to Alabaster and Lloyd (1982) and Chapman and Kimstach (1996). The pH values recorded were therefore considered to not have a limiting effect on aquatic biota.

6.7.4 Electrical Conductivity (EC)

Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current (DWAF, 1996). This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge (DWAF, 1996). Many organic compounds dissolved in water do not dissociate into ions (ionise), and consequently they do not affect the EC (DWAF, 1996).

The EC at all four (4) sites exceeded the limit of 150-500 µS/cm, as specified by (Behar, 1996). The EC may therefore have a limiting effect on aquatic biota, as the values obtained during the February 2019 survey did not meet the recommended value to support a diversity of aquatic life. Elevated EC values were observed upstream of the proposed development, indicating that water entering the site boundary is already of reduced quality that may pose a risk to aquatic biota. Electrical conductivity in this reach of the channelled valley bottom wetland may therefore be a contributing factor to the presence of aquatic biota.

6.7.5 Water Temperature

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms. Temperature affects the rate of development, reproductive periods and emergence time of organisms. Temperature varies with season and the life cycles of many aquatic macro invertebrates are cued to temperature (DWAF, 1996).

The water temperatures recorded during the February 2019 survey were between 17.2°C and 18.7°C. These temperatures are considered to be normal seasonal temperatures for South African waters and are within the guideline values. Therefore, temperature of this reach of the aquatic resource may pose no risk to aquatic biota.

6.7.6 Water Velocity (Flow)

The velocity of the channelled valley bottom wetland traversing the study site did not decrease between the four (4) sites. A constant medium flow rate of 0.41 m/s was observed. This was expected as the survey was conducted during the wet season. The slow and shallow water may favour the presence of aquatic macroinvertebrates but prove unfavourable for most fish species.

6.7.7 Water Clarity and Turbidity

The clarity of the aquatic resource traversing the Bridge 1 increased slightly between the upstream and downstream site, and decreased between the upstream and downstream sites at Bridge 2. As the water sampled and observed was relatively clear, it may be favoured by both fish and macroinvertebrates due to low turbidity.

6.7.8 *In situ* Water Quality Conclusion

The *in situ* water quality of the Channelled Valley Bottom Wetland traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium-low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

7 IMPACT ASSESSMENT

	IMPACTS		CONSEQUENCE				PROBABILITY	RANKING WITHOUT MITIGATION	IMPLEMENTATION OF MANAGEMENT MEASURES		RANKING WITH MITIGATION	DEGREE REVERSABILITY & LOSS OF RESOURCE	
	Type	Description	Nature	Extent (A)	Duration (B)	Intensity (C)	Probability (P)	Significance (A+B+C)XP	Mitigation and/or Management Measures	Mitigation Effectiveness	Significance	Loss of Resources	Reversibility
CONSTRUCTION PHASE													
Wetland	Direct	Water quality	Negative	*Local*	*Medium-term*	*Medium-High*	*Definite*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*	*Low-Medium*	*Substantial*	*Medium Degree*
	Indirect	Silt	Negative	*Neighbouring*	*Medium-term*	*Medium*	*Highly Likely*	*Low-Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*		*Partial*	*High Degree*
	Direct	Surface water run-off	Negative	*Local*	*Medium-term*	*Low-Medium*	*Highly Likely*	*Low-Medium*	Storm water management.	*Medium*		*Partial*	*High Degree*
	Indirect	Contamination of water from hazardous substances	Negative	*Neighbouring*	*Incidental*	*Medium*	*Possible*		Limited use of machinery in the wetland area. No servicing of vehicles and equipment on site.	*High*		*Partial*	*High Degree*
	Direct	Disturbance of natural system	Negative	*Local*	*Medium-term*	*Medium*	*Definite*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*Medium*	*Low-Medium*	*Substantial*	*Medium Degree*
	Direct	Disturbance/pollution of sub-surface flow	Negative	*Local*	*Medium-term*	*Medium*	*Highly Likely*	*Medium*	Stormwater management, dry season construction, coffer damming, filtration, sub-surface drains.	*High*	*Low-Medium*	*Partial*	*High Degree*
	Direct	Disturbance of aquatic ecological systems	Negative	*Local*	*Medium-term*	*Medium*	*Highly Likely*	*Medium*	Stock piling outside the wetland area, stormwater management, dry season construction, coffer damming, filtration.	*High*	*Low-Medium*	*Partial*	*High Degree*

	IMPACTS			CONSEQUENCE			PROBABILITY	RANKING WITHOUT MITIGATION	IMPLEMENTATION OF MANAGEMENT MEASURES		RANKING WITH MITIGATION	DEGREE REVERSABILITY & LOSS OF RESOURCE	
	Type	Description	Nature	Extent (A)	Duration (B)	Intensity (C)	Probability (P)	Significance (A+B+C)xP	Mitigation and/or Management Measures	Mitigation Effectiveness	Significance	Loss of Resources	Reversibility
OPERATIONAL PHASE													
Wetland	Direct	Water quality	Positive	*Neighbouring*	*Long-term*	*Medium*	*Highly Likely*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring.	*Medium*	[redacted]	*No Loss*	*Reversible*
	Indirect	Silt	Positive	*Local*	*Long-term*	*Medium*	*Definite*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring and maintenance.	*Medium*	[redacted]	*No Loss*	*Reversible*
	Direct	Surface water run-off	Positive	*Local*	*Long-term*	*Low-Medium*	*Highly Likely*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	*High*	[redacted]	*No Loss*	*Reversible*
	Indirect	Contamination of water from hazardous substances	Negative	*Site*	*Incidental*	*Low-Medium*	*Possible*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring, storm water management.	*High*	[redacted]	*Partial*	*High Degree*
	Direct	Disturbance of natural system	Negative	*Neighbouring*	*Long-term*	*Low*	*Likely*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring.	*High*	[redacted]	*Partial*	*High Degree*
	Direct	Disturbance/pollution of sub-surface flow	Negative	*Neighbouring*	*Long-term*	*Low*	*Likely*	[redacted]	Rehabilitation of construction impacted area, continuous monitoring and silt management.	*High*	[redacted]	*Partial*	*High Degree*
	Direct	Disturbance of aquatic ecological systems	Negative	*Neighbouring*	*Long-term*	*Low*	*Highly Likely*	*Low-Medium*	Rehabilitation of construction impacted area, continuous monitoring and silt management.	*High*	[redacted]	*Partial*	*High Degree*

8 REASONED OPINION AND RECOMMENDATIONS

The Present Ecological Status (PES) for the wetland scored in the lower ranges as the wetland is largely modified and impacted on by historical activities and current anthropogenic activities. The Ecological Importance and Sensitivity (EIS) falls in the moderate range and has some functionality in respect of moderating water quality before it reaches the Saalboom Spruit. The Recommended Ecological Category (REC) for the wetland was categorised to remain in the category of moderately modified wetlands. This to ensure sustainability of the system. It will thus require some rehabilitation to enhance the ecological function of the system. It is considered to be moderately sensitive wetlands, more specifically in respect of flow and water quality.

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. In conclusion, all the sites appeared to be impacted to some degree by organic enrichment/anthropogenic pollution, which may be associated with distal upstream point source pollution or runoff from the surrounding land-use. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

For this reason, it can be supported that the remediation activities may go-ahead if the required buffers are maintained (in specific the hill slope seepage wetlands) and the resource drivers preserved. The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the construction phase, it is important to ensure that the required erosion protection measures linked to the bridge crossing sections be carefully designed and installed. Silt transportation to the downstream system must also be carefully managed.

The project can be supported, should all the mitigation measures be implemented and monitored against to ensure compliance. This will ensure mitigation to acceptable levels.

8.1 Mitigation and Monitoring Requirements

Monitoring programmes can measure the success of mitigation implementations, monitor unforeseen impacts, and can be used as a feedback system to adjust or correct management of the wetlands.

The following are recommended:

- It is recommended that a Water Use registration and GA be submitted to the Department of Water Affairs, as the proposed activities will trigger sections of Section 21 of the National Water Act [NWA], 1998 (Act No. 36 of 1998) that will require such an application;
- Together with the GA, a rehabilitation and monitoring plan will have to be compiled as supporting documents to the application;
    - These documents must be incorporated as part of the Environmental Management Programme (EMPr).
- A wetland monitoring programme should be developed based on this baseline assessment and audited against post the rehabilitation activities. Feedback from the monitoring should be used to measure and mitigate further negative impacts, if found;
- The wetland monitoring occurring on a quarterly basis should be conducted by a skilled professional qualified in assessing and understanding the complex nature of wetlands and their associated drivers;
- It should be attempted to preserve complete wetland function (current status) if at all possible.
    - Wetland drivers should be protected as far as possible.
    - Wetland release into downstream aquatic resources should be rehabilitated, enhanced and monitored.
    - Water quality preservation is key. Monitoring should take place during the construction phase as per the General Authorisation (GA) requirements.
- Mitigation measures for the proposed development activities should be implemented, managed and monitored according to:
    - The following wetland ecosystem impact assessment conclusions, based on the results of the baseline survey:
        - Runoff from the construction areas may result in contamination of wetland and downstream aquatic habitat;
        - On site storm water management, must be implemented.
    - The following impacts may result in changes to the soil structure:
        - Heavy construction vehicles moving within the wetland areas;
            - Ingress and Egress must be managed to minimise impacts in respect of compaction of the wetland soils.
            - Single entry and exit points must be established.
        - Stock piling;
            - As first option - Stockpiling must be located outside the delineated wetland and buffer boundaries.

- As second option – Stockpiling must be located on the south and western banks or in the dedicated areas.
- Dedicated laydown and stockpiling areas have been identified. Some might be within the buffer areas, but same is associated with already transformed areas. Special management rules will apply for same.

- Spills from machinery;
- The mixing of concrete; and
- Clearing of vegetation for construction, and associated sedimentation and siltation.

- The following aspects may result in reduction of ecosystem habitat integrity:
  - Dust and sediment runoff from construction activities;
  - Diesel and oil spill from equipment and machinery; and
  - Higher and faster water flow from the site that could cause soil erosion.
- The following aspects may result in sedimentation of the associated aquatic systems:
  - Sedimentation due to increase runoff and dispensed soil particles and runoff from the affected areas; and
  - Increase in the velocity of the runoff from the exposed soil, due to construction.
- The proposed activities must be initiated and constructed in such a way to prevent the reduction of natural water flow into the wetland and downstream which, in essence, is the driving factor in terms of water provision.
  - An approved stormwater management plan must be implemented.
  - Subsurface drains must be installed to assist in the aquatic driver sustainability across the full width of the wetland.
  - Velocity dissipation structures (such as reno mattresses) must also be installed to prevent water flowing through culverts to gain velocity. An increase in velocity will lead to channelisation of the wetland and soil erosion.

➢ The wetland integrity should be improved during the rehabilitation phase. This may entail the following:
- Removal of alien and invasive plant species during the construction and operational phases.
- Re-vegetation and landscaping the wetland and buffer areas with indigenous wetland plant species.
- Stabilisation of gullies and drainage lines to prevent erosion.
- Planting of indigenous herbaceous plants on shallow banks and indigenous woody vegetation on steep banks to increase stability of banks, thereby preventing erosion.
- Implementation of topsoil management (stockpiling, topography shaping) and erosion control (berms, geotextiling, silt fences, hay bales and gabion structures).

9 CONCLUSION

The field investigations concluded that two (2) natural wetland systems (*three wetland units*) could be affected by the activities. Same is draining into the Saalboom Spruit.

The following Hydrogeomorphic wetland units were identified during the site evaluation:

- VBR_CVB1 was found on the valley floor draining towards the North-West into the Saalboom Spruit. This system passes under both bridges.
- VBR_HSS1 was found on the North-Eastern slope associated with VBR_CVB1 draining towards the West into VBR_CVB1 east of Bridge 1.
- VBR_HSS2 was found on the North-Eastern slope North-West of Bridge 1 draining towards the West into VBR_CVB1 and then into the Saalboom Spruit.

The wetlands recorded were assessed and the following results were attained:

- The wetland attained a low overall PES (Present Ecological State)
    - The overall wetland system, inclusive of all wetland units, ecological status was found to be largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred, however some of the natural habitat remains intact to some extent. HSS1 still remains largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place. This CVB1 wetland system is impacted by historical channelisation upstream of the system and utilisation of the wetland as grazing pastures and small-scale crop production. It forms part of a larger aquatic system leading into the Saalboom Spruit
- The wetland attained a Moderate Ecological Importance and Sensitivity (EIS) score.
    - The overall wetland system is considered to be of moderate ecologically important and sensitive on a regional scale. The biodiversity of this wetland is low with no red data species recorded. It is moderately sensitive to flow and habitat modifications. It plays an intermediate role in moderating the quantity and quality of water of major rivers. The system drains into the Saalboom Spruit. The Ecological Importance and Sensitivity (EIS) for this system is thus considered to be Moderate.
- The wetland Recommended Ecological Classification (REC) classification was rated as:
    - The wetlands will be impacted by the proposed remediation activities. This impact will be localised and at the transitional point leading from the base level re-establishment interface to the outer edge and banks of the wetland system. It will in all likelihood regress slightly in terms of its current Ecological Category during the construction period but will regenerate over time due to the resource quality characteristic improvements associated with the project. Stormwater management for the site is required specifically for the construction phase. Rehabilitation of the impacts and

maintenance of the system will further mitigate the impacts and could improve the sustainability of the system. It is thus rated that the Recommended Ecological Category (REC) will fall into:

- Category C for the overall wetland system

The diatom assemblages were generally comprised of species characteristic of fresh-brackish, circumneutral to alkaline waters and eutrophic conditions. The pollution levels indicated that all the sites showed some form of pollution. There appeared to be no spatial variation in ecological water quality between sites and all the sites reflected *Poor* conditions.

The *in situ* water quality of the Channelled Valley Bottom Wetland (VBR_CVB1) traversing Bridge 1 and Bridge 2 and the associated upstream and downstream sampling points (B1-UP, B1-DS, B2-UP, B2-DS) may therefore be **adequate** enough to support some aquatic ecosystems (predominantly macro-invertebrates and pollution-sensitive micro-invertebrates), therefore of reasonable quality. The higher EC values and medium low oxygen levels may not be preferable for some aquatic biota. The topography and location of the study site may not allow for fish species and/or certain macro-invertebrates due to associated tolerance and preferences.

Concluded from the results presented in this document, the construction activities will impact on the wetland system but can be mitigated to satisfactory standards if all mitigatory actions are implemented with due care. It is key to preserve water quality and supply to the downstream aquatic resources. Hence the actioning of this remediation project.

The rehabilitation of the wetland is vital to recover the required ecological function. The wetland drivers must be enhanced as part of the rehabilitation of the affected areas. In respect of the bridge construction, it is important to ensure that the required erosion protection measures linked to the crossing sections be carefully designed and installed.

The project can be supported should all the mitigation measures be implemented and monitored against.

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Waste Classification Study report

(Volume 4 of 4)

SASOL MINING - VULINDLELA BRIDGE MAINTENANCE AND DESILTING PROJECT -

WASTE CLASSIFICATION AND ASSESSMENT REPORT

August 2019

Volume 4 of 4

MDT environmental

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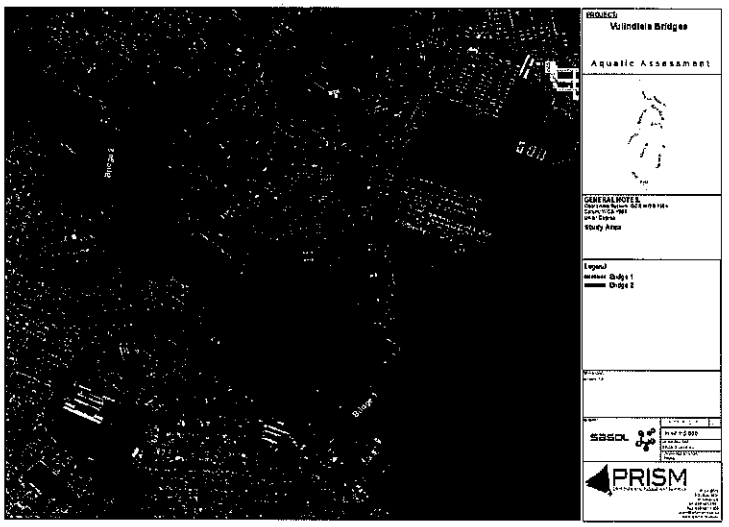
1. INTRODUCTION

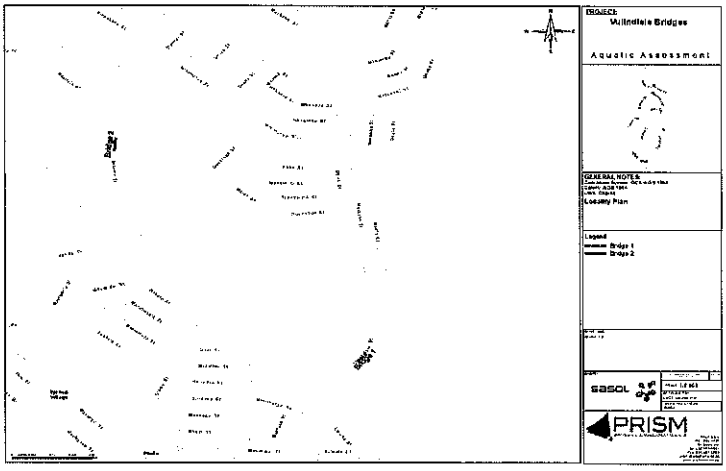
MDT Environmental has been appointed by Sasol Mining to undertake the Basic Assessment and General Authorisation applications for the Vulindlela Bridge Maintenance and desilting project.

Emalahleni Local Municipality is planning to conduct maintenance, as well as desilting activities, upstream and downstream of the Vulindlela Bridges, which is situated at Phola Township, Ogies, within the Emalahleni Local Municipality, Mpumalanga. The activities will be undertaken at two bridge crossings. The two bridge crossings are located at 26°0'18.03" S, 29°2'18.13" E and S25°59'55.17" S, 29°1'56.67" E. The Project is undertaken as part of the Local Economic Development contribution provided by Sasol Mining (Pty) Ltd and is part of the projects committed to in their social and labour plan.

The project site is located as per Figure 1 below:

Figure 1: Locality and project site area





A large quantity of silt must be removed and disposed, and for this purpose the silt has to be analysed and classified. iX engineers was appointed by MDT Environmental to conduct the waste classification.

The National Environmental Management Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA), the Waste Classification and Management Regulations, 2013 (published under Government Notice R634 in Government Gazette 36784 of 23 August 2013) (Regulations) require under regulation 4(2), that all waste generated by waste generators, be classified in accordance with SANS 10234 within one-hundred-and-eighty (180) days of generation.

Waste must be assessed in terms of the NEM:WA , the National Norms and Standards for the Assessment of Waste for Landfill Disposal (published under Government Notice R635 in Government Gazette 36784 of 23 August 2013) (Norms and Standards). Waste is assessed for the purpose of disposal to landfill through identifying the chemical substances present in the waste. The total concentrations (TC) and leachable concentrations (LC) of the elements that have been identified in the waste is sampled and analysed, this is then compared to the threshold limits specified in regulation 6 of the Norms and Standards.

2. SCOPE OF WORK

MDT Environmental requested iX engineers to classify and assess 3 (three) composite desilt waste samples from the Vulindlela Bridge Maintenance and Desilting Project, for disposal in accordance with South African waste legislation. The classification will be used to confirm the classification type (Type 0 to type 4) of the waste produced at the facility and to determine the type of containment barrier to be used for the waste management or waste treatment facility in accordance with the waste legislation.

The scope of work entails the following actions:

- SANS 1023 Classification
- Analysing and classification of the samples in according with South African waste legislation;
- Recommended methods of disposal;
- Development of Safety Data Sheet (SDS), and,
- Compilation of the Waste Classification Report.

The waste samples were collected on Wednesday 15 May 2019 and taken to the UIS Organic Laboratory in Pretoria for analysis. Clearly marked 2kg composite samples of the waste was obtained and utilised for analysis. Grid sampling was conducted to obtain the three (3) composite samples to ensure that the samples are a true representative indication of the waste stream. An additional sample was collected to conduct the SANS classification.

3. WASTE CLASSIFICATION METHODOLOGY

3.1 Sans 10234 Classification

According to section 4(2) of GN R.634 of 2013, all waste generators must ensure that their waste is classified in accordance with SANS 10234 within 180 days of generation, except if it is listed in Annexure 1 of the GN R.634. Furthermore, waste must be re-classified every 5 years.

Waste classification according to SANS 10234 (based on the Global Harmonised System) indicates physical, health and environmental hazards. The SANS 10234 covers the harmonised criteria for classification of potentially hazardous substances and mixtures, including wastes, in terms of its intrinsic properties/hazards.

3.2 Waste Assessment

In accordance with the Norms and Standards, all analyses of the TC and LC of elements and chemical substances contained in the waste, must be conducted by laboratories accredited by the South African National Accreditation System (SANAS) to conduct the techniques and analysis methods required. UIS Organic Laboratory is SANAS accredited (refer to **Appendix C** for copy of Certificate of Accreditation).

The methodology, as described in the Norms and Standards determined the methodology followed in this report. The Norms and Standards state the following:

"4 Total Concentration (TC) Analysis

(1) The TC of all the elements and chemical substances specified in section 6 of these Norms and Standards that are known to occur, likely to occur or can reasonably be expected to occur in the waste must be determined.

(2) The TC of elements and chemical substances in waste must be determined using techniques and analysis methods that will provide reliable, accurate and repeatable results of the TC of elements and chemical substances specified in section 6 of these Norms and Standards.

5 Leachable Concentration (LC) Analysis

(1) The LC of elements and chemical substances must be determined using the Australian Standard Leaching Procedure (AS 4439.1, 4439.2 and 4439.3).

(2) The type of leaching fluid (section 5.2 and 5.3 of AS 4439.3) used in the leaching procedure must be selected as follows -

(a) Waste to be disposed of with, or waste that contains, putrescible wastes: Use 0.1M acetic acid solution with altered pH 5.0 or pH 2.9 determined as per section 7.5 (a-e) of AS 4439.3;

(b) Waste to be disposed of with non-putrescible waste: Use a basic 0.1M sodium tetraborate decahydrate solution of pH 9.2 ±0.1, as well as an acetic acid solution with pH 5.0 or pH 2.9) determined as per section 7.5(a-e) of AS 4439.3; or

(c) Non-putrescible waste to be disposed of without any other wastes: Use reagent water.

(3) Existing LC results for elements and chemical substances in wastes, which have been determined in terms of the Toxicity Characteristic Leaching Procedure (TCLP) leach test criteria of the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (2nd Edition, 1998; Department of Water Affairs and Forestry) prior to the Regulations taking effect, may be utilised for comparison with the LCT limits in section 6 of these Norms and Standards to asses waste for the purpose of disposal of the waste to landfill, for a period not exceeding three (3) years from the date of publication of the Notice."

4. WASTE SAMPLING AND ANALYSIS

Grid sampling was conducted to obtain the three (3) composite samples to ensure that the samples are a true representative of the waste stream (desilt waste). An additional sample was collected to conduct the SANS 10234 classification. The 4 (four) samples in total were delivered to UIS Organic Laboratory for the prescribed tests to be performed on the samples.

UIS Organic Laboratory is an independent testing laboratory and is accredited through the SANAS which ensures that the analytical methods used, and the results achieved are traceable to international standards.

UIS Organic Laboratory assisted in the analysis and interpretation of the waste samples to ensure the correct classification in accordance with the International United Nations Globally Harmonised System of Classification (GHS) of SANS 10234 and to align this analysis with the NEM:WA requirements.

5. WASTE CLASSIFICATION: SANS 10234 CLASSIFICATION

The standard used for waste classification is the; Globally Harmonised System of Classification and Labelling of Chemicals (GHS); SANS 10234:2008.

In terms of the Waste Classification and Management Regulations of 23 August 2013, Section 4 (2) states:

All waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) day of generation.

These regulations also state in Section 5 (1), that generators of hazardous waste must ensure that a safety data sheet for the hazardous waste is prepared in accordance with SANS 10234.

According to SANS 10234:2008, the classification criteria includes the following hazard Classes:

1. Physical Hazards
2. Health Hazards
3. Environmental Hazards

The SANS 10234 classification was done by iX engineers with the analysis done by UIS Organic Laboratory. The detailed results are reflected in the UISOL Waste Assessment and Classification Report, dated August 2019, attached to this report as **Appendix A**).

Table 1 below summarised the classification of the Vulindlela Desilt waste, according to SANS 10234:2008.

Table 1: Summary of the Physical, Health and Aquatic Hazards of Desilt Waste

Hazard Class	Hazard Category	Hazard Statement
Physical Hazard		
Explosives	Not Explosive – Division 1.6	None
Flammable Gasses	N/A	None
Flammable Aerosols	N/A	None
Oxidising Gasses	N/A	None
Gasses under Pressure	N/A	None
Flammable Liquids (Up to 93 ^{o}C)	N/A	None
Flammable solids	Not Flammable	None
Self-Reactive Substances and Mixture	Self-Reactive Type G	None
Pyrophoric Substances	Not Pyrophoric	None
Self-Heating Substance and Mixtures	Not Self Heating	None

Substances and mixture that on contact with water emits flammable gasses	Not flammable gas emitted	None
Oxidising substances and Mixtures	Not Oxidising – 3b	None
Organic Peroxides	Not a Peroxide	None
Corrosive to Metals	Not Corrosive	None
Health Hazards		
Acute Toxicity: Oral	Not Classified	None
Acute Toxicity: Dermal	Not Classified	None
Acute Toxicity: Inhalation	Not Classified	None
Skin corrosion and irritation	Not Classified	None
Serious Eye Damage and Irritation	Not Classified	None
Respiratory sensitization and skin sensitization	Not Classified	None
Germ Cell Mutagenicity	Not Classified	None
Carcinogenicity	Category 1A	H350
Reproductive Toxicity	Not Classified	None
STOT-SE	Not Classified	None
STOT-RE	Category 1	H372
Aspiration hazard	Not Classified	None
Aquatic Hazards		
Acute Aquatic Toxicity	Not Classified	None
Chronic Aquatic Toxicity	Not Classified	None

The classification showed that there are no physical and aquatic hazards associated with the sediment. The sediment does have a carcinogenic hazard as well as a specific target organ toxicity hazard. The main driver for the health hazards is the quartz at a concentration of 93.2%.

The sediment contains microbial contaminants (Faecal Coliforms and E. coli). E. coli infection can lead to diarrhoea, high blood pressure, kidney problems, heart disease and even haemolytic uremic syndrome.

6. WASTE ASSESSMENT THRESHOLD LIMITS

The Total Concentration Threshold (TCT) Limits (mg/kg) as listed in the Regulations to which the results of the analysis were compared with is given below:

Table 2: Total Concentration Threshold (TCT) Limits

Elements & Chemical Substances in Waste	TCT0	TCT1	TCT2
Metal Ions			
As, Arsenic	5.8	500	2000
B, Boron	150	15000	60000
Ba, Barium	62.5	6250	25000
Cd, Cadmium	7.5	260	1040
Co, Cobalt	50	5000	20000
Cr Total, Chromium Total	46000	800000	N/A
Cr (VI), Chromium (VI)	6.5	500	2000
Cu, Copper	16	19500	78000
Hg, Mercury	0.93	160	640
Mn, Manganese	1000	25000	100000
Mo, Molybdenum	40	1000	4000
Ni, Nickel	91	10600	42400
Pb, Lead	20	1900	7600
Sb, Antimony	10	75	300
Se, Selenium	10	50	200
V, Vanadium	150	2680	10720
Zn, Zinc	240	160000	640000
Inorganic Anions			
TDS			
Chloride			
Sulphate			
N03 as N, Nitrate-N			
F, Fluoride	100	10000	40000
CN- (total), Cyanide Total	14	10500	42000
Organics			
Benzene		10	40
Benzo(a)pyrene		1.7	6.8
Carbon tetrachloride		4	16
Chlorobenzene		8800	35200
Chloroform		700	2800
2-Chlorophenol		2100	8400
Di (2 ethylhexyl} phthalate		40	160
1,2-Dichlorobenzene		31900	127600
1,4-Dichlorobenzene		18400	73600

Elements & Chemical Substances in Waste	TCT0	TCT1	TCT2
1,2-Dichloroethane		3.7	14.8
1,1-Dichloroethylene		150	600
1-2-Dichloroethylene		3750	15000
Dichloromethane		16	64
2,4-Dichlorophenol		800	3200
2,4-Dinitrotoluene		5.2	20.8
Ethylbenzene		540	2160
Formaldehyde		2000	8000
Hexachlorobutadiene		2.8	5.4
Methyl ethyl ketone		8000	32000
MTBE (Methyl t-butyl ether)		1435	5740
Nitrobenzene		45	180
PAHs (total)		50	200
Petroleum H/Cs, C6 to C9		650	2600
Petroleum H/Cs, C10 to C36		10000	40000
Phenols (total, non-halogenated)		560	2240
Polychlorinated biphenyls		12	48
Styrene		120	480
1,1,1,2-Tetrachloroethane		400	1600
1,1,2,2-Tetrachloroethane		5.0	20
Tetrachloroethylene		200	800
Toluene		1150	4600
Trichlorobenzenes (total)		3300	13200
1,1,1-Trichloroethane		1200	4800
1,1,2-Trichloroethane		48	192
Trichloroethylene		11600	46400
2,4,6-Trichlorophenol		1770	7080
Vinyl chloride		1.5	6.0
Xylenes (total)		890	3560
Pesticides			
Aldrin + Dieldrin	0.05	1.2	4.8
DDT + ODD + ODE	0.05	50	200
2,4-D	0.05	120	480
Chlordane	0.05	4	16
Heptachlor	0.05	1.2	4.8

The Leachable Concentration Threshold (LCT) Limits (mg/l) as listed in the Regulations to which the results of the analysis were compared with is given below:

Table 3: Leachable Concentration Threshold (LCT) Limits

Elements & Chemical Substances in Waste	LCT0	LCT1	LCT2	LCT3
Metal Ions				
As, Arsenic	0.01	0.5	1	4
B, Boron	0.5	25	50	200
Ba, Barium	0.7	35	70	280
Cd, Cadmium	0.003	0.15	0.3	1.2
Co, Cobalt	0.5	25	50	200
Cr Total, Chromium Total	0.1	5	10	40
Cr (VI), Chromium (VI)	0.05	2.5	5	20
Cu, Copper	2.0	100	200	800
Hg, Mercury	0.006	0.3	0.6	2.4
Mn, Manganese	0.5	25	50	200
Mo, Molybdenum	0.07	3.5	7	28
Ni, Nickel	0.07	3.5	7	28
Pb, Lead	0.01	0.5	1	4
Sb, Antimony	0.02	1.0	2	8
Se, Selenium	0.01	0.5	1	4
V, Vanadium	0.2	10	20	80
Zn, Zinc	5.0	250	500	2000
Inorganic Anions				
TDS	1000	12500	25000	100000
Chloride	300	15000	30000	120000
Sulphate	250	12500	25000	100000
N03 as N, Nitrate-N	11	550	1100	4400
F, Fluoride	1.5	75	150	600
CN- (total), Cyanide Total	0.07	3.5	7	28
Organics				
Benzene		0.01	0.02	0.08
Benzo(a)pyrene		0.035	0.07	0.28
Carbon tetrachloride		0.20	0.40	1.6
Chlorobenzene		5.0	10	40
Chloroform		15	30	120
2-Chlorophenol		15	30	120
Di (2 ethylhexyl) phthalate		0.50	1	4
1,2-Dichlorobenzene		5	10	40
1,4-Dichlorobenzene		15	30	120
1,2-Dichloroethane		1.5	3	12
1,1-Dichloroethylene		0.35	0.7	2.8
1-2-Dichloroethylene		2.5	5	20
Dichloromethane		0.25	0.5	2
2,4-Dichlorophenol		10	20	80

Elements & Chemical Substances in Waste	LCT0	LCT1	LCT2	LCT3
2,4-Dinitrotoluene		0.065	0.13	0.52
Ethylbenzene		3.5	7	28
Formaldehyde		25	50	200
Hexachlorobutadiene		0.03	0.06	0.24
Methyl ethyl ketone		100	200	800
MTBE (Methyl t-butyl ether)		2.5	5.0	20.0
Nitrobenzene		1	2	8
PAHs (total)		N/A	N/A	N/A
Petroleum H/Cs, C6 to C9		N/A	N/A	N/A
Petroleum H/Cs, C10 to C36		N/A	N/A	N/A
Phenols (total, non-halogenated)		7	14	56
Polychlorinated biphenyls		0.025	0.05	0.2
Styrene		1.0	2	8
1,1,1,2-Tetrachloroethane		5	10	40
1,1,2,2-Tetrachloroethane		0.65	1.3	5.3
Tetrachloroethylene		0.25	0.5	2
Toluene		35	70	280
Trichlorobenzenes (total)		3.5	7	28
1,1,1-Trichloroethane		15	30	120
1,1,2-Trichloroethane		0.6	1	4
Trichloroethylene		0.25	2	8
2,4,6-Trichlorophenol		10.0	20	80
Vinyl chloride		0.015	0.03	0.12
Xylenes (total)		25	50	200
Pesticides				
Aldrin + Dieldrin		0.015	0.03	0.03
DDT + DDD + DOE		1	2	2
2,4-D		1.5	3	3
Chlordane		0.05	0.1	0.1
Heptachlor		0.015	0.03	0.03

7. TC AND LC RESULTS AND SUMMURY OF THE WASTE ASSESSMENT

The TC and LC results for the composite samples are provided in Annexure B. shows the Total Concentration Threshold Values (TCT), as well as the analysed results for Vulindlela Sediment. The results were determined using the average results of the 3 samples. If results for any of the 3 samples are below the detection limit for any specific compound, but at least one of the samples are above the detection limit, those under the detection limit were ignored in the average calculation. For the leachable concentrations the Borax and TCLP samples were average separately, and the worst-case scenario used. If any of the three samples had results under the detection limit for a specific compound, but there were results above the detection as well, the results under the detection limit were ignored.

7.1 TC and LC Results Findings

The findings on TC and LC results indicate that the highest Total Concentration Value is ≤TCT1 and that the highest Leachable Concentration Value is ≤TCT1.

8. WASTE TYPE DETERMINATION

Regulation 7 of the Norms and Standards lists the conditions to which the results must be compared to, in order to determine the type of waste. This will ultimately determine the barrier requirements for landfill disposal for the specific waste type.

Based on the above assessment, the waste samples are all classified as a **Waste Type 3**, based on the results of the TC and LC analysis (worst case scenario) and the determination of waste types for landfill disposal regulation7(2)(d) of the Norms and Standards stipulates that;

- Wastes with any element or chemical substance concentration above the LCT0 but below or equal to the LCT1 limits and all TC concentrations below or equal to the TCT1 limits (LCT0 < LC ≤ LCT1 and TC ≤ TCT1) are Type 3 Wastes.

9. DISPOSAL BARRIER REQUIREMENTS

The National Norms and Standards for Disposal of Waste to Landfill (published under Government Notice R636 in Government Gazette 36784 of 23 August 2013) (Regulation 636) contains the standard containment barriers for all of the various waste types, namely Types 1 to 4.

Regulation 4(1) of Regulation 636 stipulates that waste assessed in terms of the Norms and Standards and classified as a Waste Type 3 must be disposed to a licensed landfill as follows:

- *"Type 3 waste may only be disposed of at a Class C landfill designed in accordance with section 3(1) and (2) of these Norms and Standards, or, subject to section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998)."*

The class of landfill is determined using GN R. 636. Table 1.4 indicates the Class landfill for each of the different waste types. However, there are other landfill restrictions in GN R. 636, such as pH. The pH of 7.72 for Vulindlela Sediments fall within the disposal limits. The pH between the different samples varies between pH 7.4 and 8.2.

Therefore, based on the above and the provisions for containment barriers contained in Regulation 636, the specified barrier for Waste Type 3 waste is a Class C Liner. The liner is depicted below.

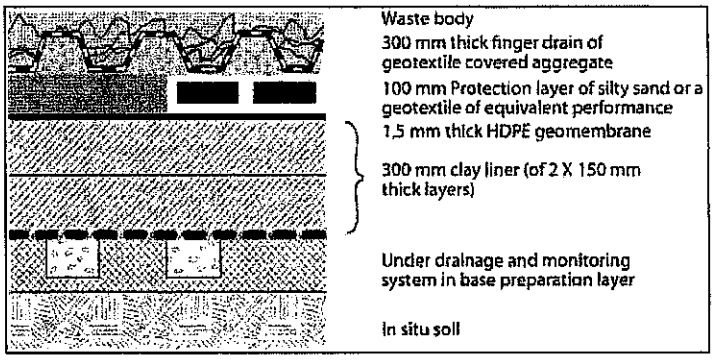


Figure 2- Class C Containment Barrier

10. MATERIAL SAFETY DATA SHEET

A Material Safety Data Sheet (MSDS) was developed for the waste stream to provide comprehensive information related to:

- health effects of exposure to the waste,
- hazard evaluation related to the waste handling, storage or use,
- measure to protect workers at risk of exposure, and,
- emergency procedures.

The MSDS is attached as **Annexure D** to the report.

11. CONCLUSION

iX engineers was requested to conduct a waste assessment on three composite desilt waste samples obtained through grid sampling, from the Vulindlela Maintenance and Desilt project, to confirm the type of waste and to determine the type of barrier to be used for the waste management facility in accordance with the waste legislation of South Africa where these waste can be disposed of. An additional sample was also collected to conduct SANS 10234 Waste Classification.

The detailed results are reflected in the UISOL Waste Assessment and Classification Report, dated August 2019, attached to this report as **Appendix A.**

The classification showed that there are no physical and aquatic hazards associated with the sediment. The sediment does have a carcinogenic hazard as well as a specific target organ toxicity hazard. The main driver for the health hazards is the quartz at a concentration of 93.2%.

The sediment contains microbial contaminants (Faecal Coliforms and E. coli). E. coli infection can lead to diarrhoea, high blood pressure, kidney problems, heart disease and even haemolytic uremic syndrome.

Following the above, an assessment of the waste stream was conducted by iX engineers. UIS Organic Laboratory, an independent and SANAS accredited laboratory, assisted in the analysis of the waste samples to assess and classify the waste and recommend the disposal requirements in terms of the the waste legislation of South Africa.

The waste samples are classified as a **Waste Type 3**, based on the findings of the TC and LC results. **The required containment barrier according to Regulation 636 for a Waste Type 3 waste is a Class C containment barrier.**

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12. REFERENCES

1. National Environmental Management: Waste Act, 2008 (Act No.59 of 2008);
2. Waste Classification and Management Regulations, 2013 (published under Government Notice R634 in Government Gazette 36784 of 23 August 2013);
3. The National Norms and Standards for Disposal of Waste to Landfill (published under Government Notice R636 in Government Gazette 36784 of 23 August 2013); and
4. UIS Organic Analytical Reports – August 2019

APPENDIX A

UIS ORGANIC LABORATORY WASTE ASSESSMENT AND CLASSIFICATION REPORT, DATED AUGUST 2019

UIS ORGANIC LABORATORY

Waste Assessment

&

Classification Report

IX ENGINEERS

WASTE STREAM:

VULINDLELA SEDIMENT DESILT SAMPLING

August 2019

UIS ORGANIC LABORATORY

UIS Organic Disclaimer:

All the samples mentioned in this report were analysed as received by the laboratory. UIS Organic laboratory takes no responsibility for sample/s prior to submission: this includes sampling, sample container, storage and shipping to our testing facility. The sample is analysed as per customer request.

The information contained in this report is based upon data considered to be accurate at the time of preparation. UIS Organic Laboratory (Pty) Ltd, has taken reasonable care in the preparation of this report, however it assumes no responsibility or liability to the accuracy as well as the suitability of the information, for both the intended purpose of this waste stream or any consequences of its use. Since regulatory standards and guideline recommendations are revised on a continues basis, UIS Organic Laboratory cannot insure that the information contained in this report will be current at the time of use.

Storage Conditions in the Laboratory: Fridge @ <6 ^{0}C

Abbreviations:

UTD – Unable to Determine

NR – Not Requested

BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)

TOM – Total Organic Matter

TOC – Total Organic Carbon

LD50 - Lethal Dose, 50% kill

NOEC – No Observed Effect Concentration

NOAEL – No Observed Adverse Effect Level

LOAEC – Lowest Observed Adverse Effect Level

CCOHS - Canadian Centre for Occupational Health and Safety

XRF - X-ray fluorescence spectroscopy

Executive Summary

Vulindlela sediment were submitted by IX Engineers to UIS Organic Laboratory (Pty) Ltd for Waste Assessment and Waste Classification. The sample were registered on 15 May 2019.

After the waste assessment the sample were determined to be a Type 3 Waste, that should be disposed at a Class C landfill. We analysed three (3) samples for waste assessment, however the average is used in this report.

The classification showed that there are no physical and aquatic hazards associated with the sediment. The sediment does have a carcinogenic hazard as well as a specific target organ toxicity hazard. The main driver for the health hazards is the quartz at a concentration of 93.2%.

The sediment contains microbial contaminants (Faecal Coliforms and *E. coli*). *E. coli* infection can lead to diarrhoea, high blood pressure, kidney problems, heart disease and even haemolytic uremic syndrome.

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Introduction

UIS Organic Laboratory was appointed to do Waste Assessment, Classification and compile an SDS (not part of this report). This was performed using mainly the following standards and/or regulations. Please note that the report contains various quotes or copied section, directly from the following regulations.

- GN R. 634: Waste Classification and Management Regulations (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- GN R. 635: National Norms and Standards for the Assessment of Waste for Landfill Disposal (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- GN R. 636: National Norms and Standards for Disposal of Waste to Landfill (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))
- Globally Harmonised System of Classification and Labelling of Chemicals (GHS); SANS 10234:2008.

The Waste Classification and Management regulations were published on 23 August 2013. This were published in conjunction with two other acts, GN R. 635 and GN R.636. The purpose of these regulations is as follow;

1. Regulates the classification and management of waste
2. Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence
3. Prescribe requirement for the disposal of waste to landfill
4. Prescribe requirements and timeframes for the management of certain wastes
5. Prescribe general duties of waste generators, transporters and managers
6. Prescribe the requirements for the assessment of waste prior to disposal to landfill
7. Determine the requirements for the disposal of waste to landfill.

In terms of the Waste Classification and Management Regulations of 23 August 2013, Section 4 (2) states;

All waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) day of generation.

These regulations also state in Section 5 (1);

That generators of hazardous waste must ensure that a safety data sheet for the hazardous waste is prepared in accordance with SANS 10234.

According to SANS 10234:2008, the classification criteria includes the following hazards;

1. Physical Hazards
2. Health Hazards
3. Environmental Hazards

1.1 Waste Material

Sedimente sample, Vulindlela sediment desilt, were submitted for analysis.

1.2 Legal Framework

- GN R. 635: National Norms and Standards for the Assessment of Waste for Landfill Disposal (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))

- GN R. 636: National Norms and Standards for Disposal of Waste to Landfill (National Environmental Management: Waste Act, 2008 (Act no.59 of 2008))

1.3 Methodology

To assess waste, the following is required;

- Identification of chemical substances present in the waste
- Determination of the Total Concentration (TC) and Leachable Concentration (LC) for the elements and chemical substances identified in the waste.
- These analyses must be conducted by laboratories that is accredited by the South African National Accreditation System (SANAS).
- The tested TC and LC values must be compared to the threshold limits found in GN R. 635 (Section 6 (1 and 2)).
- Based on the TC and LC values found in the waste, exceeding the TCT and LCT limits, the specific Type of Waste can be determined.
- Leachable concentration is determined by using the Australian Standard AS 4439.1 – AS 4439.3.
- The TC for the metal concentration were determined using an aqua regia digestion.

1.4 Results and Laboratory Analysis

Table 1.1 shows the Total Concentration Threshold Values (TCT), as well as the analysed results for Vulindlela Sediment. The results were determined using the

average results of the 3 samples submitted to UIS Organic Laboratory under the lab number 14178, registered 15 February 2019. If results for any of the 3 samples are below the detection limit for any specific compound, but at least one of the samples are above the detection limit, those under the detection limit were ignored in the average calculation.

For the leachable concentrations the Borax and TCLP samples were average separately, and the worst-case scenario used for Table 1.3. If any of the three samples had results under the detection limit for a specific compound, but there were results above the detection as well, the results under the detection limit were ignored.

Table1.1: TCT value Comparison in mg/kg.

Element/ Chemical substance in waste	Tested Analysis	TCT0	TCT1	TCT2
Metal Ions in mg/kg				
As, Arsenic	4.025	5.8	500	2000
B, Boron	54.1	150	15000	60000
Ba, Barium	60.097	62.5	6250	25000
Cd, Cadmium	<4	7.5	260	1040
Co, Cobalt	6.1	50	5000	20000
Cr (total), Chromium Total	44.207	46000	800000	N/A
Cr (VI), Chromium (VI)	<2	6.5	500	2000
Cu, Copper	15.213	16	19500	78000
Hg, Mercury	<0.16	0.93	160	640
Mn, Manganese	101.047	1000	25000	100000
Mo, Molybdenum	<7.467	40	1000	4000
Ni, Nickel	11.917	91	10600	42400
Pb, Lead	20.753	20	1900	7600
Sb, Antimony	<3.733	10	75	300
Se, Selenium	4.32	10	50	200
V, Vanadium	33.963	150	2680	10720
Zn, Zinc	62.74	240	160000	640000
Inorganic Anions				
TDS	N/A			
Chloride	N/A			
Sulphate	N/A			
NO3 as N, Nitrate-N	N/A			
F, Fluoride	<4	100	10000	40000
CN- (Total), Cyanide Total	<0.1	14	10500	42000
Organics				
Benzene	<0.024		10	40
Benzo(a)pyrene	<0.2		1.7	6.8
Carbon tetrachloride	<1		4	16
Chlorobenzene	<0.4		8800	35200
Chloroform	<1		700	2800

2-Chlorophenol	<0.4		2100	8400
Di (2 ethylhexyl) phthalate	0.46		40	160
1,2-Dichlorobenzene	<0.4		31900	127600
1,4-Dichlorobenzene	<0.4		18400	73600
1,2-Dichloroethane	<0.4		3.7	14.8
1,1-Dichloroethylene	<2		150	600
1,2-Dichloroethylene	<2		3750	15000
Dichloromethane	<10		16	64
2,4-Dichlorophenol	<0.4		800	3200
2,4-Dinitrotoleune	<1		5.2	20.8
Ethylbenzene	<0.4		540	2160
Formaldehyde	<2		2000	8000
Hexachlorobutadiene	<0.4		2.8	5.4
Methyl ethyl Ketone	<2		8000	32000
MTBE (Methyl t-butyl ether)	<0.1		1435	5740
Nitrobenzene	<0.2		45	180
PAHs (total)	0.41		50	200
Petroleum H/Cs, C6 to C9	0.26		650	2600
Petroleum H/Cs, C10 to C36	<38		10000	40000
Phenols Speciated (total, non-halogenated)	<0.4		560	2240
Polychlorinated biphenyls	<0.35		12	48
Styrene	<1		120	480
1,1,1,2-Tetrachloroethane	<2		400	1600
1,1,2,2-Tetrachloroethane	<2		5	20
Tetrachloroethane	<2		200	800
Toluene	0.26		1150	4600
Trichlorobenzenes (total)	<1		3300	13200
1,1,1-Trichloroethane	<1		1200	4800
1,1,2-Trichloroethane	<1		48	192
Trichloroethylene	<2		11600	46400
2,4,6-Trichlorophenol	<0.4		1770	7080
Vinyl chloride	<0.02		1.5	6
Xylenes (total)	<1		890	3560
Pesticides				
Aldrin + Dieldrin	<0.02	0.05	1.2	4.8
DDT + DDD + DDE	<0.02	0.05	50	200
2,4-D	UTD	0.05	120	480
Chlordane	<0.02	0.05	4	16
Heptachlor	<0.02	0.05	1.2	4.8

Table 1.2: TCT values to determine if Type 4 waste is applicable

Chemical Substances in Waste	Total Concentration (mg/kg)
Organics	
TOC	95 667 (should be < 30 000)
BTEX	<6
PCB's	<1
Mineral Oil (C10 to C40)	<500
Pesticides	
Aldrin + Dieldrin	<0.05
DDT + DDD + DDE	<0.05
2,4-D	UTD
Chlordane	<0.05
Heptachlor	<0.05

Table 1.3 shows the Leachable Concentration Threshold Values (LCT), as well as the analysed results for

Table1.3: LCT value Comparison in mg/liter.

Element/ Chemical substance in waste	Tested Analysis	LCT0	LCT1	LCT2	LCT3
Metal Ions mg/liter					
As, Arsenic	<0.01	0.01	0.5	1	4
B, Boron*	0.1	0.5	25	50	200
Ba, Barium	0.427	0.7	35	70	280
Cd, Cadmium	0.014	0.003	0.15	0.3	1.2
Co, Cobalt	0.023	0.5	25	50	200
Cr (total), Chromium Total	0.04	0.05	2.5	5	20
Cr (VI), Chromium (VI)	<0.05	0.05	2.5	5	20
Cu, Copper	0.033	2	100	200	800
Hg, Mercury	0.005	0.006	0.3	0.6	2.4
Mn, Manganese	1.27	0.5	25	50	200
Mo, Molybdenum	0.08	0.07	3.5	7	28
Ni, Nickel	0.02	0.07	3.5	7	28
Pb, Lead	<0.01	0.01	0.5	1	4
Sb, Antimony	0.016	0.02	1	2	8
Se, Selenium	<0.01	0.01	0.5	1	4
V, Vanadium	0.077	0.2	10	20	80
Zn, Zinc	0.287	5	250	500	2000
Inorganic Anions mg/liter					
TDS	637	1000	12500	25000	100000
Chloride	<20	300	15000	30000	120000
Sulphate	<20	250	12500	25000	100000
NO3 as N, Nitrate-N	<5	11	550	1100	4400
F, Fluoride	0.06	1.5	75	150	600

Cn- (Total), Cyanide Total	<0.07	0.07	3.5	7	28
Organics mg/liter					
Benzene	<0.001		0.01	0.02	0.08
Benzo(a)pyrene	<0.001		0.035	0.07	0.28
Carbon tetrachloride	<0.005		0.2	0.4	1.6
Chlorobenzene	<0.002		5	10	40
Chloroform	0.006		15	30	120
2-Chlorophenol	<0.02		15	30	120
Di (2 ethylhexyl) phthalate	<0.1		0.5	1	4
1,2-Dichlorobenzene	<0.002		50	10	40
1,4-Dichlorobenzene	<0.002		15	30	120
1,2-Dichloroethane	<0.002		1.5	3	12
1,1-Dichloroethylene	<0.01		0.35	0.7	2.8
1,2-Dichloroethylene	<0.01		2.5	5	20
Dichloromethane	<0.05		0.25	0.5	2
2,4-Dichlorophenol	<0.02		10	20	80
2,4-Dinitrotoluene	<0.05		0.065	0.13	0.52
Ethylbenzene	<0.002		3.5	7	28
Formaldehyde	<0.1		25	50	200
Hexachlorobutadiene	<0.002		0.03	0.06	0.24
Methyl ethyl Ketone	<0.1		100	200	800
MTBE (Methyl t-butyl ether)	<0.005		2.5	5	20
Nitrobenzene	<0.01		1	2	8
PAHs (total)	<0.2		N/A	N/A	N/A
Petroleum H/Cs, C6 to C9	0.076		N/A	N/A	N/A
Petroleum H/Cs, C10 to C36	1.33		N/A	N/A	N/A
Phenols Speciated (total, non halogenated)	<0.2		7	14	56
Polychlorinated biphenyls	<0.01		0.025	0.05	0.2
Styrene	<0.005		1	2	8
1,1,1,2-Tetrachloroethane	<0.01		5	10	40
1,1,2,2-Tetrachloroethane	<0.01		0.65	1.3	5.3
Tetrachloroethane	<0.01		0.25	0.5	2
Toluene	0.067		35	70	280
Trichlorobenzenes (total)	<0.005		3.5	7	28
1,1,1-Trichloroethane	<0.005		15	30	120
1,1,2-Trichloroethane	<0.005		0.6	1	4
Trichloroethylene	<0.01		0.25	2	8
2,4,,6-Trichlorophenol	<0.02		10	20	80
Vinyl chloride	<0.001		0.015	0.03	0.12
Xylenes (total)			25	50	200
Pesticides mg/liter					
Aldrin + Dieldrin	<0.001		0.015	0.03	0.03
DDT + DDD + DDE	<0.001		1	2	2

2,4-D	UTD	[redacted]	1.5	3	3
Chlordane	<0.001	[redacted]	0.05	0.1	0.1
Heptachlor	<0.001	[redacted]	0.015	0.03	0.03

* Only the Boron from the TCLP were used.

1.5 Type of Waste

The type of waste is determined by using section 7 of GN R.365, as explained below.

(1) The specific type of waste for disposal to landfill must be determined by comparing the TC and LC of the elements and chemical substances in the waste with the TCT and LCT limits specified in section 6 of these Norms and Standards.

(2) Based on the assessment of the particular waste destined for disposal to landfill, the type of waste is determined as follows:

(a) Wastes with any element or chemical substance concentration above the LCT3 or TCT2 limits (LC > LCT3 or TC > TCT2) are Type 0 Wastes;

(b) Wastes with any element or chemical substance concentration above the LCT2 but below or equal to the LCT3 limits, or above the TCT1 but below or equal to the TCT2 limits (LCT2 < LC > LCT3 or TCT1 < TC TCT2), are Type 1 Wastes;

(c) Wastes with any element or chemical substance concentration above the LCT1 but below or equal to the LCT2 limits and all concentrations below or equal to the TCT1 limits (LCT1 < LC ≤ LCT2 and TC ≤ TCT1) are Type 2 Wastes;

(d) Wastes with any element or chemical substance concentration above the LCT0 but below or equal to the LCT1 limits and all TC concentrations below or equal to the TCT1 limits (LCT0 < LC ≤ LCT1 and TC ≤ TCT1) are Type 3 Wastes; or

(e) Wastes with all element and chemical substance concentration levels for metal ions and inorganic anions below or equal to the LCT0 and TCT0 limits (LC ≤ LCT0 and TC ≤ TCT0), and with all the chemical substance listed in table 1.2 below the total concentration limits for organics and pesticides, is considered a Type 4 Wastes.

(3) If a particular chemical substance in a waste is not listed with corresponding LCT and TCT limits in section 6 of these Norms and Standards, and the waste has been classified as hazardous in terms of regulation 4(2) of the Regulations based on the health or environmental hazard characteristics of the particular element or chemical substance, the following applies:

(a) the waste is considered to be Type 1 Waste; and
(b) the Department must be informed in writing in 30 days of the particular element or chemical substance not listed in section 6 of these Norms and Standards.

(4) Notwithstanding section 7(2) of these Norms and Standards, if the TC of an element or chemical substance is above the TCT2 limit, and the concentration cannot be reduced to below the TCT2 limit, but the LC for the particular element or chemical substance is below the LCT3 limit, the waste is considered to be a Type 1 Waste.

(5) Wastes listed in item (2)(b) of Annexure 1 to the Regulations are considered to be Type 1 Waste, unless assessed and determined otherwise in terms of these Norms and Standards.

(6) Notwithstanding section 7(2) of these Norms and Standards, wastes with all element or chemical substance leachable concentration levels for metal ions and inorganic anions below or equal to the LCT0 limits are considered to be Type 3 waste, irrespective of the total concentration of elements or chemical substances in the waste, provided that-

(a) all chemical substance concentration levels are below the total concentration limits for organics and pesticides in table 1.2:

1.6 Conclusion regarding the Type of Waste

To determine the waste type, both TC and LC results are necessary.

According to the analysed results, this waste stream is a Type 3 waste. This can be seen using the below legend, and looking at Table 1.1, 1.2 and 1.3.

LEGEND	TYPE 0	TYPE 1	TYPE 2	TYPE 3	TYPE 4

1.7 Class of Landfill and/or Liner to use

The class of landfill is determined using GN R. 636. Table 1.4 indicates the Class landfill for each of the different waste types. However, there are other landfill restrictions in GN R. 636, such as pH. The pH of 7.72 for Vulindlela Sedimentis within the disposal limits. The pH between the different samples varies between pH 7.4 and 8.2. The applicable landfill design for a type 3 waste is indicated by the coloured block in Table 1.4, and Figure 1.1.

Table 1.4: Waste Type corresponding to landfill design.

Waste Type	Landfill Disposal Requirements
Type 0	The disposal of Type 0 waste to landfill is not allowed. The waste must be treated and re-assessed in terms of the Norms and Standards for Assessment of Waste for Landfill Disposal.
Type 1	Type 1 waste may only be disposed of at a Class A landfill designed in accordance with section 3(1) and (2) of these Norms and Standards, or, subject to section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a Hh / HH landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., Department of Water Affairs and Forestry, 1998).
Type 2	Type 2 waste may only be disposed of at a Class B landfill designed in accordance with section 3(1) and (2) of these Norms and Standards, or, subject to section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 3	Type 3 waste may only be disposed of at a Class C landfill designed in accordance with section 3(1) and (2) of these Norms and Standards, or, subject to section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 4	Type 4 waste may only be disposed of at a Class D landfill designed in accordance with section 3(1) and (2) of these Norms and Standards, or, subject to section 3(4) of these Norms and Standards, may be disposed of at a landfill site designed in accordance with the requirements for a GLB landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).

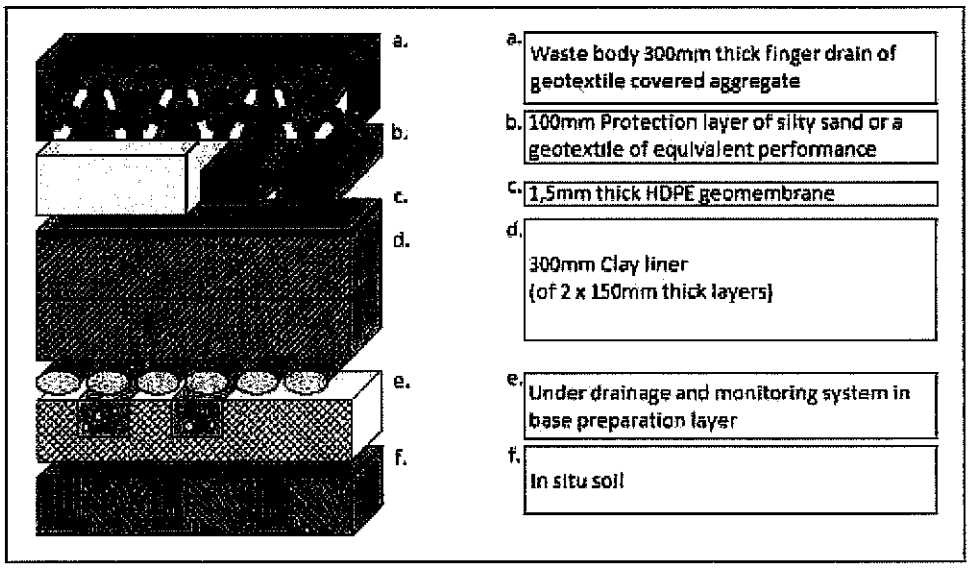

Figure 1.1: Class C Landfill Design

2 Waste Classification

2.1 Waste Material

Sediment sample, Vulindlela Sediment, were submitted for analysis.

2.2 Legal Framework

The standard used for waste classification is the; Globally Harmonised System of Classification and Labelling of Chemicals (GHS); SANS 10234:2008.

2.3 Methodology

Classification consist of three Hazard Classes, as seen in table 2.1.

Table 2.1: Hazard Classes and associated methods.

Hazard Class	Methods
Physical Hazards	All 14 Physical Hazard categories has different methods specified by SANS 10234.
Health Hazards	Bio-Elution analysis; Gastric Extraction, Intestinal fluid, Alveolar fluid and Sweat. As well as estimates using the ingredients.
Aquatic Hazards	Acute Toxicity: Fish species *P. reticulata* (Guppy), OECD 203; Crustacea species *D. magna* (Water flea), OECD 202; Aquatic Plant Species *S. polyrhiza* (Duckweed), OECD 201.

2.4 Results and Lab Analysis

For most of the analysis the product as such was tested. However, in some instances estimations was made, based on the composition of the waste stream. According to SANS 10234, the following criteria (cut-off values) is used to determine if a compound should be included in both an SDS and Classification report.

- If a compound is ≥ 1 % and this compound contributes to; Acute Toxicity, Skin Corrosion, Skin irritation, Serious eye damage or eye irritation, respiratory

sensitisation, skin sensitivity, Mutagenicity – Category 2, target organ toxicity or if its hazardous to the aquatic environment.

- If a compound is ≥ 0.1 % and this compound contributes to; Mutagenicity – Category 1, Carcinogenicity or reproductive toxicity.

Table 2.2 shows the composition for this waste stream.

Table 2.2: The composition of waste stream – Vulindlela Sediment

Element	Cas No	XRF (%)	XRD (%)
Iron (Fe)	7439-89-6	3.78	1.02
Silicon (Si)	7440-21-3	39.44	44.2
Aluminium (Al)	7429-90.5	2.30	1.1
Potassium (K)	7440-09-7	0.17	0.08
Phosphorus (P)	7723-14-0	0.04	N/A
Manganese (Mn)	7439-96-5	0.17	N/A
Calcium (Ca)	7440-70-2	0.71	0.27
Magnesium (Mg)	7439-95-4	0.15	0.2
Titanium (Ti)	7440-32-6	0.19	N/A
Vanadium (V)	7440-62-2	0.01	N/A
Barium (Ba)	7440-39-3	0.02	N/A
Chromium (Cr)	7440-47-3	0.10	N/A
Strontium (Sr)	7440-24-6	0.01	N/A
Zirconium (Zr)	7440-67-7	0.02	N/A
Sulphur (S)	7704-34-9	0.00	0.15
Lead (Pb)	7439-92-1	0.01	N/A
Zinc (Zn)	7440-66-6	0.01	N/A
Oxide		49.3	52.3
Other (% unless stated otherwise)			
Carbon	0.98		
Sulphur	0.046		
TOM	57.21		
Moisture	14.89		
Total Volatiles	20.29		
Faecal Coliforms	452 1g dry weight		
E. coli	325 1g dry weight		

The results of the XRD analysis are below;

Quartz 93.2 %

Kaolinite 2.1%

Geothite 1.4%

Spinel 1.2%

Muscovite 0.8%

Gypsum 0.8%

Calcite 0.2%

Hematite 0.2%

2.4.1 Physical Analysis

The parameters listed below were analysed as per SANS10234:2008. Therefore, it's not estimations, but actual laboratory results.

2.4.1. A. Explosive

Extremely insensitive article that do not present a mass explosion hazard and the probability of accidental initiation or propagation is negligible. (1.6)

2.4.1. B. Flammable Gasses

There was no measurable flammable gas produced

2.4.1. C. Flammable Aerosols

N/A

2.4.1. D. Oxidising Gasses

N/A and no oxidising gasses were produced

2.4.1. E. Gasses under Pressure

N/A

2.4.1. F. Flammable Liquids (Up to 93 °C)

N/A

2.4.1. G. Flammable Solids

Not Flammable

2.4.1. H. Self-Reactive Substances and Mixture

Type G: A substance or mixture that, during laboratory testing, neither detonates in the cavitated state nor deflagrates at all, shows little or no effect when heated under confinement, and shows no explosive power. However, the substance or mixture shall be thermally stable with a self-accelerating decomposition temperature (SADT) of 60 °C to 75 °C for a 50kg package.

2.4.1. I. Pyrophoric Substances

Not pyrophoric

2.4.1. J. Self-Heating Substance and Mixtures

Not self-heating

2.4.1. K. Substances and mixture that on contact with water emits flammable gasses

No flammable gas emitted

2.4.1. L. Oxidising substances and Mixtures

Not oxidising, Category 3b; The criteria for category 1 and 2 are not met.

2.4.1. M. Organic Peroxides

Not a peroxide

2.4.1. N. Corrosive to Metals

Not Corrosive

2.4.2. Health Hazards

Table 2.3 below shows the metals analysed in the bio-elution (Bio-accessibility) analysis done on artificial Gastric, Intestinal, Alveolar and Sweat fluid. Table 2.4 shows the results of the metals that are above the detection limit. The % is shown to 2 decimals only, if there is no value to the second decimal the result in percentage are indicated as 0. The results from Table 2.4 are used to estimate the health hazards and not the XRF and XRD results from Table 2.2, unless Table 2.2 contains compounds that is not included in Table 2.4. Table 2.4 shows how bio-available the metals in

Vulindlela sediment is, as appose to the total concentration using XRF, XRD or Aqua Regia digestion used for Waste Assessment Table 1.1.

Table 2.3: Metals analysed in the Bio-elution analysis

Ag	Cr	Ho	Nd	Sc	Tm
Al	Cs	In	Ni	Se	U
As	Cu	Ir	Os	Si	V
Au	Dy	K	P	Sm	W
B	Er	La	Pb	Sn	Y
Ba	Eu	Li	Pd	Sr	Yb
Be	Fe	Lu	Pr	Ta	Zn
Bi	Ga	Mg	Pt	Tb	Zr
Ca	Gd	Mn	Rb	Te	
Cd	Ge	Mo	Rh	Th	
Ce	Hf	Na	Ru	Ti	
Co	Hg	Nb	Sb	Tl	

Table 2.4: Bio-Elution results for Vulindlela Sediment.

	Gastric		Intestinal		Alveolar		Sweat	
	mg/kg	%	mg/kg	%	mg/kg	%	mg/kg	%
Al	1580	0.16	11	0.00	2	0.00	723	0.07
B	1	0.00	0	0.00	0	0.00	1	0.00
Ba	50	0.01	12	0.00	3	0.00	50	0.01
Ca	4640	0.46	845	0.08	230	0.02	4487	0.45
Ce	12	0.00	0	0.00	0	0.00	2	0.00
Co	4	0.00	0	0.00	0	0.00	2	0.00
Cr	33	0.00	0	0.00	0	0.00	8	0.00
Cu	2	0.00	0	0.00	0	0.00	0	0.00
Fe	1994	0.20	2	0.00	0	0.00	643	0.06
Ga	2	0.00	0	0.00	0	0.00	1	0.00
K	147	0.01	0	0.00	0	0.00	120	0.01
La	1	0.00	0	0.00	0	0.00	0	0.00
Li	1	0.00	0	0.00	0	0.00	0	0.00
Mg	402	0.04	36	0.00	0	0.00	267	0.03
Mn	586	0.06	7	0.00	8	0.00	556	0.06
Nd	1	0.00	0	0.00	0	0.00	1	0.00
Ni	2	0.00	0	0.00	0	0.00	1	0.00
P	29	0.00	2	0.00	0	0.00	2	0.00
Pb	18	0.00	0	0.00	0	0.00	2	0.00
Si	1299	0.13	114	0.01	207	0.02	773	0.08
Sr	3	0.00	0	0.00	0	0.00	2	0.00
Ti	12	0.00	0	0.00	0	0.00	15	0.00
U	1	0.00	0	0.00	0	0.00	0	0.00

V	4	0.00	0	0.00	0	0.00	1	0.00
Zn	10	0.00	0	0.00	0	0.00	6	0.00

To determine the various toxicities (ATE) below, LC_{50} values for the constitutes of this waste stream, were sourced from the Internet, mainly RTECS and ECHA CLP online. Table 2.5 below shows the LC_{50} values. If the LC_{50} value is > 2000 mg/kg you do not need to include it in the ATE calculations.

2.4.2. A. Acute Toxicity

According to SANS 10234:2008, chemical substances can be allocated to one of five hazard categories, based on acute toxicity by oral, dermal or inhalation route of exposure. To establish the toxicity, the results from the bio-elution analysis were used; the gastric and intestinal fluid for oral toxicity, alveolar fluid for inhalation toxicity, and sweat fluid for dermal toxicity.

Acute toxicity estimates (ATE) are used to determine the toxicity. According to SANS 10234:2008 you only need to calculate the ATE's for compounds that exceeds either 0.1% or 1% as per the above explanation under section 2.4. Table 2.5 summarises the acute toxicity hazard.

Table 2.5: Acute toxicity hazards of Vulindlela Sediment

	Oral Toxicity (mg/kg)	Dermal Toxicity (mg/kg)	Inhalation Toxicity (mg/l)
Calculated ATE:	> 5000 mg/kg	> 5000 mg/kg	> 20 mg/l
Acute Toxicity Category:	Not Classified	Not Classified	Not Classified
Symbol:	N/A	N/A	N/A
Signal Word:	N/A	N/A	N/A
Hazard Statement:	N/A	N/A	N/A

Table 2.6 shows the available LC_{50} data used in the acute toxicity classification. In some instances, the element is used to source LD_{50} and in other instances salts are used.

Table 2.6: LC_{50} values obtained from databases.

Compound	Oral	Inhalation	Dermal
Iron	98.6 g/kg	< 250 mg/m3	No Data
Aluminium	> 15900mg/kg	6.1 mg/l/4h	> 5000 mg/kg
Potassium	333 - 338 mg/kg	5.1 mg/l/h	No Data
Calcium	300 mg/kg	No Data	No Data
Magnesium	> 2000 mg/kg	No Data	> 2000 mg/kg
Manganese	> 2000 mg/kg	> 5.14 mg/l/4h	No Data
Hematite	14.6 mg/kg	>2.2 mg/l/1h	No Data

Apart from the metals tested for in the bio-elution analysis, the sample also contain microbial contaminants (Faecal Coliforms and *E. coli*). *E. coli* infection can lead to diarrhoea, high blood pressure, kidney problems, heart disease and even haemolytic uremic syndrome.

The most likely route of exposure to Vulindlela Sediment would be inhalation of dust. It's unlikely that it will be orally consumed, especially not chronically. It's also unlikely that will be applied to the skin, although it can come into contact with skin should you work with the sediment.

2.4.2. B. Skin corrosion and skin irritation

According to SANS 10234:2008, a substance can be classified as a skin corrosive or irritant based on hazards of its constituents. SANS 10234:2008 also states that if the substance has a pH ≤ 2 or ≥ 11.5, the substance is an eye and/or skin corrosive, unless there is data to indicate that the statement is false. For this the sweat bio-elution results were used.

Hematite is a category 2 skin irritant, however the concentration in sediment is only 0.2% which does not warrant classification.

2.4.2. C. Serious eye damage and eye irritation

Muscovite is a category 2 eye irritant and Hematite is a eye corrosive. However the sediment does not need to be classify, because the concentration is only 0.8% and 0.2% respectively. This is also the total concentration and not the bioavailable concentrations.

2.4.2. D. Respiratory sensitization and skin sensitization

According to SANS 10234:2008, respiratory sensitization is when a substance induces specific respiratory hypersensitivity of the airways following inhalation. Examples of this is asthma, rhinitis (conjunctivitis) and alveolitis. Skin sensitization is an allergic reaction after skin contact.

Vulindlela Sediment is not classified as a respiratory or skin sensitizer.

2.4.2. E. Germ cell mutagenicity

According to SANS 10234, this hazard class are for substances that cause mutations in the germ cells of humans and that can be transferred to the progeny.

Mutation is a heritable genetic change that can manifest at phenotypic level and to underlying DNA modifications, such as base pare changes and chromosomal translocations. The term mutagenic and mutagen are used for substances that increases the incidents of mutations in populations of cells or the whole organism.

Genotoxic and genotoxicity applies to substances that alter DNA structure or information, such as interfering with normal replication. Genotoxicity test results are used as indications for mutagenic effects.

According to the RTECS database ingestion of nanoparticles aluminium oxide in rats showed positive results. However larger particles 50 – 200 micron showed negative results. The positive results obtained were numerical chromosome aberrations in bone morrow and bone morrow micronuclei. In cultured mammalian cells both positive and negative results were obtained, rendering it inconclusive.

Vulindlela Sedimentis not classified as a germ cell mutagen, based on its constituents.

2.4.2. F. Carcinogenicity

According to SANS 10234:2008, the carcinogenicity of a substance is based on the inherent properties of the substance. It does not provide information on the level of human cancer risk, which use of the substance may lead to.

According to the Canadian Centre for Occupational Health and Safety (CCOHS), the International Agency for Research on Cancer (IARC) has concluded that crystalline silica in the form of quartz or cristobalite dust is a human carcinogen. Under SANS 10234:2008 Quartz dust is a Carcinogen, Category 1A.

Since the waste stream is a fine material, it is very likely that dust may be created which contains quartz. For this reason, the waste stream will need to be classified. However, if it's not in dust form or in conditions that creates dust this is not necessary. Table 2.7 indicates the carcinogenic classification.

Table 2.7: Carcinogenic Classification

	Category 1A
Symbol	
Signal Word	Danger
Hazard Statement	H350: May Cause Cancer, due to inhalation.

2.4.2. G. Reproductive Toxicity (Teratogenicity in MRHW)

According to SANS 10234:2008, reproductive toxicity can refer to impairment of sexual function, fertility or developmental toxicity. Effects on sexual function and fertility include, alterations to reproductive systems, the onset of puberty, gamete production and transport, sexual behaviour, fertility, the ability to give birth, premature aging or any other effect dependant on the reproductive system.

ECHA has two studies regarding aluminium. Female rats treated with 102 mg/kg body weight per day, had less living pups than untreated females. The body weight, body length and tail length were also significantly lower in the treated group. Therefore, aluminium could have a reproductive impact if consumed daily for a certain time. However, there is no clear human data to classify this waste stream as toxic to reproduction, although it is suspected.

ECHA Reach dossier list one (1) human study, sourced from Gilbert-Barness et al. (1998). A four (4) month old girl were diagnosed with severe mental retardation. At nine (9) years of age her autopsy reveals the following; CNS cortical atrophy, small basal ganglia and hypomyelination of the spinal cord, cerebral cortex, sub cortex and cerebellar white matter. It was later found that the mother took Maalox tablets during pregnancy, which contains 200 mg of aluminium hydroxide per tablet. Later studies suggest that the high aluminium intake by the mother during the critical stages of foetus brain development, caused neurological damage to the infant. The link between aluminium and mental retardation were not proven.

The constituent of Vulindlela Sedimentdoes not signal classification for reproductive toxicity.

2.4.2. H. Specific target organ toxicity – Single exposure (STOT-SE)

For a substance to be classified as a STOT-SE reliable evidence of the following is necessary; consistent identifiable toxic effects in humans and test animals, the toxicological effect should be significant bringing change to the function and morphology of tissue and/or organs, thus there should be serious changes to the biochemistry or haematology of the organism. Human data should be the primary source for classification, considering all the changes that occurred to various organs.

Based on the constituents of Vulindlela Sediment, this waste stream is not considered to be a STOT-SE. However, exposure to pathogens within the waste stream could lead to health effects, however not as severe to be classified as a STOT.

2.4.2. I. Specific target organ toxicity – Repeated exposure (STOT-RE)

The criteria for classification as a STOT-RE is the same as that for STOT-SE, with the exception that the effect only occur after repeated exposure.

Rats were exposed to carbonyl iron in their feed at 2.5% and 3%, for six (6) and nine (9) weeks respectively, followed by a liquid diet. Hepatoxic effects were noticed. This study is from the ECHA Dossier website, and the examinations were done five (5) to nine (9) weeks after the carbonyl iron diet.

Carbonyl iron also showed a positive response in a subacute inhalation study. The NOAEC were determined to be 5 mg/m^3. The rats showed a clear inflammatory reaction in the lungs as well as increased cell proliferation, hypertrophy and hyperplasia at 50 and 250 mg/m^3. No systemic endpoints were investigated.

In animal studies using airborne aluminium oxide fumes or aluminium dust, chronic exposure showed significant temporary lung effects such as pneumonia, granuloma and alveolar proteinosis, but no scaring of the lungs. The sub chronic inhalation LOAEC is 50 mg Al/m^3 as aluminium powder However according to DSD (67/548/EEC) or CLP (1272/2008/EC) classification is not required.

The effects of aluminium in drinking water were also studied to see if there is an increased risk of Alzheimer's disease with an increase in aluminium. The study concluded that there is probably a link between aluminium intake and the risk of developing Alzheimer disease. However, the study showed that drinking water plays a small role in aluminium ingestion. The factors that contribute largely to oral ingestion of aluminium is dietary and pharmacological sources.

The oral chronic NOAEL for aluminium is 30 mg Al/kg bw/day as aluminium citrate. Various studies have been done on rats, that showed that chronic ingestion of aluminium leads to harmful effects on the blood system and nervous system. The oral route of exposure is unlikely for Vulindlela Sediment, and even more unlikely for chronic exposure.

Quartz dust is a Category 1 STOT RE. Table 2.8 shows the STOR RE classification for Vulindlela sediment.

Table 2.8: STOT RE Classification

	Category 1
Symbol	
Signal Word	Danger
Hazard Statement	H372: Causes damage to lungs through prolonged or repeated exposure via inhalation.

2.4.2. J. Aspiration Hazard

According to SANS 10234:2008 this is a substance that causes severe acute effects, such as chemical pneumonia, pulmonary injury or death after aspiration. Aspiration is initiated from the moment of inhalation.

Vulindlela Sediment is not seen to be an aspiration hazard.

2.4.3. Hazards to the Aquatic Environment

To determine if a substance is hazardous to the aquatic environment, the following elements are looked at; acute toxicity, bioaccumulation, degradation and chronic toxicity.

The sample were tested for acute toxicity and the results are displayed in Table 2.8.

The below Toxicity is based on the Direct Estimate of Ecological Effect Potential (DEEEP) Protocol. From table 2.9 the classification statement, "No acute/short-chronic hazards", means that none of the test showed an toxic effect. According to SANS 10234:2008, this test is only applicable to the acute toxicity. The Toxicity Unit (TU), will be converted to mg/l to use as part of the SANS 10234 classification. The higher the TU the lower to mg/l value, therefore the toxicity increase as TU increase. TU can be converted to mg/l based on the following; 100% v/v solution is 100g of product in 100 ml of water. 1 g/ml Is equivalent to 1 000 000 mg/l. Also, a 100% v/v toxicity response is equivalent to 1 toxic unit (100/100% v/v = 1 TU), therefore 1 TU corresponds to 1 000 000 mg/l. Therefor a TU of 250 corresponds to 4000 mg/l. The TU is calculated as follows; $TU = \frac{Concentration}{EC_{50}}$. This explanation is from Environmental Xenobiotics by Mervyn Richardson, page 167.

Table 2.9: Acute Toxicity Test Results (From BiotoxSA)

	Results	Vulindlela Sediment
Initial water quality	pH @ 25°C (A)	7.2
	EC (Electrical conductivity) (mS/m) @ 25°C (A)	25.3
	Dissolved oxygen (mg/l) (NA)	7.0
	Chemical oxygen demand (COD) (total) as O2 (OS)	<10
	Biological oxygen demand (BOD) (mg/l) as O2 (OS)	<10
Daphnia (A)	Test started on (yy/mm/dd)	19/06/04
	% 48 hour mortality rate (%)	34
	EC/LC50 (48 hours)	n.r.
	EC/LC50 (48 hours)	n.r.
	Toxicity unit (TU) / Description	<1
Algae (A)	Test started on (yy/mm/dd)	19/05/27
	% 48 hour mortality rate (%)	-5
	EC/LC50 (48 hours)	n.r.
	EC/LC50 (48 hours)	n.r.
	Toxicity unit (TU) / Description	<1
Fish (A)	Test started on (yy/mm/dd)	19/05/23
	% 96 hour mortality rate (%)	0
	EC/LC50 (96 hours)	n.r.
	EC/LC50 (96 hours)	n.r.
	Toxicity unit (TU) / Description	<1
Estimated safe dilution factor (%) [for definitive testing only]		**None Required**
Overall classification - Hazard class***		Class I - No acute/short-chronic hazard
Weight (%)		0

Table 2.10 shows the results from the Transformation/Dissolution Test. The elements that were tested are the same as those in Table 2.3.

Table 2.10: Transformation/Dissolution results for Vulindlela Sediment

	mg/kg	%
Al	320	0.032
Ca	22700	2.27
K	8550	0.855
Mn	150	0.015
Si	400	0.04

Transformation/Dissolution test are done to access the impact of heavy metals on the aquatic environment.

2.4.3. A. Acute Aquatic Toxicity

Acute toxicity is determined by the following three (3) species. A fish population for 96 h to determine the LC_{50} using OECD 203. A crustacea (daphnia, water flea) species for 48 h to determine the EC_{50}, using OECD 202. Lastly an algae species or an aquatic plant species for 72 h or 96 h to determine ErC_{50} using OECD 201. The acute hazard

categories are summarised in table 2.11 below. The LC_{50} values for the acute and chronic classification were mainly sourced from ECHA CLP inventory.

Table 2.11: Acute toxicity categories for substances hazardous to the aquatic environment, from SANS 10234:2008.

Hazard Category of Acute Toxicity	Classification Criteria	Values
1	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	≤ 1 mg/l ≤ 1 mg/l ≤ 1 mg/l
2	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	>1 to ≤ 10 mg/l and/or >1 to ≤ 10 mg/l and/or >1 to ≤ 10 mg/l
3	96 h LC_{50} (For Fish) 48 h EC_{50} (For Crustacea) 72 h or 96 h ErC50 (For Algae or aquatic plant)	>10 to ≤ 100 mg/l and/or >10 to ≤ 100 mg/l and/or >10 to ≤ 100 mg/l

According to the tested product, Vulindlela sediment does not pose an acute aquatic risk.

The Transformation/Dissolution analysis also indicates that classification is not necessary for acute toxicity.

The DEEEP analysis are used for classification, since this is the results on the tested product/waste stream. Therefore, Vulindlela sediment does not need to be classified in terms of acute aquatic toxicity.

2.4.3. B. Chronic Aquatic Toxicity

Table 2.12 below shows the classification criteria for chronic aquatic toxicity.

Table 2.12: Hazards categories of chronic toxicity for substances hazardous to the aquatic environment, from SANS 10234:2008.

Hazard Category	Classification Criteria
1	a) 96 h LC_{50} (For Fish) ≤ 1mg/L; and/or b) 48 h EC_{50} (For Crustacea) ≤ 1mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) ≤ 1mg/L; and d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500)
2	a) 96 h LC_{50} (For Fish) > 10 to ≤ 100 mg/L; and/or b) 48 h EC_{50} (For Crustacea) > 10 to ≤ 100 mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) > 10 to ≤ 100 mg/L; and d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500) and f) Unless the chronic NOECs are > 1mg/L
3	a) 96 h LC_{50} (For Fish) > 1 to ≤ 10 mg/L; and/or b) 48 h EC_{50} (For Crustacea) > 1 to ≤ 10 mg/L; and/or c) 72 h or 96 h ErC50 (For Algae or aquatic plant) > 1 to ≤ 10 mg/L; and d) The substance is not rapidly degradable; and/or e) The log K_{ow} ≥ 4 (unless the experimentally determined BCF < 500) and f) Unless the chronic NOECs are > 1mg/L
4	Poorly soluble substances for which no acute toxicity is recorded at levels up to the water solubility, that are not rapidly degradable and have a log Kow ≥ 4, indicating a potential to bioaccumulate are to be classified in this category, unless other scientific evidence shows classification to be unnecessary. Such evidence would include an experimentally determined BCF < 500, or a chronic toxicity NOECs >1 mg/L, or evidence of rapid degradation in the environment.

The chronic toxicity was calculated mainly from the Transformation/Dissolution analysis, however constituents that were not reported in Transformation/Dissolution scan were sourced from the sample composition Table 2.2.

From the calculations using the Transformation/Dissolution results this waste stream has no chronic classification.

According to SANS 10234 a product is rapidly degradable when the BOD_5/COD is ≥ 0.5. The BOD and COD were analysed but its below the detection limit of the lab.

2.5. Conclusion

Table 2.13 summarised the classification of Vulindlela Sediment, according to SANS 10234:2008.

Table 2.13: Summary of the Physical, Health and Aquatic Hazards of Vulindlela Sediment.

Hazard Class	Hazard Category	Hazard Statement
Physical Hazard		
Explosives	Not Explosive – Division 1.6	None
Flammable Gasses	N/A	None
Flammable Aerosols	N/A	None
Oxidising Gasses	N/A	None
Gasses under Pressure	N/A	None
Flammable Liquids (Up to 93 ^{o}C)	N/A	None
Flammable solids	Not Flammable	None
Self-Reactive Substances and Mixture	Self-Reactive Type G	None
Pyrophoric Substances	Not Pyrophoric	None
Self-Heating Substance and Mixtures	Not Self Heating	None
Substances and mixture that on contact with water emits flammable gasses	No flammable gas emitted	None
Oxidising substances and Mixtures	Not Oxidising – 3b	None
Organic Peroxides	Not a Peroxide	None
Corrosive to Metals	Not Corrosive	None
Health Hazards		
Acute Toxicity: Oral	Not Classified	None
Acute Toxicity: Dermal	Not Classified	None
Acute Toxicity: Inhalation	Not Classified	None
Skin corrosion and irritation	Not Classified	None
Serious Eye Damage and Irritation	Not Classified	None
Respiratory sensitization and skin sensitization	Not Classified	None
Germ Cell Mutagenicity	Not Classified	None
Carcinogenicity	Category 1A	H350
Reproductive Toxicity	Not Classified	None

STOT-SE	Not Classified	None
STOT-RE	Category 1	H372
Aspiration hazard	Not Classified	None
Aquatic Hazards		
Acute Aquatic Toxicity	Not Classified	None
Chronic Aquatic Toxicity	Not Classified	None

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APPENDIX B

UIS TC & LC ANALYTICAL RESULTS

UIS SEDIBA LABORATORY

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Analysis Report

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GNR 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , ICP-OES/MS and IC

Date Received: 2019/05/15
Date Completed: 2019/06/25
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 1: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids	TCLP	Borax		
pH - Leach Fluid	N/A	4.93	9.38		
PH - Sample	6.75	5.06	9.35		
Metal Ions	mg/kg *	mg/liter *	mg/liter *		
As - Arsenic *	< 4	< 0.01	< 0.01	< TCT0	= LCT0
B - Boron *	< 40	0.1	1062	< TCT0	> LCT3
Ba - Barium *	85.14	0.5	0.05	< TCT1	< LCT0
Cd - Cadmium *	< 4	0.014	< 0.003	< TCT0	= LCT0
Co - Cobalt *	6.86	0.02	< 0.02	< TCT0	< LCT0
Cr Total - Chromium Total *	51.19	0.04	0.05	< TCT0	< LCT0
Cr (VI) - Chromium (VI) *	< 2	< 0.05	< 0.05	< TCT0	= LCT0
Cu - Copper *	19.09	0.03	0.04	< TCT1	< LCT0
Hg - Mercury *	< 0.16	0.0057	0.0046	< TCT0	< LCT0
Mn - Manganese *	101.3	1.68	0.07	< TCT0	< LCT1
Mo - Molybdenum *	< 8	0.08	< 0.07	< TCT0	= LCT0
Ni - Nickel *	13.5	0.02	< 0.02	< TCT0	< LCT0
Pb - Lead *	26.71	< 0.01	< 0.01	< TCT1	= LCT0
Sb - Antimony *	< 4	< 0.009	0.0169	< TCT0	< LCT0
Se - Selenium *	< 8	< 0.01	< 0.01	< TCT0	= LCT0
V - Vanadium *	37.1	< 0.02	0.08	< TCT0	< LCT0
Zn - Zinc *	119.6	0.32	0.07	< TCT0	< LCT0
Anions	mg/kg *	mg/liter	mg/liter		
Fluoride - F	< 4	< 0.5	< 0.5	< TCT0	< LCT0
Chloride - Cl	N/A	< 20	< 20	N/A	< LCT0
Nitrate as NO3	N/A	< 22.2	< 22.2	N/A	N/A
NO3 as N	N/A	< 5	< 5	N/A	< LCT0
Sulphate - SO4	N/A	< 20	< 20	N/A	< LCT0
CN - Total Cyanide *	< 0.1	< 0.07	< 0.07	< TCT0	= LCT0
Total Dissolved Solids	mg/kg	mg/liter	mg/liter		
TDS	N/A	706	< 10	N/A	< LCT0

Authorized Signatory

C. Swanepoel

sanas Testing Laboratory T0584

Disclaimer:

The above-mentioned sample/s were analysed as received by the laboratory on the date stated above. UIS Organic laboratory takes no responsibility for sample/s prior to submission: this includes sampling, sample container, storage and shipping to our testing facility. The sample is analysed per customer request for analysis.
This report may not be reproduced, except in full, without the prior written approval of the laboratory.
Analysis mark with (*), have been outsourced.
UTD – Unable to Determine
NR – Not Requested
RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 1: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters		Results			TCT	LCT
		Solids ug/kg	TCLP ug/liter	Borax ug/liter		
VOC's	Dilution	X20	X1	X1		
Benzene		< 20	< 1	< 1	< TCT1	< LCT1
Carbon Tetrachloride		< 100	< 5	< 5	< TCT1	< LCT1
Chlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
Chloroform		< 100	< 5	< 5	< TCT1	< LCT1
1,2-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,4-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,2-Dichloroethane		< 40	< 2	< 2	< TCT1	< LCT1
Ethylbenzene		< 40	< 2	< 2	< TCT1	< LCT1
Hexachlorobutadiene		< 40	< 2	< 2	< TCT1	< LCT1
MTBE		< 100	< 5	< 5	< TCT1	< LCT1
Styrene		< 100	< 5	< 5	< TCT1	< LCT1
1,1,1,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
1,1,2,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
Toluene		260	67	< 10	< TCT1	< LCT1
1,1,1-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
1,1,2-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
Xylenes total		< 100	< 5	< 5	< TCT1	< LCT1
Trichlorobenzene (Total)		< 100	< 5	< 5	< TCT1	< LCT1
Dichloromethane		< 1000	< 50	< 50	< TCT1	< LCT1
1,1-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
1,2-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Tetrachloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Trichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
TPH	Dilution	x20	X1	X1		
Petroleum H/Cs,C6-C9		260	76	< 10	< TCT1	N/A
Petroleum H/Cs,C10 to C36		< 38000	2200	1900	< TCT1	N/A
Formaldehyde	Dilution	X10 *	X2	X2		
Formaldehyde		< 2000	< 100	< 100	< TCT1	< LCT1

Authorized Signatory

H. Richter

sanas Testing Laboratory T0418

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NR – Not Requested
RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 1: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids ug/kg	TCLP ug/liter	Borax ug/liter		
SVOCs Dilution	X20 *	X10	X10		
Benzo(a)pyrene *	24	< 1	< 1	< TCT1	< LCT1
Di (2 ethylhexyl) Phthalate *	460	< 100	< 100	< TCT1	< LCT1
Nitrobenzene *	< 200	< 10	< 10	< TCT1	< LCT1
2,4 Dinitrotoluene *	< 1000	< 50	< 50	< TCT1	< LCT1
Total PAH's	410	< 200	< 200	< TCT1	N/A
PHENOLS Dilution	X200	X10	X10		
2-Chlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4-Dichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4,6-Trichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
Phenols Speciated (total,non-halogenated) *	< 4000	< 200	< 200	< TCT1	< LCT1
Pesticides Dilution	X200	X10	X10		
Aldrin *	< 20	< 1	< 1	< TCT0	< LCT1
Dieldrin *	< 20	< 1	< 1	< TCT0	< LCT1
DDT *	< 20	< 1	< 1	< TCT0	< LCT1
DDE *	< 20	< 1	< 1	< TCT0	< LCT1
DDD *	< 20	< 1	< 1	< TCT0	< LCT1
Heptachlor *	< 20	< 1	< 1	< TCT0	< LCT1
Chlordane *	< 20	< 1	< 1	< TCT0	< LCT1
2,4 Dichlorophenoxyacetic Acid	Unable to Detect			UTD	UTD
Polychlorinated Biphen Dilution	X1	X10	X10		
Ballsmitters Totals *	< 350	< 10	< 10	< TCT1	< LCT1
Polars Dilution	X20	X1	X1		
Methyl Ethyl Ketone (2-Butanone) *	< 2000	< 100	< 100	< TCT1	< LCT1
Vinyl Chloride *	< 20	< 1	< 1	< TCT1	< LCT1
	mg/kg	mg/liter	mg/liter		
Total Organic Carbon *	150000	< 1000	< 100		

Type Assessment, based only on results and not detection limits

Highest Total Concentration Value		≤ TCT1
Highest Leachable Concentration Value	excluding Boron from the Borax leaches	≤ LCT 1
Final Waste Type Classification		Type 3

Authorized Signatory

H. Richter

sanas Testing Laboratory T0418

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NR – Not Requested
RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS SEDIBA LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GNR 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , ICP-OES/MS and IC

Date Received: 2019/05/15
Date Completed: 2019/06/25
Date Issued: 2019/08/01

Sample Information

Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 2: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids	TCLP	Borax		
pH - Leach Fluid	N/A	4.93	9.38		
PH - Sample	6.68	4.97	9.37		
Metal Ions	mg/kg *	mg/liter *	mg/liter *		
As - Arsenic *	3.97	< 0.01	< 0.01	< TCT0	= LCT0
B - Boron *	54.1	< 0.02	867	< TCT0	> LCT3
Ba - Barium *	40.1	0.39	0.03	< TCT0	< LCT0
Cd - Cadmium *	< 3.2	< 0.003	< 0.003	< TCT0	= LCT0
Co - Cobalt *	5.64	0.03	< 0.02	< TCT0	< LCT0
Cr Total - Chromium Total *	46.55	0.04	0.08	< TCT0	< LCT0
Cr (VI) - Chromium (VI) *	< 2	< 0.05	< 0.05	< TCT0	= LCT0
Cu - Copper *	9.28	0.03	0.02	< TCT0	< LCT0
Hg - Mercury *	< 0.16	< 0.002	0.0051	< TCT0	< LCT0
Mn - Manganese *	82.94	< 0.01	< 0.02	< TCT0	< LCT0
Mo - Molybdenum *	< 6.4	< 0.07	< 0.07	< TCT0	= LCT0
Ni - Nickel *	11.74	< 0.02	< 0.02	< TCT0	< LCT0
Pb - Lead *	19	< 0.01	< 0.01	< TCT0	= LCT0
Sb - Antimony *	< 3.2	0.0158	0.017	< TCT0	< LCT0
Se - Selenium *	4.32	< 0.01	< 0.01	< TCT0	= LCT0
V - Vanadium *	32.9	< 0.02	0.07	< TCT0	< LCT0
Zn - Zinc *	24.44	0.29	0.04	< TCT0	< LCT0
Anions	mg/kg *	mg/liter	mg/liter		
Fluoride - F	< 4	< 0.5	< 0.5	< TCT0	< LCT0
Chloride - Cl	N/A	< 20	< 20	N/A	< LCT0
Nitrate as NO3	N/A	< 22.2	< 22.2	N/A	N/A
NO3 as N	N/A	< 5	< 5	N/A	< LCT0
Sulphate - SO4	N/A	< 20	< 20	N/A	< LCT0
CN - Total Cyanide *	< 0.1	< 0.07	< 0.07	< TCT0	= LCT0
Total Dissolved Solids	mg/kg	mg/liter	mg/liter		
TDS	N/A	267	673	N/A	< LCT0

Authorized Signatory

C. Swanepoel

sanas Testing Laboratory T0584

Disclaimer:

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RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 2: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters		Results			TCT	LCT
		Solids ug/kg	TCLP ug/liter	Borax ug/liter		
VOC's	Dilution	X20	X1	X1		
Benzene		< 20	< 1	< 1	< TCT1	< LCT1
Carbon Tetrachloride		< 100	< 5	< 5	< TCT1	< LCT1
Chlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
Chloroform		< 100	< 5	< 5	< TCT1	< LCT1
1,2-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,4-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,2-Dichloroethane		< 40	< 2	< 2	< TCT1	< LCT1
Ethylbenzene		< 40	< 2	< 2	< TCT1	< LCT1
Hexachlorobutadiene		< 40	< 2	< 2	< TCT1	< LCT1
MTBE		< 100	< 5	< 5	< TCT1	< LCT1
Styrene		< 100	< 5	< 5	< TCT1	< LCT1
1,1,1,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
1,1,2,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
Toluene		< 200	< 10	< 10	< TCT1	< LCT1
1,1,1-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
1,1,2-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
Xylenes total		< 100	< 5	< 5	< TCT1	< LCT1
Trichlorobenzene (Total)		< 100	< 5	< 5	< TCT1	< LCT1
Dichloromethane		< 1000	< 50	< 50	< TCT1	< LCT1
1,1-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
1,2-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Tetrachloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Trichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
TPH	Dilution	X1	X1	X1		
Petroleum H/Cs,C6-C9		< 200	< 10	< 10	< TCT1	N/A
Petroleum H/Cs,C10 to C36		< 38000	1300	1000	< TCT1	N/A
Formaldehyde	Dilution	X10 *	X2	X2		
Formaldehyde		< 2000	< 100	< 100	< TCT1	< LCT1

Authorized Signatory

H. Richter

sanas Testing Laboratory T0419

Disclaimer:

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NR – Not Requested
RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 2: Bridge 1
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids ug/kg	TCLP ug/liter	Borax ug/liter		
SVOCs Dilution	X20 *	X10	X10		
Benzo(a)pyrene *	< 2	< 1	< 1	< TCT1	< LCT1
Di (2 ethylhexyl) Phthalate *	< 200	< 100	< 100	< TCT1	< LCT1
Nitrobenzene *	< 200	< 10	< 10	< TCT1	< LCT1
2,4 Dinitrotoluene *	< 1000	< 50	< 50	< TCT1	< LCT1
Total PAH's	< 40	< 200	< 200	< TCT1	N/A
PHENOLS Dilution	X200	X10	X10		
2-Chlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4-Dichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4,6-Trichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
Phenols Speciated (total,non-halogenated) *	< 4000	< 200	< 200	< TCT1	< LCT1
Pesticides Dilution	X200	X10	X10		
Aldrin *	< 20	< 1	< 1	< TCT0	< LCT1
Dieldrin *	< 20	< 1	< 1	< TCT0	< LCT1
DDT *	< 20	< 1	< 1	< TCT0	< LCT1
DDE *	< 20	< 1	< 1	< TCT0	< LCT1
DDD *	< 20	< 1	< 1	< TCT0	< LCT1
Heptachlor *	< 20	< 1	< 1	< TCT0	< LCT1
Chlordane *	< 20	< 1	< 1	< TCT0	< LCT1
2,4 Dichlorophenoxyacetic Acid	Unable to Detect			UTD	UTD
Polychlorinated Biphen Dilution	X1	X10	X10		
Ballsmitters Totals *	< 350	< 10	< 10	< TCT1	< LCT1
Polars Dilution	X20	X1	X1		
Methyl Ethyl Ketone (2-Butanone) *	< 2000	< 100	< 100	< TCT1	< LCT1
Vinyl Chloride *	< 20	< 1	< 1	< TCT1	< LCT1
	mg/kg	mg/liter	mg/liter		
Total Organic Carbon *	27000	< 1000	< 100		

Type Assessment, based only on results and not detection limits

Highest Total Concentration Value		≤ TCT 1
Highest Leachable Concentration Value	excluding Boron from the Borax leaches	≤ LCT 1
Final Waste Type Classification		Type 4

Authorized Signatory

H. Richter

sanas Testing Laboratory T0419

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Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS SEDIBA LABORATORY

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Analysis Report

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GNR 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , ICP-OES/MS and IC

Date Received: 2019/05/15
Date Completed: 2019/06/25
Date Issued: 2019/08/01

Sample Information
Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 3: Bridge 2
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids	TCLP	Borax		
pH - Leach Fluid	N/A	4.93	9.38		
PH - Sample	7.22	5.03	9.37		
Metal Ions	mg/kg *	mg/liter *	mg/liter *		
As - Arsenic *	4.08	< 0.01	< 0.01	< TCT0	= LCT0
B - Boron *	< 40	< 0.02	1401	< TCT0	> LCT3
Ba - Barium *	55.05	0.39	0.06	< TCT0	< LCT0
Cd - Cadmium *	< 4	< 0.003	< 0.003	< TCT0	= LCT0
Co - Cobalt *	5.89	< 0.02	< 0.02	< TCT0	< LCT0
Cr Total - Chromium Total *	34.88	0.04	0.05	< TCT0	< LCT0
Cr (VI) - Chromium (VI) *	< 2	< 0.05	< 0.05	< TCT0	= LCT0
Cu - Copper *	17.27	< 0.02	0.04	< TCT1	< LCT0
Hg - Mercury *	< 0.16	0.0025	< 0.005	< TCT0	< LCT0
Mn - Manganese *	118.9	1.46	< 0.02	< TCT0	< LCT1
Mo - Molybdenum *	< 8	< 0.07	< 0.07	< TCT0	= LCT0
Ni - Nickel *	10.51	< 0.02	< 0.02	< TCT0	< LCT0
Pb - Lead *	16.55	< 0.01	< 0.01	< TCT0	= LCT0
Sb - Antimony *	< 4	< 0.009	0.0154	< TCT0	< LCT0
Se - Selenium *	< 8	< 0.01	0.01	< TCT0	= LCT0
V - Vanadium *	31.89	< 0.02	0.08	< TCT0	< LCT0
Zn - Zinc *	44.18	0.25	0.06	< TCT0	< LCT0
Anions	mg/kg *	mg/liter	mg/liter		
Fluoride - F	< 4	< 0.5	0.6	< TCT0	< LCT0
Chloride - Cl	N/A	< 20	< 20	N/A	< LCT0
Nitrate as NO3	N/A	< 22.2	< 22.2	N/A	N/A
NO3 as N	N/A	< 5	< 5	N/A	< LCT0
Sulphate - SO4	N/A	< 20	< 20	N/A	< LCT0
CN - Total Cyanide *	< 0.1	< 0.07	< 0.07	< TCT0	= LCT0
Total Dissolved Solids	mg/kg	mg/liter	mg/liter		
TDS	N/A	465	15	N/A	< LCT0

Authorized Signatory

C. Swanepoel

sanas Testing Laboratory T0584

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BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information

Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 3: Bridge 2
Ref No: Vulindlela Sediment Desilt Sampling

Parameters		Results			TCT	LCT
		Solids ug/kg	TCLP ug/liter	Borax ug/liter		
VOC's	Dilution	X20	X1	X1		
Benzene		< 20	< 1	< 1	< TCT1	< LCT1
Carbon Tetrachloride		< 100	< 5	< 5	< TCT1	< LCT1
Chlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
Chloroform		< 100	< 5	< 5	< TCT1	< LCT1
1,2-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,4-Dichlorobenzene		< 40	< 2	< 2	< TCT1	< LCT1
1,2-Dichloroethane		< 40	< 2	< 2	< TCT1	< LCT1
Ethylbenzene		< 40	< 2	< 2	< TCT1	< LCT1
Hexachlorobutadiene		< 40	< 2	< 2	< TCT1	< LCT1
MTBE		< 100	< 5	< 5	< TCT1	< LCT1
Styrene		< 100	< 5	< 5	< TCT1	< LCT1
1,1,1,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
1,1,2,2-Tetrachloroethane		< 200	< 10	< 10	< TCT1	< LCT1
Toluene		< 200	< 10	< 10	< TCT1	< LCT1
1,1,1-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
1,1,2-Trichloroethane		< 100	< 5	< 5	< TCT1	< LCT1
Xylenes total		< 100	< 5	< 5	< TCT1	< LCT1
Trichlorobenzene (Total)		< 100	< 5	< 5	< TCT1	< LCT1
Dichloromethane		< 1000	< 50	< 50	< TCT1	< LCT1
1,1-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
1,2-Dichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Tetrachloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
Trichloroethylene		< 200	< 10	< 10	< TCT1	< LCT1
TPH	Dilution	X1	X1	X1		
Petroleum H/Cs,C6-C9		< 200	< 10	< 10	< TCT1	N/A
Petroleum H/Cs,C10 to C36		< 38000	< 382	1100	< TCT1	N/A
Formaldehyde	Dilution	X10 *	X2	X2		
Formaldehyde		< 2000	< 100	< 100	< TCT1	< LCT1

Authorized Signatory

H. Richter

sanas Testing Laboratory T0419

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UTD – Unable to Determine
NR – Not Requested
RTF – Results to Follow
BDL – Below Detection Limit (Please note that if the results for an analyte is below our detection limit, it does not indicate that the sample is clean or that the analyte result is equal to zero.)
Storage Conditions in the Laboratory: Fridge @ <6 °C

UIS ORGANIC LABORATORY

Analysis Report

Client Information

Company: IX Engineers
Attention: Gerrie Le Roux
Tel: 012 745 2000
Fax:
Address: 270 Lynwood Service road
Lynnwood Ridge
Pretoria, 0081

Lab No: 24178

Test Information: *Waste Assesment for Disposal, GN R. 635 (Gazette No. 36784)*
Australian Standard Leaching
AS4439 - 1997 , SPME Extraction & GC/MS

Date Received: 2019/05/15
Date Completed: 2019/05/27
Date Issued: 2019/08/01

Sample Information

Matrix: Solid Composite - TCLP and Borax Leaches
Sample ID: Composite 3: Bridge 2
Ref No: Vulindlela Sediment Desilt Sampling

Parameters	Results			TCT	LCT
	Solids ug/kg	TCLP ug/liter	Borax ug/liter		
SVOCs Dilution	X20 *	X10	X1		
Benzo(a)pyrene *	< 2	< 1	< 1	< TCT1	< LCT1
Di (2 ethylhexyl) Phthalate *	< 200	< 100	< 100	< TCT1	< LCT1
Nitrobenzene *	< 200	< 10	< 10	< TCT1	< LCT1
2,4 Dinitrotoluene *	< 1000	< 50	< 50	< TCT1	< LCT1
Total PAH's	< 40	< 200	< 200	< TCT1	N/A
PHENOLS Dilution	X200	X10	X10		
2-Chlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4-Dichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
2,4,6-Trichlorophenol *	< 400	< 20	< 20	< TCT1	< LCT1
Phenols Speciated (total,non-halogenated) *	< 4000	< 200	< 200	< TCT1	< LCT1
Pesticides Dilution	X200	X10	X10		
Aldrin *	< 20	< 1	< 1	< TCT0	< LCT1
Dieldrin *	< 20	< 1	< 1	< TCT0	< LCT1
DDT *	< 20	< 1	< 1	< TCT0	< LCT1
DDE *	< 20	< 1	< 1	< TCT0	< LCT1
DDD *	< 20	< 1	< 1	< TCT0	< LCT1
Heptachlor *	< 20	< 1	< 1	< TCT0	< LCT1
Chlordane *	< 20	< 1	< 1	< TCT0	< LCT1
2,4 Dichlorophenoxyacetic Acid	Unable to Detect			UTD	UTD
Polychlorinated Biphen Dilution	X1	X10	X10		
Ballsmitters Totals *	< 350	< 10	< 10	< TCT1	< LCT1
Polars Dilution	X20	X1	X1		
Methyl Ethyl Ketone (2-Butanone) *	< 2000	< 100	< 100	< TCT1	< LCT1
Vinyl Chloride *	< 20	< 1	< 1	< TCT1	< LCT1
	mg/kg	mg/liter	mg/liter		
Total Organic Carbon *	110000	< 1000	< 100		

Type Assessment, based only on results and not detection limits

Highest Total Concentration Value		≤ TCT1
Highest Leachable Concentration Value	excluding Boron from the Borax leaches	≤ LCT 1
Final Waste Type Classification		Type 3

Authorized Signatory

H. Richter

sanas Testing Laboratory T0419

Disclaimer:

The above-mentioned sample/s were analysed as received by the laboratory on the date stated above. UIS Organic laboratory takes no responsibility for sample/s prior to submission: this includes sampling, sample container, storage and shipping to our testing facility. The sample is analysed per customer request for analysis.
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Storage Conditions in the Laboratory: Fridge @ <6 °C

APPENDIX C

UIS SANAS ACCREDITATION

sanas
South African National Accreditation System

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

UIS ORGANIC LABORATORY (PTY) LTD
Co. Reg. No.: 2007/001896/07

Facility Accreditation Number: **T0419**

is a South African National Accreditation System accredited Testing laboratory provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation Annexure "A", bearing the above accreditation number for

CHEMICAL ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a laboratory quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

Mr M Phaloane
Acting Chief Executive Officer

Effective Date: 05 October 2014
Certificate Expires: 04 October 2019

APPENDIX D

MATERIAL SAFETY DATA SHEET

Safety Data Sheet

Vulindlela Sediment

Section 1: Identification

Product Name:	Desilt / Sediment Waste : Vulindlela Bridge Maintenance and desilting project
Synonyms:	None
CAS Number:	Not Applicable
EC Number:	Not Applicable
Product Use:	None
Company Identification:	
Emergency Telephone Number:	Papa Mkhabela, Project Manager, Sasol Mining
	Tel +27 17 614 3016
	Fax +27 11 219 3172
	Mobile +27 79 505 8023

Section 2: Hazard(s) Identification

Classification per SANS 10234 (GHS), CLP and (EC) No 1272/2008:

Physical Hazard:	**Not Classified**
Health Hazard:	**Carcinogenic Category 1A**
	STOT-RE Category 1
Aquatic Hazard:	**Not Classified**

Pictogram:

Signal Word: **Danger**

Hazard Statement:

H303	May be Harmful if Swallowed (Due to Faecal Coliforms)
H350	May Cause Cancer, due to inhalation
H372	Causes damage to lungs through prolonged or repeated exposure via inhalation.

Precautionary Statement:

P260	Do not breath dust
P262	Do not get in eyes, on skin, or on clothing
P264	Wash skin and clothes thoroughly after handling, where and if spills occurred.
P270	Do not eat drink or smoke when handling the sediment
P363	Wash contaminated clothing before reuse
P305+P351+P338	If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present, and easy to do. Continue rinsing.

Section 3: Composition and Information on Ingredients

Element	Cas No	XRF (%)	XRD (%)
Iron (Fe)	7439-89-6	3.78	1.02
Silicon (Si)	7440-21-3	39.44	44.2
Aluminium (Al)	7429-90.5	2.30	1.1
Potassium (K)	7440-09-7	0.17	0.08
Phosphorus (P)	7723-14-0	0.04	N/A
Manganese (Mn)	7439-96-5	0.17	N/A
Calcium (Ca)	7440-70-2	0.71	0.27
Magnesium (Mg)	7439-95-4	0.15	0.2

Titanium (Ti)	7440-32-6	0.19	N/A
Vanadium (V)	7440-62-2	0.01	N/A
Barium (Ba)	7440-39-3	0.02	N/A
Chromium (Cr)	7440-47-3	0.10	N/A
Strontium (Sr)	7440-24-6	0.01	N/A
Zirconium (Zr)	7440-67-7	0.02	N/A
Sulphur (S)	7704-34-9	0.00	0.15
Lead (Pb)	7439-92-1	0.01	N/A
Zinc (Zn)	7440-66-6	0.01	N/A
Oxide		49.3	52.3
Other (% unless stated otherwise)			
Carbon	0.98		
Sulphur	0.046		
TOM	57.21		
Moisture	14.89		
Total Volatiles	20.29		
Faecal Coliforms	452 1g dry weight		
E. coli	325 1g dry weight		

XRD Species	Percentage (%)
Quartz	93.2
Kaolinite	2.1
Goethite	1.4
Spinel	1.2
Muscovite	0.8
Gypsum	0.8
Calcite	0.2
Hematite	0.2

Section 4: First Aid Measures

Eye Contact: Do not rub eyes. Thoroughly wash out the opened eye/s with plenty of water for at least 15 min. Remove contact lenses if it's easy to do so and continue rinsing the eyes. Consult a doctor.

Inhalation: Move into fresh air and consult a doctor if necessary. If not breathing give artificial respiration or oxygen by a qualified person.

Skin contact: Wash off with plenty of soap and water, consult a doctor if necessary. Remove any contaminated clothing.

Ingestion: Rinse out the mouth and drink plenty of water. Consult a doctor. Never induce vomiting.

Most important symptoms and effects, both acute and delayed:
The sediment consists mainly of Quarts which is carcinogenic. Chronic exposure to quartz dust can also lead to lung damage, such as inflammation or silicosis.

Indication of any immediate medical attention and special treatment needed:
Consult a doctor, you may need to be treated for diarrhoea or bloody diarrhoea, due to faecal contamination.

Section 5: Fire Fighting Measures

Suitable extinguishing media:
Use extinguishing media appropriate to surroundings.

Unsuitable extinguishing media:
None identified.

Special Hazards arising from the substance or mixture:
Do not create dust.

Advice to firefighters and protective equipment:
Wear a self-contained breathing apparatus with full protective clothing to prevent contact with skin and eyes.

Section 6 – Accidental Release Measures

Personal Precaution:
Wear personal protective clothing including a respiratory mask, to prevent inhaling dust. Wash with soap and water after handling the sediment. Remove contaminated clothing immediately after spilling and rinse skin. For further information, see Section 8.

Emergency Procedure:
Immediately isolate the spill and prevent further leakage or spillage. Keep un authorized personnel or bystanders away from the spill.

Environmental Precaution:
Prevent entry of spilled product into waterbodies, waterways or confined areas.

Methods for Clean up:
It can be shovelled up into labelled containers but wet it first if its dry. This is to limit dust creation and breathing in quartz dust.

Other Information: See Section 13 for disposal Considerations.

Section 7 – Handling and Storage

Precautions for safe handling:

Use respiratory masks with dust filters and other personal protective equipment and clothing, such as gloves and safety glasses. Do not smoke, drink or eat while handling the product.

After working with the sediment ensure you wash your hands before eating, drinking or smoking.

Conditions for safe storage, including any incompatibilities:

Store in a well-ventilated area. Ensure that the containers are tightly sealed, and correctly labelled, if applicable. Ensure no unauthorised entry.

Section 8 – Exposure Controls and Personal protection

Components Occupational Exposure limit:

Particulates not otherwise regulated – Total Dust
OSHA PEL: TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (respirable)
General Industry - TWA 15 mg/m^3
Construction Industry – TWA 15 mg/m^3
NIOSH REL: TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (resp)
ACGIH Guideline: TWA 10 mg/m^3 (Inhalable Particles)

Quartz (Crystalline Silica) [CAS No: 14808-60-7]
OSHA PEL: TWA 0.1 mg/m^3
NIOSH REL: TWA 0.05 mg/m^3
ACGIH Guideline: TLV-TWA - 0.025 mg/m3 (Respirable particulate matter)

Information from the REACH Dossier (ECHA Website):

The Derived No- or Minimal Effect Level (DN(M)EL), is the level above which a human should not be exposed to a substance. The information below is for constituents of the waste stream.

Aluminium [CAS No: 7429-90-5]

Workers			General Population		
Inhalation	Threshold	Most Sensitive study	Inhalation	Threshold	Most Sensitive study
Systemic Effects			Systemic Effects		
Long Term	(DNEL) 3.72 mg/m³	Repeated Dose Toxicity	**Long Term**	No Data	No Data
Acute/Short Term	No Identified Hazard	No Data	**Acute/Short Term**	No Data	No Data
Local Effects			Local Effects		
Long Term	(DNEL) 3.72 mg/m³	Repeated Dose Toxicity	**Long Term**	No Data	No Data
Acute/Short Term	No Data	No Data	**Acute/Short Term**	No Data	No Data
Dermal	Threshold	Most Sensitive study	Dermal	Threshold	Most Sensitive study
Systemic Effects			Systemic Effects		
Long Term	No Data	No Data	**Long Term**	No Data	No Data
Acute/Short Term	No Data	No Data	**Acute/Short Term**	No Data	No Data
Local Effects			Local Effects		
Long Term	No Data	No Data	**Long Term**	No Data	No Data
Acute/Short Term	No data	No Data	**Acute/Short Term**	No Data	No Data
Oral	Threshold	Most Sensitive Study	Oral	Threshold	Most Sensitive study
Systemic Effects			Systemic Effects		
Long Term	No Data	No Data	**Long Term**	(DNEL) 3.95 mg/kg bw/day	Repeated Dose Toxicity
Acute/Short Term	No Data	No Data	**Acute/Short Term**	No Identified Hazard	No Data
Local Effects			Local Effects		
Long Term	No Data	No Data	**Long Term**	No Data	No Data
Acute/Short Term	No Data	No Data	**Acute/Short Term**	No Data	No Data

Iron [CAS No. 7439-89-6]

No hazards have been identified by EHCH, REACH Dossier.

Engineering Controls:
No Specific engineering controls.

Personal Protection:
Avoid contact with skin, eyes and clothing. Use safety glasses (preferably with side shields), dust coat/overall and gloves when handling the waste stream. Respiration masks should be NIOSH certified, equipped with an N100, R100 or P100 filter, or P2 (EN 143) equivalent (OSHA 29 CRF 1910.134). All PPE must be approved under standards such as OSHA 29 CFR 1910.132 or EU directive 89/686/EEC.

Section 9 - Physical and Chemical Properties

Appearance	Muddy course heterogenous sand
Colour	Brown with white and black particles
Odour	Wer sand smell
pH	7.35
Melting Point	< -8 °C
Boiling Point	Not Applicable
Flash Point	Not Available
Evaporation Rate	Not Applicable
Flammability	Not Flammable
Upper/Lower explosion limits	Not AExplosive
Vapour Pressure	Not Available
Bulk Density	1744 kg/m^3
Relative Density	Not Determined
Solubility in Water	Not Soluble
Partition Coefficient: n-octanol/water	Not Determined
Auto-ignition temperature	> 1200 °C
Decomposition temperature	> 1200 °C

Oxidising Properties	Not Oxidising
Pyrophoricity	Not Pyrophoric

Section 10 – Stability and Reactivity

Reactivity:
None known.

Stability:
Stable under normal conditions, ensure no unauthorised entry.

Possibility of Hazardous Reactions:
None Known

Conditions to Avoid:
Generating Dust

Incompatible Materials:
Strong oxidizing agents.

Hazardous Decomposition Products:
None Known

Corrosivity:
Quartz is not corrosive to metals, it also does not attack plastic.

Section 11 – Toxicological information

The Health Hazards are estimated from bio-elution analysis.

a) **Acute Toxicity**

Oral:	**Not Classified**
Dermal:	**Not Classified**
Inhalation:	**Not Classified**

Likely routes of exposure: Inhalation of dust.

Target Organs: Respiratory System

b) **Skin Corrosion/irritation:**	Not Classified
c) **Serious eye Damage/irritation:**	Not Classified
d) **Respiratory and Skin Sensation:**	Not Classified
e) **Germ Cell Mutagenicity:**	Not Classified
f) **Carcinogenicity:**	Category 1A
g) **Reproductive Toxicity:**	Not Classified
h) **Specific Target organ Toxicity – Single Exposure:**	Not Classified
i) **Specific Target organ Toxicity – Repeated Exposure:**	Category 1
j) **Aspiration hazard:**	Not Classified

Additional Information:

Pathogens in this waste stream may present a risk.

Section 12 – Ecological Information

This product was tested at Biotox laboratory Services (PTY) LTD, and the results are displayed below. In addition, Transformation/Dissolution tests were also done, estimate the dangers of metal and heavy metal compounds in this waste stream.

	Results	Vulindlela Sediment
Water quality	pH @ 25°C (A)	7.2
	EC (Electrical conductivity) (mS/m) @ 25°C (A)	25.3
	Dissolved oxygen (mg/l) (NA)	7.0
	Chemical oxygen demand (COD) (total) as O2 (OS)	<10
	Biological oxygen demand (BOD) (mg/l) as O2 (OS)	<10
[illegible]	[illegible]	19/06/04
	[illegible]	34
	[illegible]	n.r.
	[illegible]	n.r.
	[illegible]	<1
[illegible]	[illegible]	19/05/27
	[illegible]	-5
	[illegible]	n.r.
	[illegible]	n.r.
	[illegible]	<1
[illegible]	[illegible]	19/05/23
	[illegible]	0
	[illegible]	n.r.
	[illegible]	n.r.
	[illegible]	<1
Estimated safe dilution factor (%) [for definitive testing only]		**None Required**
Overall classification - Hazard class* **		**Class I - No acute/short-chronic hazard**
Weight (%)		0

The above Toxicity is based on the Direct Estimate of Ecological Effect Potential (DEEEP) Protocol.

Acute Aquatic Toxicity: **Not Classified**

Chronic Aquatic Toxicity: **Not Classified**

Persistence and Degradability: Not analysed, but not expected

Bio accumulative potential: Not analysed

Mobility in soil: Not analysed

Other Adverse effects: None known

Section 13 – Disposal Considerations

Disposal should comply with the waste disposal legislation (GN R. 634, 635 and 636) as well as any other municipal regulations. This waste stream should be disposed at a Class C landfill, since it's a Type 3 Waste.

Section 14 – Transport Information

UN Number:	None Known for the waste
UN Proper Shipping Name:	None Known
Transport Hazard Class:	None Known
Environmental hazard:	None Known
Special Precaution for User:	Wear proper personal protective equipment (PPE) when handling the sediment

Section 15 – Regulatory Information

Sediment is not listed in SANS 10234a of 2008, however compounds within the sediment may be listed. Estimations were done in accordance with SANS 10234 to access the hazards, if it were not tested.

Section 16 – Any other Relevant information

Date of issue: 1ste Issue; 1 August 2019

Compiled by: UIS Organic Laboratory (Pty) Ltd, Hugonette Richter

To be noted:

The information contained in this SDS is based upon data considered to be accurate at the time of preparation. UIS Organic Laboratory (Pty) Ltd, has taken reasonable care in the preparation of this SDS, however it assumes no responsibility or liability to the accuracy as

well as the suitability of the information, for any consequences of its use. Since regulatory standards and guideline recommendations are revised on a continues basis, UIS Organic Laboratory cannot insure that the information contained in this SDS will be current at the time of use.

Abbreviations:

C:	Under exposure limits, the C stands for ceiling. A ceiling value should not be exceeded at any time.
IC_{50}:	Inhibitor Concentration
LDL_0:	Lowest Published Toxic Dose
LD50:	Lethal Dose, 50% kill
TCL_0:	Lowest Published Toxic Concentration
TWA:	Time-Weighted Average
ST:	Short Term Exposure Limit
RDT:	Repeated Dose Toxicity
REL:	Recommended Exposure Limits
PEL:	Permissible Exposure Limit
ACGIH:	American Conference of Governmental Industrial Hygienists
NIOSH:	National Institute for Occupational Safety and Health