mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

BASIC ASSESSMENT REPORT
AND
ENVIRONMENTAL MANAGEMENT PROGRAMME FOR THE PROPOSED SASOL SIGMA DEFUNCT COLLIERY ASH BACKFILLING PROJECT
FINAL REPORT FOR SUBMISSION TO DMR

SUBMITTED FOR ENVIRONMENTAL AUTHORISATIONS IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998 (ACT NO. 107 OF 1998) (NEMA) AND THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT, 2008 (ACT NO. 59 OF 2008) (NEM:WA) IN RESPECT OF LISTED ACTIVITIES THAT HAVE BEEN TRIGGERED BY APPLICATIONS IN TERMS OF THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002 (ACT NO. 28 OF 2002) (MPRDA) (AS AMENDED).

Name of Applicant:	Sasol Mining (Pty) Ltd
Tel no:	+27 17 614 2313
Fax no:	+27 11 522 5279
Physical Address:	Sigma Defunct Colliery , 137 Saltberry Plain Sasolburg, 9570
File Reference Number SAMRAD:	FS 6/2/2 (693) EM

Digby Wells and Associates (South Africa) (Pty) Ltd. Co. Reg. No. 2010/008577/07. Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191. Private Bag X10046, Randburg, 2125, South Africa
Tel: +27 11 789 9495, Fax: +27 11 069 6801, info@digbywells.com, www.digbywells.com

Directors: GE Trusler (C.E.O), GB Beringer, LF Koeslag, J Leaver (Chairman)*, NA Mehlomakulu*, DJ Otto, RA Williams*

*Non-Executive

This document has been prepared by Digby Wells Environmental.

Report Type:	**BAR and EMP Report**
Project Name:	**Basic Assessment Report and Environmental Management Programme Report for the Sasol Sigma Ash backfilling Project**
Project Code:	**SAS5184**

Name	Responsibility	Signature	Date
Claire Wannenburgh	Report Compiler		Draft July 2018 / Final August 2018
Barbara Wessels	Report Reviewer		July 2018
Danie Otto	ExCo Reviewer		July 2018

IMPORTANT NOTICE

In terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002 as amended), the Minister must grant a prospecting or mining right if among others the mining "will not result in unacceptable pollution, ecological degradation or damage to the environment".

Unless an Environmental Authorisation can be granted following the evaluation of an Environmental Impact Assessment and an Environmental Management Programme report in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA), it cannot be concluded that the said activities will not result in unacceptable pollution, ecological degradation or damage to the environment.

In terms of section 16(3)(b) of the EIA Regulations, 2014 (as amended), any report submitted as part of an application must be prepared in a format that may be determined by the Competent Authority and in terms of section 17 (1) (c) the competent Authority must check whether the application has taken into account any minimum requirements applicable or instructions or guidance provided by the competent authority to the submission of applications.

It is therefore an instruction that the prescribed reports required in respect of applications for an environmental authorisation for listed activities triggered by an application for a right or a permit are submitted in the exact format of, and provide all the information required in terms of, this template. Furthermore, please be advised that failure to submit the information required in the format provided in this template will be regarded as a failure to meet the requirements of the Regulation and will lead to the Environmental Authorisation being refused.

It is furthermore an instruction that the Environmental Assessment Practitioner must process and interpret his/her research and analysis and use the findings thereof to compile the information required herein. (Unprocessed supporting information may be attached as appendices). The EAP must ensure that the information required is placed correctly in the relevant sections of the Report, in the order, and under the provided headings as set out below, and ensure that the report is not cluttered with un-interpreted information and that it unambiguously represents the interpretation of the applicant.

OBJECTIVE OF THE BASIC ASSESSMENT PROCESS

The objective of the basic assessment process is to, through a consultative process—

- determine the policy and legislative context within which the proposed activity is located and how the activity complies with and responds to the policy and legislative context;
- identify the alternatives considered, including the activity, location, and technology alternatives;
- describe the need and desirability of the proposed alternatives;
- through the undertaking of an impact and risk assessment process inclusive of cumulative impacts which focused on determining the geographical, physical, biological, social, economic, heritage, and cultural sensitivity of the sites and locations within sites and the risk of impact of the proposed activity and technology alternatives on these aspects to determine:
- the nature, significance, consequence, extent, duration, and probability of the impacts occurring to; and
- the degree to which these impacts—
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be managed, avoided or mitigated;
- through a ranking of the site sensitivities and possible impacts the activity and technology alternatives will impose on the sites and location identified through the life of the activity to—
  - identify and motivate a preferred site, activity and technology alternative;
  - identify suitable measures to manage, avoid or mitigate identified impacts; and
  - identify residual risks that need to be managed and monitored.

EXECUTIVE SUMMARY

Introduction

Sasol Mining's Sigma Defunct Colliery now referred to as the Sigma Defunct Colliery commenced operations in 1952, holding mineral rights to several coal deposits in the Sasolburg district. Underground mining methods were the primary method of extracting these reserves and included board-and-pillar and rib pillar methods. Access to the underground operations was via several shafts, and the coal was conveyed to a 'dry' coal handling plant at 3 Shaft where the coal was screened and fed to silos. In 1992 the Wonderwater opencast mining area (open cast mine) was developed to extract coal from the north-eastern side of the reserves and the underground mining was scaled down and ceased by 1999.

As a result of the underground mining activities which were undertaken at the Sigma Defunct Colliery, the potential for pillar failure has been identified which can lead to potential environmental impacts on surface. The identification of where pillar failure could occur has been identified through the compilation of a risk assessment report compiled by Jones and Wagener (J&W) in 2015 and updated in 2018. Pilar failure has been identified throughout the Sigma Defunct Colliery mining area with specific risk identified along the Rietspruit and the Leeuspruit. Mitigation measures have been proposed to reduce the risk of pillar failure which has been identified through a combination of underground mitigation measures and surface mitigation measures.

This Basic Assessment Report (BAR) specifically focuses on the environmental authorisation required for the implementation of underground mitigation measures. A separate Basic Assessment process will be undertaken to obtain the required authorisations for the surface mitigation measures.

It must be noted that the ash backfilling project environmental authorisation process was previously commenced with in 2013 with an Environmental Authorisation granted in 2014 while the Waste Management Licence (WML) and Integrated Water Use Licence (IWUL) was granted in 2017. Unfortunately, the Environmental Authorisation lapsed and therefore Sasol Mining are now required to reapply for this licence for listed activities triggered in terms of the Environmental Impact Assessment (EIA) Regulations, 2014 as amended by Government Notice No. R. 982 of 4 December 2014 which was again amended by Government Notice No. R.326 of 7 April 2017 from here on referred to as the EIA Regulations, 2014 (as amended).

The proposed underground mitigation measures (ash backfilling project) is aimed at backfilling mine voids where significant risk of subsidence has been identified with ash from the ash supplier being Sasolburg Operations (SO) (previously known as Sasol Infrochem). The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water) to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The water that will be

pumped will be reutilised into this process. Excess water pumped from the underground water that is not reutilised into the process will be sent for treatment at a water treatment plant.

The pipelines transporting slurry will run above ground on Sasol owned properties and within existing servitudes where possible. Where this is not possible, existing culverts and crossings will be used; alternatively, new agreements will be entered into with land owners. The pipeline route will be specifically selected to ensure that the pipes run along existing servitudes, linear infrastructure and disturbed areas to minimise the impact on the receiving environment.

Project Applicant

The particulars of the applicant are detailed in the table below.

Company name:	Sasol Mining (Pty) Ltd
Contact person:	Trevor Davids
Physical address:	Sigma Defunct Colliery , 137 Saltberry Plain Sasolburg, 9570
Telephone:	+27 17 614 2313
Email:	trevor.davids@sasol.com

Environmental Consultants

Contact details for the independent EAP are provided in the table below.

Company name:	Digby Wells and Associates (South Africa) (Pty) Ltd (trading as Digby Wells Environmental)
Contact person:	Danie Otto
Physical address:	Digby Wells House, Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191
Telephone:	011 789 9495
Email:	Danie.Otto@digbywells.com

Approach and Methodology for the Public Participation Process

The Public Participation Process (PPP) was developed to ensure compliance with environmental regulatory requirements and to provide Interested and Affected Parties (I&APs) with an opportunity to evaluate the project. During this process stakeholders are able to provide inputs and to receive feedback from the environmental specialists and/or proponent.

A summary of the PPP activities undertaken during the basic assessment process are provided in Table 10-1 of this report. Consultation with I&APs during the basic assessment process was undertaken as follows:

- **Background Information Document:** Included the location and a project description, legislative processes and requirements, specialist studies that have been conducted, a list of competent authorities, triggered listed activities in terms of NEMA, and the consultation / registration process with contact details of the Stakeholder Engagement Office and Project team members' details;
- **Newspaper Advertisement:** An English newspaper advertisement was placed in two local newspapers, Vaalweekblad and Sasolburg. The advertisement included a brief project description, applicable legislation, competent authorities, details of the appointed Environmental Assessment Practitioner (EAP) and information about availability of the Basic Assessment Report for public comment;
- **Site Notices:** English site notices were put up at various places around the project site. These site notices contained a brief project description, information about the required legislation, competent authorities, details of the appointed EAP, information about availability of the Basic Assessment Report for public comment;
- **Announcement Letter with Comment and Registration Form:** A letter was sent in English which contained information about the proposed project, applicable legislation and competent authorities, details of the EAP, information about availability of the Basic Assessment Report for public comment. A Registration and Comment Sheet was also provided for stakeholders to use for formal registration as I&APs or to submit comments;
- **Focus Group and One-on-one Discussions**: Due to various stakeholders and different landowners within the study area, focus group and one-on-one discussions were utilised during this process in order to obtain comments and to identify any issues raised by individuals.
    - Landowner one-on-one meetings: Directly affected landowners and the majority of the adjacent landowners were consulted by means of one-on-one meeting during which project details were provided, discussions were held to obtain comments and to identify additional landowners. A map was also used as part of the discussions to provide landowners with a reference to locality and recognisable landmarks. Key comments from attendees included, but isn't limited to the following:
        - Confirmation of project timelines and infrastructure locations;
        - Details of the pipeline routes and the construction of the pipelines;
        - Existing impacts on groundwater within the area; and
        - Existing impacts on water reservoirs and impacts on fauna and flora

- **Stakeholder Meeting**: A meeting was held with the directly affected Local Municipality of Metsimaholo in order to engage with the authorities on the project and re-introduce the scope of work. This meeting allowed us to understand key concerns and obtain further comments. Key comments from attendees included, but isn't limited to the following:
    - Existing dust and noise impacts to be reduced before commencement of this project;
    - Clarification around water usage for the purposes of this project;
    - Construction of boreholes in order to access groundwater; and
    - Jobs for the local community during construction and operation of the project.

The Draft BAR was made available for a public comment period of 30 days from 16 July 2018 to 15 August 2018 at the Zamdela and Sasolburg Public Library and on the Digby Wells website: www.digbywells.com (under Public Documents). Comments were received from I&APs regarding the project during this period. The comments were incorporated within this Final BAR and include in Appendix C 7. The Draft BAR has been subsequently updated to reflect a final version. The Final BAR was submitted to the DMR on 30 August 2018. The Final BAR has also been made available to I&APs on the Digby Wells website. I&APs were informed of the availability of the Final BAR by means of a letter (email and SMS) on 30 August 2018. This enabled I&APs to verify that their comments have been captured and responded to accordingly.

Impact Assessment Summary

The primary environmental concern of the project relates to groundwater contamination. From the groundwater specialist report, once the mine voids have been backfilled, the hydrostatic pressure in the backfilled areas will lead to an increase in water levels in the mine groundwater system. From groundwater monitoring data it is observed that the local groundwater levels have recovered and the aquifers have been found to reach hydrostatic equilibrium. All existing subsidence areas are expected to have higher recharge due to the disturbed geology that has resulted in increased permeability. Additionally, these areas of subsidence are potential decant locations. The overall impact post-closure on groundwater quantity prior to mitigation is minor. If the mitigation measures are applied, the impact will be low.

In terms of groundwater quality, after the mine void has been backfilled with the ash slurry the pH of the resulting water in the vicinity of the backfilled areas is predicted to peak at 11. Only aluminium is likely to be present in the leachate, above acceptable standards. Soon after the aluminium leaches from the southern backfill areas, the leachate is predicted to move towards the southern compartments by advection. The concentration of the transported aluminium is predicted to range between 0.5 and 1 mg/L. Dilution of aluminium will likely occur as the southern compartments approaches hydrostatic equilibrium with the intermediate aquifer. This will cause the plume to retreat over time. The overall movement of the leachate from the backfill will be slow. The plume from each backfill area is predicted to move, on average 150 m over 100 years.

Conclusion

This BAR was compiled in support of an application for Environmental Authorisation for listed activities in terms of the provisions of the NEMA for backfilling additional mine voids with ash in the Metsimaholo Local Municipality, within the Fezile Dabi District Municipality in Free State.

The aim of the Basic Assessment process is to provide adequate information to the DMR to make an informed decision as to whether an environmental authorisation should be granted or not. This report details the potential impacts of the proposed activities on the receiving environment. These impacts focus on the environmental, socio-economic, as well as the cultural heritage environment in the project area. These potential impacts were investigated and quantified. Based on the significance of the proposed activities on the environment, mitigation measures and monitoring programs have been compiled in order to assist Sasol Mining in minimising and avoiding negative impacts and maximising the benefits of the project.

A comprehensive PPP for the Sasol Sigma ash backfilling project will be conducted with I&APs to determine issues and concerns related to the project and to establish a working relationship between the communities, mine and authorities as part of the BA process. This process also served to introduce the project to I&APs.

The results from the previous consultation process have indicated the following which needs to be considered in the development of the Sasol Sigma ash backfilling project:

- Notification to stakeholders on the ash backfilling project schedule should be communicated timeously to landowners in person before and during implementation;
- Provide periodic feedback on monitoring results to stakeholders including landowners. This will enable Sasol to pro-actively identify and address key concerns;
- It is proposed that Sasol provide feedback to landowners in person on the following matters:
    - Timelines required for the stabilisation of sub-surface ash used during the backfilling;

- Progress of stabilisation of the surface to enable landowners to plan accordingly; and
- How the ash backfilling will impact the supply of water, now and for the future.

Based on the discussions made above and the information provided in this BAR, Digby Wells recommends that Environmental Authorisation be granted for the proposed ash backfilling project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PLANS

LIST OF ABBREVIATIONS

Acronym	Description
DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
HDPE	High Density Polyethylene
IWUL	Integrated Water Use licence
LOM	Life of Mine
MHSA	Mine Health and Safety Act (Act 29 of 1996)
MINACT	Minerals Act No.(Act 50 of 1991)
MPRDA	Mineral and Petroleum Resources Development (Act 28 of 2002)
NEMA	National Environmental Management Act (Act 107 of 1998)
NEM:AQA	National Environmental Management: Air Quality Act (Act 39 of 2004)
NEM:BA	National Environmental Management: Biodiversity Act (Act 10 of 2004)
NEM:WA	National Environmental Management: Waste Act (59 of 2008)

Acronym	Description
NHRA	National Heritage Resources Act (Act 25 of 1999)
NWA	National Water Act (Act 36 of 1998)
PCD	Pollution Control Dam
SAHRA	South African Heritage Resource Agency
SANS	South African National Standards
SO	Sasolburg Operations
WULA	Water Use Licence Application
WML	Waste Management Licence

Part A: Scope of Assessment and Basic Assessment Report

1 Introduction

Sasol Mining's Sigma Defunct Colliery now referred to as the Sigma Defunct Colliery occupies a mining area of approximately 11 643 ha. Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR).

Sigma Defunct Colliery commenced operations in 1952 with underground mining, holding mineral rights to several coal deposits in the Sasolburg district. Underground mining methods was the primary method of extracting these reserves and included mechanised board-and-pillar and rib pillar extraction and bottom coaling methods. Access to the underground operations was via several shafts, and the coal was then conveyed to a 'dry' coal handling plant at 3 Shaft where the coal was screened and fed to silos.

In 1992 the Wonderwater opencast mine within the Sigma Defunct mining lease area was developed to extract coal from the north-eastern side of the reserves which occupied a mining area of approximately 385 ha. The Wonderwater opencast mine was mined utilising truck and shovel mechanisms. The mining ceased in 2005 after which the opencast mine was backfilled and rehabilitated. The final voids were left as part of the water management of the underground workings.

The Mohlolo Operations, situated adjacent to the Wonderwater opencast mine commenced with its activities in 1999 and occupied a mining area or approximately 264 ha. The underground operations were accessed from the Wonderwater opencast mines highwalls in the north and the south and divided the operations into Moholo North and Mohlolo South. The underground mining was scaled down and ceased by 2005, the underground mine workings were left to be flooded.

As a result of the underground mining activities which were undertaken at the Sigma Defunct Colliery, the potential for pillar failure has been identified which can lead to potential environmental impacts on surface. The identification of where pillar failure could occur has been identified through the compilation of a risk assessment report compiled by Sasol with the assistance of Jones and Wagener (J&W) in 2015 and updated in 2018. Pilar failure has been identified throughout the Sigma Defunct Colliery mining area with specific risk identified along the Rietspruit and the Leeuspruit. Mitigation measures have been proposed to reduce the risk of pillar failure which has been identified through a combination of underground mitigation measures and surface mitigation measures.

This Basic Assessment Report (BAR) specifically focuses on the environmental authorisation required for the implementation of underground mitigation measures. A separate Basic Assessment (BA) process will be undertaken to obtain the required authorisations for the surface mitigation measures.

The proposed underground mitigation measures (ash backfilling project) is aimed at backfilling mine voids where significant risk of subsidence has been identified with ash from the ash supplier being Sasolburg Operations (SO) (previously known as Sasol Chemical

Industries (SCI)). It must be noted that the ash backfilling project environmental authorisation process was previously commenced with in 2013 with an Environmental Authorisation (EA) granted in 2014 while the Waste Management Licence (WML) and Integrated Water Use Licence (IWUL) was granted in 2017. Unfortunately, the Environmental Authorisation lapsed and therefore Sasol Mining are now required to reapply for this licence for listed activities triggered in terms of the Environmental Impact Assessment (EIA) Regulations, 2014 as amended by Government Notice No. R. 982 of 4 December 2014 which was again amended by Government Notice No. R.326 of 7 April 2017 from here on referred to as the EIA Regulations, 2014 (as amended).

2 Project Applicant

2.1 Details of EAP

Sasol Mining Sigma Defunct Colliery particulars are detailed in Table 2-1.

Table 2-1: Particulars of the Applicant

Applicant Name:	Sasol Mining (Pty) Ltd
Contact Person:	Trevor Davids
Telephone No:	+27 17 614 2313
Email Address:	trevor.davids@sasol.com
Physical Address:	Sigma Defunct Colliery , 137 Saltberry Plain Sasolburg, 9570

2.2 Expertise of the EAP

Digby Wells has been appointed by Sasol Mining as the independent Environmental Assessment Practitioner (EAP) to conduct the Basic Assessment process according to the National Environmental Management Act, 1998 (Act No. 107 Of 1998) (NEMA) and the EIA Regulations, 2014 (as amended) as well as the required Public Participation Process (PPP). The particulars of the EAP undertaking the Basic Assessment process is supplied in Table 2-2.

Table 2-2: Contact Details of the EAP

EAP Company Name:	Digby Wells Environmental
EAP:	Danie Otto
Telephone No:	+27 11 789 9495
Fax No:	+27 11 069 6801
Email Address:	danie.otto@digbywells.com
Physical Address:	Turnberry Office Park, 48 Grosvenor Road, Bryanston, 2191, South Africa.
Postal Address:	Private Bag X10046, Randburg, 2125

2.2.1 The qualifications of the EAP

Danie Otto manages the Southern African Operations and Technical Services at Digby Wells. He holds an M.Sc in Environmental Management. He is a biogeomorphologist who specialises in ecology of wetlands and rehabilitation. He has been a registered Professional Natural Scientist (Ref No. 115092) since 2002.

Danie has 21 years of experience in the mining industry in environmental and specialist assessments, management plans, audits, rehabilitation, and research. He has experience in eight countries and his experience is in the environmental sector of coal, gold, platinum (PGMs), diamonds, asbestos, rock, clay and sand quarries, copper, phosphate, andalusite, base metals, heavy minerals (titanium), uranium, pyrophyllite, chrome, nickel etc.

He has wetland and geomorphology working experience across Africa including specialist environmental input into various water resource related studies. These vary from studies of the wetlands of the Kruger National Park to swamp forests in central Africa to alpine systems in Lesotho. Danie's CV is included in Appendix A.

2.2.2 Summary of the EAP's Past Experience

The CV of Danie Otto, including the relevant project experience, is included in Appendix A.

3 Location of the overall Activity

Details for the location of the proposed project are provided in Table 3-1.

Table 3-1: Location of Proposed Project

Farm Name:	▪ The Star 387 Ptn No. 1 ▪ Bersheba 1 Ptn No. 7 ▪ Boschbank 12 Ptn No. R ▪ Boschbank 12 Ptn No. 2 ▪ Boschbank 12 Ptn No. 3 ▪ Boschbank 12 Ptn No. 5 ▪ Kruidfontein 67 Ptn No. 5 ▪ Kruidfontein 67 Ptn No. 6 ▪ Kruidfontein 67 Ptn No. 7 ▪ Saltberry Plain 137 Rem 1 ▪ Wonderfontein 350 Remaining Extent ▪ Wonderwater 180 Ptn No. 1 ▪ Wonderwater 180 Ptn No. 3 ▪ Wonderwater 180 Ptn No. 9 ▪ Wonderwater 180 Ptn No. 10 ▪ Wonderwater 180 Ptn No. 22 ▪ Wonderfontein 350 Ptn No. 23 ▪ Wonderwater 180 Ptn No. 23 ▪ Wonderfontein 350 Ptn No. 24 ▪ Wonderwater 180 Ptn No. 24 ▪ Wonderwater 180 Ptn No. 25 ▪ Wonderwater 180 Ptn No. 27 ▪ Weltevreden 182 Remaining Extent ▪ Alfresco 202 Ptn No. 1 ▪ Zaaiplaats 203 Remaining Extent ▪ Die Pan 225 Remining Extent ▪ Roseberry Plain 250 Ptn No. 1

<table>
<tr><td></td><td>

Roseberry Plain 250 Ptn No. 5
Roseberry Plain 250 Ptn No. 6
Roseberry Plain 250 Ptn No. 7
Rietfontein 251 Ptn No. 4
Rietfontein 251 Ptn No. 19
Rietfontein 251 Ptn No. 20
Goedehoop 272 Ptn No. 4
Alicedale 301 Ptn No. 1
Beginsel 310 Remaining Extent
Clifton 316 Remaining Extent
Donkerhoek 323 Ptn No. 1
Gouverneur`S Kraal 333 Remaining Extent
Mullersrust 352 Ptn No. 18
Brakkuil 401 Remaining Extent
Herewarde 409 Ptn No. 42
Herewarde 409 Ptn No. 6
Uitkomst 413
Wilgefontein 431 Remaining Extent
Die Pan 440 Remaining Extent
Londondale 442 Remaining Extent
Londondale 422 Ptn No. 8
Herewarde 409 Remaining Extent
Saltberry Plain 137 Rem 1
Gysbertshoek 315 Ptn No 1
Saltberry Plain 422 Ptn No 1
Gysbert 1161

</td></tr>
<tr><td>Application Area (Ha):</td><td>
<table>
<tr><th>Farm</th><th>Size (Hectares)</th></tr>
<tr><td>The Star 387 Ptn No. 1</td><td>60.292507</td></tr>
<tr><td>Bersheba 1 Ptn No. 7</td><td>10.07113</td></tr>
<tr><td>Boschbank 12 Ptn No. R</td><td>666.057031</td></tr>
<tr><td>Boschbank 12 Ptn No. 2</td><td>238.502791</td></tr>
<tr><td>Boschbank 12 Ptn No. 3</td><td>261.162838</td></tr>
<tr><td>Boschbank 12 Ptn No. 5</td><td>7.052123</td></tr>
<tr><td>Kruidfontein 67 Ptn No. 5</td><td>456.795069</td></tr>
<tr><td>Kruidfontein 67 Ptn No. 6</td><td>300.014283</td></tr>
<tr><td>Kruidfontein 67 Ptn No. 7</td><td>356.099283</td></tr>
<tr><td>Saltberry Plain 137 Rem 1</td><td>150.423699</td></tr>
<tr><td>Wonderfontein 350 Remaining Extent</td><td>61.778863</td></tr>
<tr><td>Wonderwater 180 Ptn No. 1</td><td>149.322678</td></tr>
<tr><td>Wonderwater 180 Ptn No. 3</td><td>27.887332</td></tr>
</table>
</td></tr>
</table>

	Wonderwater 180 Ptn No. 9	257.870256
	Wonderwater 180 Ptn No. 10	16.351608
	Wonderwater 180 Ptn No. 22	3.900096
	Wonderfontein 350 Ptn No. 23	7.823675
	Wonderwater 180 Ptn No. 23	3.398894
	Wonderfontein 350 Ptn No. 24	2.788018
	Wonderwater 180 Ptn No. 24	3.399939
	Wonderwater 180 Ptn No. 25	3.100484
	Wonderwater 180 Ptn No. 27	3.069625
	Weltevreden 182 Remaining Extent	190.032521
	Alfresco 202 Ptn No. 1	144.13739
	Zaaiplaats 203 Remaining Extent	191.843947
	Die Pan 225 Remining Extent	848.440573
	Roseberry Plain 250 Ptn No. 1	224.342308
	Roseberry Plain 250 Ptn No. 5	15.612462
	Roseberry Plain 250 Ptn No. 6	1.627824
	Roseberry Plain 250 Ptn No. 7	180.346257
	Rietfontein 251 Ptn No. 4	54.514223
	Rietfontein 251 Ptn No. 19	1.197958
	Rietfontein 251 Ptn No. 20	0.573286
	Goedehoop 272 Ptn No. 4	25.704155
	Alicedale 301 Ptn No. 1	246.846636
	Beginsel 310 Remaining Extent	190.170046
	Clifton 316 Remaining Extent	189.319423
	Donkerhoek 323 Ptn No. 1	32.031913
	Gouverneur`S Kraal 333 Remaining Extent	105.770514
	Mullersrust 352 Ptn No. 18	68.817876
	Brakkuil 401 Remaining Extent	193.085165
	Herewarde 409 Ptn No. 42	60.485682
	Herewarde 409 Ptn No. 6	167.49736
	Uitkomst 413	694.705505

	Wilgefontein 431 Remaining Extent	856.154942
	Die Pan 440 Remaining Extent	8.20889
	Londondale 442 Remaining Extent	20.879886
	Londondale 422 Ptn No. 8	95.641495
	Herewarde 409 Remaining Extent	30.741381
	Saltberry Plain 137 Rem 1	150.423699
	Gysbertshoek 315 Ptn No 1	92.166985
	Saltberry Plain 422 Ptn No 1	639.423199
	Gysbert 1161	82.258718
	Total Area	**8850.1644**
Magisterial District:	Metsimaholo Local Municipality Fezile Dabi District Municipality	
Distance and direction from nearest town:	The closest towns in Sasolburg which is located 1.8 km north of the Sigma Defunct Colliery where the proposed backfilling project is located. .	

21 digit Surveyor General Code for each farm portion:	**Farm**	**21 Digit Surveyor General Code**
	The Star 387 Ptn No. 1	F02500000000000100000
	Bersheba 1 Ptn No. 7	F02500000000000100007
	Boschbank 12 Ptn No. R	F02500000000001200000
	Boschbank 12 Ptn No. 2	F02500000000001200002
	Boschbank 12 Ptn No. 3	F02500000000001200003
	Boschbank 12 Ptn No. 5	F02500000000001200005
	Kruidfontein 67 Ptn No. 5	F02500000000006700005
	Kruidfontein 67 Ptn No. 6	F02500000000006700006
	Kruidfontein 67 Ptn No. 7	F02500000000006700007
	Saltberry Plain 137 Rem 1	F02500000000013700001
	Wonderfontein 350 Remaining Extent	F02500000000018000000
	Wonderwater 180 Ptn No. 1	F02500000000018000001
	Wonderwater 180 Ptn No. 3	F02500000000018000003
	Wonderwater 180 Ptn No. 9	F02500000000018000009
	Wonderwater 180 Ptn No. 10	F02500000000018000010
	Wonderwater 180 Ptn No. 22	F02500000000018000022

	Wonderfontein 350 Ptn No. 23	F02500000000018000023
	Wonderwater 180 Ptn No. 23	F02500000000018000023
	Wonderfontein 350 Ptn No. 24	F02500000000018000024
	Wonderwater 180 Ptn No. 24	F02500000000018000024
	Wonderwater 180 Ptn No. 25	F02500000000018000025
	Wonderwater 180 Ptn No. 27	F02500000000018000027
	Weltevreden 182 Remaining Extent	F02500000000018200000
	Alfresco 202 Ptn No. 1	F02500000000020200001
	Zaaiplaats 203 Remaining Extent	F02500000000020300000
	Die Pan 225 Remining Extent	F02500000000022500000
	Roseberry Plain 250 Ptn No. 1	F02500000000025000001
	Roseberry Plain 250 Ptn No. 5	F02500000000025000005
	Roseberry Plain 250 Ptn No. 6	F02500000000025000006
	Roseberry Plain 250 Ptn No. 7	F02500000000025000007
	Rietfontein 251 Ptn No. 4	F02500000000025100004
	Rietfontein 251 Ptn No. 19	F02500000000025100019
	Rietfontein 251 Ptn No. 20	F02500000000025100020
	Goedehoop 272 Ptn No. 4	F02500000000027200004
	Alicedale 301 Ptn No. 1	F02500000000030100000
	Beginsel 310 Remaining Extent	F02500000000031000000
	Clifton 316 Remaining Extent	F02500000000031600000
	Donkerhoek 323 Ptn No. 1	F02500000000032300001
	Gouverneur`S Kraal 333 Remaining Extent	F02500000000033300000
	Mullersrust 352 Ptn No. 18	F02500000000035200018
	Brakkuil 401 Remaining Extent	F02500000000040100000
	Herewarde 409 Ptn No. 42	F02500000000040900000
	Herewarde 409 Ptn No. 6	F02500000000040900006
	Uitkomst 413	F02500000000041300000
	Wilgefontein 431 Remaining Extent	F02500000000043100018
	Die Pan 440 Remaining Extent	F02500000000044000000
	Londondale 442 Remaining Extent	F02500000000044200000

	Londondale 422 Ptn No. 8	F02500000000044200008
	Herewarde 409 Remaining Extent	F02500000000044900000
	Saltberry Plain 137 Rem 1	F02500000000013700001
	Gysbertshoek 315 Ptn No 1	F02500000000031500000
	Saltberry Plain 422 Ptn No 1	F02500000000042200001
	Gysbert 1161	F02500000000116100000

4 Locality Map

The Sigma Defunct Colliery falls under the jurisdiction of the Metsimaholo Local Municipality (MLM) and is situated in the Fezile Dabi District Municipality (FDDM) in the Free State Province. The closest towns are Sasolburg, Deneysville, Oranjeville and Viljoensdrift. See Plan 1 of Appendix B for a regional setting. Plan 2 (Appendix B) illustrates the local setting of the project area.

5 Description of the Scope of the proposed Overall Activity

Sasol Sigma under went three separate processes at the beginning of 2013 to obtain the following authorisations for this project:

- Environmental Authorisation in terms of the NEMA for listed activities associated with the ash backfilling project received in 10 April 2014 (Ref No. EMB/9(i)(ii)11(iii)(vi)/13/42);
  - Environmental Authorisation was granted by the Free State Department of Economic Development, Tourism and Environmental Affairs (FS – DEDTEA);
  - The activities included Listing Notice 1 (GNR 544), Activity 9 and Activity 11 in accordance with the EIA 2010 Regulations, which was applicable at the time of the application;
  - The Final BAR was submitted to FS-DEDTEA on 3 March 2014 and an Environmental Authorisation for the Sigma Defunct Colliery ash backfilling project was subsequently granted on 10 April 2014.
- WML in terms of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA) for the ash backfilling project received in 20 June 2017 (Ref No. 12/9/11/L1369/2); and
  - WML was granted by the Department of Environmental Affairs.
- IWUL in terms of the National Water Act, 1998 (Act No. 36 of 1998) (NWA) received in 11 October 2017 (Ref No. 10/C22K/CGIJ/4608).
  - IWUL was granted by the Department of Water and Sanitation (DWS).

As per Condition 1.5 of the EA, Sasol Mining had three years to commence with the ash backfilling project and unfortunately due to the WML and WUL not being granted the Environmental Authorisation lapsed in April 2017.

Digby Wells have attempted several avenues with the FS-DEDTEA to re-issue the EA, to provide an extension to the existing Environmental Authorisation and have also considered requesting the DEA to provide an integrated EA. However, with the one environmental system now in place there is no legal basis on which the Environmental Authorisation can be reinstated and therefore Sasol is required to submit a new application to the Department of Mineral resources (DMR) as the competent authority. Please see Appendix D for Copies of the EA, WML and WUL.

5.1 Listed and Specified Activities

The following listed activities in accordance with the EIA regulations, 2014 (as amended) are triggered by the proposed project as shown in Table 5-1.

Table 5-1: Listed and specified activities for the project

Name of activity	Aerial extent of the activity (ha or m^2)	Listed activity	Applicable listing notice (GNR 324, GNR 325 or GNR 326)
The development and related operation of infrastructure exceeding 1000 metres in length for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, excluding where: (a) such facilities or infrastructure are for bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or (b) where such development will occur within an urban area ***Sasol aims to construct a number of pipelines from the ash pump station to the various voids (for the transportation of ash slurry). These pipelines will have a combined length of more than 1000 metres with various diameters, however the larger***	3 ha	X	GNR 327 –Activity 10 of Listing Notice 1

Name of activity	Aerial extent of the activity (ha or m^2)	Listed activity	Applicable listing notice (GNR 324, GNR 325 or GNR 326)
ones will have an internal diameter of approximately 0.36 m.			
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. ***The construction of the pipelines over the various water courses may result in the movement of soil of more than 10 cubic metres therefore this activity is found to be applicable.***	3 ha	X	GNR 327 –Activity 19 of Listing Notice 1
The continuation of any development where the environmental authorisation has lapsed and where the continuation of the development, after the date the environmental authorisation has lapsed, will meet the threshold of any activity or activities listed in this Notice, Listing Notice 2 of 2017 or Listing Notice 3 of 2017. ***The project was granted Environmental Authorisation on 10 April 2014 however the Environmental Authorisation lapsed on 20 June 2017.***	N/A	X	GNR 327 – Activity 32 Listing Notice 1
The clearance of an area of 300 square metres or more of indigenous vegetation. ***Free State Biodiversity Plan was published in 2015, and like those of the other provinces, identifies and maps the protected areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) to aid management guidelines for the Free State.*** ***Currently there is only a terrestrial component for the plan; however, the aquatic component is expected in 2018. While most of the pipeline servitude is classified as 'degraded' and 'other,' small portions of the proposed pipelines are classified as CBA 1, CBA 2, ESA 1 and ESA 2.***	3 ha	X	GNR 324 – Activity 12 Listing Notice 3

5.2 Description of the Activities to be undertaken

5.2.1 Sigma Defunct Colliery Mining Operation and Background

Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the DMR. During its operations, Sigma Defunct Colliery supplied coal to SO (previously known as Sasol Infrochem) from its underground and opencast mining operations. Mining was ceased in 2006 and the relevant old order mining rights lapsed due to a decision not to submit applications for the conversion of these rights.

As a result of underground mining activities, subsidence of the surface has been identified as a major hazard. A Potential Failure Report[1] was compiled in 2012 and analysed the probability of incidents occurring on the surface overlying the Sigma Defunct Colliery workings immediate actions are thus required. In this report, some areas were listed as high-risk areas, as they had the potential to cause fatalities, should an incident occur. Mitigation measures such as ash backfilling have been proposed as a means to mitigate against these high risk areas. It must be noted that ash backfilling may not be undertaken throughout the mining lease area as a combination of mitigation measures will be utilised.

5.2.2 Location and Site Description

5.2.2.1 Regional Setting

The ash backfilling project falls under the jurisdiction of the MLM, situated in the FDDM in Free State and the nearby towns are Sasolburg, Deneysville, Oranjeville and Viljoensdrift (refer to Plan 1, Appendix B).

5.2.2.2 Property Particulars

The local and site-specific study areas have been defined as Ward 14, Sasolburg residential area, as well as Zamdela. See Plan 2, Appendix B for an illustration of the local setting of the proposed Sasol Sigma ash backfilling project area.

The proposed ash backfilling project area is dominated by maize, wheat and livestock farming in the central, western and southern areas; urban built-up areas to the east and mining activities to the north and east. The general topography of the landscape in which the proposed project is located can be described as undulating and sloping towards the Vaal River. Years of underground mining at the Sigma Defunct Colliery has resulted in large subsided areas with the potential of further subsidence occurring in the future.

[1] Risk Assessment Report on Surface Areas of Old Sigma Workings. Author not listed.

The land owner information, as well as the land owners adjacent to Sasol Sigma is listed in Table 5-2 and Table 5-3 and the land tenure is depicted in Plan 3, Appendix B.

Table 5-2: Landowner Information

Farm	Portion Number	Land Owner Name
Alfresco 202	1	Interferon Trust, Kerneels Rossouw
Alicedale 301	R	Dirk Strydom
Alicedale 301	1	N/A
Beginsel 310	R	Lucas Erasmus
Boschbank 12	2	Sasol Mining (Pty) Ltd, As Potgieter
Boschbank 12	3	Ca Jordaan
Boschbank 12	R	Am Rossouw Eiendomme (Pty) Ltd
Brakkuil 401	R	Brakkuil Trust, Dirk Strydom
Clifton 316	R	Dj Strydom Trust
Clifton 316	1	N/A
Die Pan 225	R	Tharina No 2 Trust, Tharina
Die Pan 225	1	N/A
Donkerhoek 323	R	Lewies Trust
Gouverneur`S Kraal 333	R	Beginsel Boerdery Trust, Lukas Erasmus
Herewarde 409	R	Sasol Townships (Pty) Ltd, Johan Van Rooyen
Herewarde 409	6	Sasol Chemical Industries (Pty) Ltd, As Potgieter
Kruidfontein 67	4	N/A
Kruidfontein 67	5	Lpj Besigheidsdienste, Louis Barnard
Kruidfontein 67	6	Robbie Cronje
Kruidfontein 67	7	Robbie Cronje
Roseberry Plain 250	6	N/A
Uitkomst 413	R	Sasol Mining (Pty) Ltd, As Potgieter
Weltevreden 182	R	Beginsel Boerdery Trust, Lukas Erasmus
Zaaiplaats 203	R	Brakkuil Trust, Dirk Strydom
Roseberry Plain 250	7	Sasol Chemical Industries (Pty) Ltd, As Potgieter
Roseberry Plain 250	5	Metsimaholo Local Municipality
Roseberry Plain 250	1	Sasol Chemical Industries (Pty) Ltd, As Potgieter

Farm	Portion Number	Land Owner Name
Donkerhoek 323	1	Sasol Chemical Industries (Pty) Ltd, As Potgieter
The Star 387	1	Sasol Townships (Pty) Ltd, Johan Van Rooyen
Mullersrust 352	17	Sasol Mining (Pty) Ltd, As Potgieter
Mullersrust 352	18	Sasol Mining (Pty) Ltd, As Potgieter
Boschbank 12	5	Jan Rossouw Trust
Bersheba 1	4	George Atkinson Trust
Londondale 442	R	Sasol Mining (Pty) Ltd, As Potgieter
Londondale 422	8	Sasol Mining (Pty) Ltd, As Potgieter
Wonderfontein 350	24	Sasol Mining (Pty) Ltd, As Potgieter
Wonderfontein 350	23	Sasol Mining (Pty) Ltd, As Potgieter
Wonderwater 180	9	Sasol Mining (Pty) Ltd, As Potgieter
Wonderwater 180	3	Sasol Mining (Pty) Ltd, As Potgieter
Saltberry Plain 422	1	Allan Peeters
Saltberry Plain 422	R	Allan Peeters
Gysbert 1161		Edwin Claassen
Gysbertshoek 315	R	Edwin Claassen
Wonderwater 180	R	N/A
Wonderwater 180	1	Jaco Burger (Bothma & Son Transport)
Saltberry Plain 137	1	Allan Peeters
Wonderwater 180	10	Sasol Mining (Pty) Ltd, As Potgieter
Wonderwater 180	22	N/A
Wonderwater 180	23	N/A
Wonderwater 180	24	N/A
Zwanenberg 450	25	N/A
Rietfontein 251	19	N/A
Rietfontein 251	20	N/A
Wonderfontein 350	R	N/A
Rietfontein 251	4	N/A
Goedehoop 272	4	N/A
Bersheba 1	7	N/A

Farm	Portion Number	Land Owner Name
Wonderfontein 180	27	N/A

Table 5-3: Adjacent Landowners

Farm	Portion Number	Land Owner Name
Alfresco 202	R	Interferon Trust, Kerneels Rossouw
Zwanenberg 450	2	Roberts Knoetze
Roseberry Plain 250	R	Knoetze Family Trust
Herewarde 409	8	Sasol Chemical Industries (Pty) Ltd, As Potgieter
The Star 387	R	Alfresco Trust, Kerneels Rossouw
Kruidfontein 67	R	Prontuitbeleggings 11 (Pty) Ltd, August Weilbach
Wonderfontein 426	R	No Longer Exists
Tweelingfontein 386	R	Beginsel Boerdery Trust, Lukas Erasmus
Wonderfontein 350	21	Hannelie De Jager
Wonderwater 180	R	Sasol Mining (Pty) Ltd, As Potgieter
Gysbertshoek 315	2	Edwin Claassen
Zwanenberg 450	26	N/A
Mullersrust 352	R	N/A
Bersheba 1	5	N/A

5.2.3 Proposed Ash Backfilling

Underground mine backfilling is a method utilised to stabilise mining pillars (Sivakugan, N *et al*, 2015).

The proposed underground mitigation measures (ash backfilling project) is aimed at backfilling mine voids where significant risk of subsidence has been identified with ash from the ash supplier being SO. The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water, the water is proposed to be sourced from SO from the Sasol Ash pump station at SO, to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The water that will be pumped will be reutilised into this process. Excess water pumped from the underground water that is not reutilised into the process will be sent for treatment at a water treatment plant.

The pipelines transporting slurry will run above ground on Sasol owned properties and within existing servitudes where possible. Where this is not possible, existing culverts and crossings will be used; alternatively, new agreements will be entered into with land owners. The pipeline routes will be specifically selected to ensure that the pipes run along existing servitudes, linear infrastructure and disturbed areas to minimise the impact on the receiving environment.

It should be noted that in 2005 a significant risk of subsidence was identified along the Parys road (R59). To ensure that these areas did not collapse ash backfilling was utilised to minimise the hazard in the area. The ash backfilling was undertaken in accordance with the IWUL (Ref No. 16/2/7/C223/C296/1) issued by the Department of Water Affairs and Forestry in 2005. The licence subsequently expired in 2010.

Sasol aims to construct a number of pipelines from the ash pump station to the various voids (for the transportation of ash slurry). These pipelines will have a combined length of more than 1,000 metres with various diameters; however, the larger ones will have an internal diameter of approximately 0.36 m. The pipelines will be constructed of steel for the main feeder lines to each cluster, High-density polyethylene (HDPE) for secondary pipe lines from the cluster control valves to the boreholes. The proposed location of the pipelines is shown in Plan 4 in Appendix B.

5.2.4 Waste Management Facilities

All waste will be handled in accordance to the general and hazardous waste provisions of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEMWA).

5.2.4.1 Industrial Waste

Industrial waste includes steel, used oil, petroleum and cleaning material. The industrial waste is isolated and temporarily stored in clearly marked skip bins before disposal where:

- Salvageable material is sent to a redundant materials management site and sold to employees or external recyclers; and
- Recyclable material is transported by recycling contractors off-site.

5.2.4.2 Domestic Waste

Domestic waste generated will be collected into labelled bins and skips and temporarily stored on site in designated areas. Domestic waste will be disposed at an accredited disposal site. There are a number of waste management and recycling companies contracted by Sasol.

5.2.4.3 Hazardous Waste

All the hazardous waste is collected and temporarily stored in clearly marked appropriate disposal structures (bins and drums) and is removed from the site by a contracted waste company and disposed of at a licenced landfill site.

5.2.5 Employment

The ash backfilling project will generate approximately 60 - 90 employment opportunities during the construction phase. The construction phase will be approximately twelve months. The operational phase will generate approximately 20 - 30 employment opportunities. During decommissioning phase a total of approximately 20 – 30 employment opportunities will be generated.

6 Policy and Legislative Context

This section provides a description of the policy and legislative context within which the project is being proposed. The table indicates what legislation is applicable to the project and how it has been complied with as discussed in Table 6-1.

Table 6-1: Policy and Legislative Context

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996)	Section 24 of the Constitution states that everyone has the right to an environment that is not harmful to their health or well-being and 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	In support of the above rights, the environmental management objectives of the proposed Sasol Sigma ash backfilling project will incorporate the protection of ecologically sensitive areas and support sustainable development and the use of natural resources, whilst promoting justifiable socio-economic development in the project area.
National Environmental Management Act, 1998 (Act No. 107 of 1998)	The NEMA, as amended was set in place in accordance with section 24 of the Constitution of the Republic of South Africa. Certain environmental principles under NEMA have to be adhered to, to inform decision making for issues affecting the environment. Section 24 (1)(a) and (b) of NEMA state that: *The potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment, must be considered, investigated and assessed prior to their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity.* The EIA Regulations, 2014 (as amended). Together with the EIA Regulations, the Minister also published GN R.327 (Listing Notice No. 1 which requires a basic assessment process), GN R.325 (Listing Notice No. 2 which requires an EIA process) and GN R.324 (Listing Notice No. 3 which requires a basic assessment process) in terms of sections 24(2) and 24D of the NEMA, as amended.	Environmental authorisation for the proposed ash backfilling project is required for listed activities in terms of the EIA Regulations (2014) (as amended) of the NEMA. The listed activities are listed in Table 5-1. No activities identified in Listing Notice 2 apply to the proposed ash backfilling project, and therefore a BA Process is being followed in applying for authorisation.
National Water Act, 1998 (Act No. 36 of 1998) (NWA)	The NWA provides for the sustainable and equitable use and protection of water resources. It is founded on the principle that the National Government has overall responsibility for and authority over water resource management, including the equitable allocation and beneficial use of water in the public interest, and that a person can only be entitled to use water if the use is permissible under the NWA. **GN R704 National Water Act, 1998 (Act No. 36 of 1998)** Regulations 6 of the regulation on use of water for mining and related activities aimed at the protection of water resources, Government Notice Regulation 704 (GN R No. 704) published in June 1999.	An IWUL application with its associated IWWMP for the proposed ash backfilling project was submitted to the DWS on 3 March 2014. An IWUL was granted along with its amendments by the DWS on 11 October 2017 (Licence No. 10/C22K/CGIJ/4608). The IWUL was granted for the triggering of Section 21 water uses as listed below: ▪ Section 21 (c): impeding or diverting the flow of water in a watercourse; ▪ Section 21(g): disposing of waste in a manner which may detrimentally impact on a water resource ▪ Section 21 (i): altering the bed, banks, course or characteristics of a watercourse ▪ Section 21 (j): removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people
National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA)	The National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA) is the overarching legislation that protects and regulates the management of heritage resources in South Africa. The Act requires that Heritage Resources be managed and conserved by a Resource Authority, either nationally, by the South African Heritage Resources Agency (SAHRA) or by the relevant provincial Agency. In this case, the Provincial Heritage Resources Authority Mpumalanga (PHRA-M) is responsible for the identification, conservation and management of heritage resources throughout the province.	No heritage/archaeological resources associated with the project site have been identified within the footprint of the pipeline and ash backfilling project. However the conservation of heritage resources has been considered as part of this project. A Heritage BAR has been compiled and has been submitted to SAHRA and the Heritage Free State (HFS). The report has been attached as Appendix H. Comments were received from the South Africa Heritage Resource Authority (SAHRA) on 17 November 2014.

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
Mineral and Petroleum Resource Development Act. 2002 (Act No. 28 of 2002) The MPRDA sets out the requirements relating to the development of the nation's mineral and petroleum resources. It also aims to ensure the promotion of economic and social development through exploration and mining related activities. In accordance with the 2014 EIA regulations(as amended) and one environmental management system, all environmental authorisations and EMPs that relate to any mining activity must be submitted to the DMR for consideration and authorisation.		Mining activities at the Sigma Defunct Colliery was conducted under Mining Licences No. 1/2001 and 3/2001, granted by the Department of Mineral Resources (DMR). During its operations, Sigma Defunct Colliery supplied coal to SO from its underground and opencast mining operations. Mining was ceased during 2006 and the relevant old order mining rights lapsed due to a decision not to submit applications for conversion of these rights. A BA application to undertake the ash backfilling project was submitted to the Free State Regional office of the DMR in Welkom on 30 May 2018 detailing the activities being undertaken as part of the project. A BA Process has been undertaken which includes the compilation of a BA report where the impacts associated with the activities being undertaken have been determined. The proposed measures in which to mitigate and manage the impacts are also detailed as part of this process (Part B: Section 5 and 0). A monitoring programme has also been compiled to ensure the project does not result in significant environmental damage during the construction, operation and decommissioning of the ash backfilling project (Part B: Section 8).
National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA)	NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act also regulates to the protection of species and ecosystems that require national protection and also takes into account the management of alien and invasive species. This Act works in accordance to the framework set under NEMA. The following regulations which have been promulgated in terms of the NEM:BA are also of relevance: ▪ Alien and Invasive Species Lists, 2014 published (GN R.599 in GG 37886 of 1 August 2014) ; ▪ National Environmental Management: Biodiversity Act, 2004: Threatened and Protected Species Regulations (GN R.152 in GG 29657 of 23 February 2007) and ▪ National list of Ecosystems Threatened and in need of Protection under Section 52(1) (a) of the Biodiversity Act (GG 34809, GN R.1002, 9 December 2011).	As part of this project, flora and wetlands have been investigated to determine the current status of the environment and to determine any potential ecological sensitivity to be avoided and/or mitigated. The study focused specifically on where the pipeline is proposed to be located as well as the impact associated with the ash backfilling. No applications have been submitted in terms of NEM:BA for the project as no protected species were identified along the pipeline routes and therefore permits are not required to relocate them. The flora and wetlands assessment details the area where the pipeline will be located as well as the impact associated with ash backfilling on wetlands and fauna and flora. The study has determined the ecological importance of the area. The findings of the flora and wetlands assessments, in the form of the impacts and the proposed mitigation measures for the project are detailed in Part A: Section 15 and Part B: 5 and 6 of this report. The project is not anticipated to impact on any protected species. No protected species were identified during the site visit.
National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)	On 29 November 2013, the list of waste management activities published under GN R718 of 3 July 2009 (GN R718) was repealed and replaced with a new list of waste management activities under GN R921 of 29 November 2013. Included in the new list are activities listed under Category A, B and C. These activities include inter alia the following: ▪ Category A describes waste management activities requiring a Basic Assessment process to be carried out in accordance with the EIA Regulations supporting an application for a waste management licence; ▪ Category B describes waste management activities requiring an EIA process to be conducted in accordance with the EIA Regulations supporting a waste management licence application; and ▪ Category C describes waste management activities that do not require a WML but these activities will have to comply with the prescribed requirements and standards as prescribed by the Minister, which includes the Norms and Standards for Storage of Waste, 2013. These activities include the storage of general waste at a facility with a capacity to store in excess of 100 m3 and storage of hazardous waste in excess of 80 m3. The Waste Classification and Management Regulations published under GN R 634 of November 2013 require that all wastes be classified according to SANS10234 and managed according to its classification. The National Norms and Standards for the Assessment of Waste for Landfill Disposal were published under GN R635 on 23 August 2013 and prescribe the requirements for the assessment of waste prior to disposal to landfill in terms of Regulation 8(1)(a) of the Waste Classification and Management Regulations. The National Norms and Standards for the Disposal of Waste to Landfill were published under GN R 636 of 23 August 2013 and determine the requirements for the disposal of waste to landfill as contemplated in Regulation 8(1)(b) and (c) of the Waste Classification and Management Regulations.	A WML in terms of the NEMWA for the Ash Backfilling Project was received in 2017. The listed waste activities which were triggered was Category B listed activity 9 in accordance with GN NO. 718 pf 3 July 2009. It should be noted that these regulations have been repealed and replaced with GN R921 of 29 November 2013. The licence granted all waste

Applicable legislation and guidelines used to compile the report	Reference where applied	How does this development comply with and respond to the policy and legislative context
National Environmental Management: Protected Areas Act, 2003 (Act. 57 of 2003)	The act aims to provide protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas.	A flora and wetland assessment has been undertaken to determine whether any protected areas are located within the project site. It has been determined that the Sigma Defunct Colliery does not fall within a protected area. The nearest protected area is 35 km to the east of the Sigma Defunct Colliery called "Vaal Dam Nature Reserve". The Vaal Dam Nature Reserve is not expected to be impacted on by the normal procedure of ash backfilling.
Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983) (CARA)	CARA aims to provide for the conservation of the natural agricultural resources of the country through the maintenance of the production potential of land, by combatting and preventing erosion and the weakening of water sources. In addition, this Act aims to protect vegetation, while combatting weeds and invader plants	Section 12 of the CARA details the maintenance of soil conservation in which every land user will be responsible for the maintenance and conservation of soil. The mitigation measures recommended as part of this BAR aim to prevent the compaction, erosion and degradation of the soil resources. An invasive species management plan is proposed to be developed and implement to mitigate against the spread of these invasive species. The project will not result in the loss of agricultural land.
National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM:AQA)	According to the NEM:AQA the Department of Environmental Affairs (DEA), the provincial environmental departments and local authorities (district and local municipalities) are separately and jointly responsible for the implementation and enforcement of various aspects of NEM:AQA. A fundamental aspect of the new approach to the air quality regulation, as reflected in the NEM:AQA is the establishment of National Ambient Air Quality Standards (NAAQS) (GN R 1210 of 2009). These standards provide the goals for air quality management plans and also provide the benchmark by which the effectiveness of these management plans is measured.	Air Quality has been considered for the project. The activities proposed to take place do not trigger any air quality activities and therefore no Air Emissions License will be applied for. The mitigation and management measures to be implemented as part of the project aim to manage and prevent potential impacts to air quality. Dust suppression will be implemented during the construction phase as necessary. In the operational phase the ash backfilling project is not expected to contribute to generation of dust or any other emissions.

7 Need and Desirability of the Proposed Activities

Section 24 of the Constitution provides that everyone has the right to an environment that is not harmful to their health or well-being and to have the environment protected through reasonable legislative and other measures that prevents pollution and ecological degradation.

Sasol Sigma Defunct Colliery was commissioned in 1952 and subsequently decommissioned in 2006. Decommissioning and rehabilitation activities have been undertaken since 2005 and are still continuing to date. Due to underground mining of the Sigma Colliery, a risk of subsidence has been identified. In order to effectively manage the residual risk in a responsible manner, further mitigation measures are required to reduce this risk to an acceptable level.

Sasol has been applying best practice approach (with reference to current SA Legislation) and ensuring compliance with the Sigma Defunct Colliery EMPr and Closure Plan. This application seeks authorisation to implement the underground mitigation measures proposed to address the possibility of pillar failure which will result in subsidence.

The proposed construction and operation of the ash backfilling project is crucial to the success of the remediation efforts and to ensure compliance with the EMPr and Closure Plan. It is important to reiterate that the purpose of the project is to ensure effective protection:

- Of natural resources on site (e.g. soil, water, biodiversity etc.) and the surrounding environment; and
- To minimise any potential health and safety risks to the surrounding community.

Furthermore, the commencement of the ash backfilling project will result in the following:

- Prevent the possibility of pillar failure which can result in subsidence;
- Reduce the negative impacts associated with historical mining on the community living in close proximity to the mine;
- Create an environment that is left in a safe manner that is not harmful to the people or the environment; and
- Ensure a sustainable land use is achieved.

7.1 Socio-Economic Consideration

The proposed Sasol Sigma ash backfilling project will be undertaken to stabilise underground mine workings which are considered to have a high potential for land subsidence which can result in a health and safety impact. The proposed Sasol Sigma ash backfilling project will create a safer physical environment for residents in nearby areas.

The Sigma Defunct Colliery surface rights are owned in some areas by farmers which utilise the land for maize and cattle farming. Additionally, game farming is also being undertaken

within the Sigma mineral right area. Should subsidence occur, farmers will be directly impacted as the land may be deemed unsafe and may not be able to be utilised for any further farming practises. Subsidence therefore poses a health and safety risk to both people and livestock. Should the project be authorised to commence the use of ash backfilling will stabilise the mine voids and potentially eliminate the risk that subsidence will occur.

Additionally it should be considered that if ash backfilling is not undertaken, subsidence will occur which can have a direct impact on the visual landscape at Sigma Defunct Colliery.

7.2 Environmental Consideration

The risk due to pillar failure has been identified as potential hazards throughput the mining lease area. Priority areas have been identified beneath the Rietspruit and Leeuspruit Rivers which are the main rivers which run through the Sigma Defunct Colliery and feed into the Vaal River.

Should subsidence occur along these rivers, the surface water will be lost to the underground mine workings. This will have a direct negative impact on the quantity of water entering the Vaal River, wetlands and aquatic ecosystems which rely on these rivers for environmental functioning.

Additionally, where subsidence may occur outside the river systems, this can result in surface water ponding and thereby negatively impact soil, land use, land capability, wetlands, fauna and flora and aquatic ecology. Should ash backfilling be utilised subsidence can be prevented which will ensure the impact to the environment is reduced.

8 Motivation for the Overall Preferred Site, Activities and Technology Alternative

As discussed in Section 9, various alternatives to the proposed ash backfilling have been investigated to ensure the most suitable and preferable alternatives are selected. The investigation aims to ensure the least number of impacts on the environment occur, and that those impacts that are unavoidable are managed to an acceptable level of significance. The motivation for the preferred alternatives has been discussed in Section 9.

9 Full Description of the Process followed to reach the proposed Preferred Alternatives within the Site

9.1 Details of the Development Footprint Alternatives Considered

Alternatives are different means of meeting the general purpose and need of a proposed activity. Alternatives aid in identifying the most appropriate method of developing the project, taking into account location or site alternatives, rehabilitation alternatives, as well as the no-project alternative. Alternatives also aid in determining the activity with the least environmental impact.

The potential alternatives that have been identified to date are provided below.

9.1.1 Ash Backfilling Location Alternatives

The location of where ash backfilling will be conducted which includes where the boreholes would be drilled to pump the ash underground is predetermined by the potential of pillar collapse. An assessment was undertaken which specifically identified where pillar failure could occur which would result in subsidence. The areas where subsidence could occur are shown in Plan 5, Appendix B. Therefore, alternative locations for where ash backfilling will occur were not investigated.

9.1.2 Backfill Material

“The purpose of backfilling after underground mining operations have ceased or when mining in a certain area has reached its limit is to ensure that subsidence is counter acted as much as possible” (Masniyom, 2009). Masniyom (2009) further explains that “backfilling goes beyond preventing the ground from collapsing; that it is also for the purposes of preventing fires and stabilising the rock, to mention a few”.

The following backfilling material was investigated to backfill the underground workings.

9.1.2.1 Hydraulic Backfilling

This method involves the use of water as a transportation medium (Masniyom, 2009) for the pumping of waste material to the underground workings. The materials that can be used in hydraulic backfilling are waste tailings, ash, mountain sand, river sand and crushed sand, to mention a few (Sheshpari, 2015). The material often used for hydraulic backfilling requires cement as a binding agent which is considered very expensive and is usually found to not be economically viable (Masniyom, 2009). It was found that non-cemented hydraulic backfilling was the most cost effective method if small waste particles were available from the mining activities and the preferred option considered for this project (Sheshpari, 2015).

Drainage is an important aspect of hydraulic backfilling as it prevents decanting (Sheshpari, 2015) and to allow for the excess water to leave the stopes as quickly as possible through the barricades (Sivakugan *et al*., 2015).

9.1.2.1.1 Ash Backfilling (Preferred Means of Backfilling)

The backfilling option proposed for the Sigma Defunct Colliery is an ash management activity that will be a mono-disposal process (non-cemented hydraulic backfilling). Due to the mono-disposal nature of the backfilling option the ash slurry was sent for Distilled/Reagent water leachate tests, as well as a complete analysis of the fluid phase. The results of these tests were then classed and compared against the Total Concentration Threshold (TCT) and Leachable Concentration Threshold (LCT) limits to determine the waste type as per legislative guidelines given in the NEMWA.

The results of the water analysis and ash analysis were combined in a weighted average calculation of 80% water and 20% ash for the total concentrations. This procedure was

followed as the current and planned water to ash ratio in the slurry will be 80% water and 20% ash. The sum of these weighted average calculations thus gives an accurate indication of the concentrations that can be expected to enter the mine voids. The leachable concentrations however represent an accurate indication of what can leach from the solid phase into the environment and was used as such. Where values were below the limit of detection they were indicated as such.

The water phase of the slurry was submitted for a full organic analysis. Due to the volatile nature of most of the organic compounds and its high mobility, if any organic compounds were found in the ash material itself it would either have combusted or dissolved into the liquid.

Based on the classification of the Distilled/Reagent water leachate test results against the relevant TCT and LCT limits as given in the legislative guidelines for waste classification (DEA 2013a), the ash to be used as backfill can be classified as follows:

- For boron (B) the results show that LCT0<LC<LCT1 and TC<TCT0;
- The ash to be used for the backfilling of the underground voids can be classed as a Type 3 waste;
- A Type 3 waste may only be disposed of at a Class C (GLB+) landfill;
- Based on the low concentrations of the leachable ions (although they are above TCT0 and LCT0 in certain cases), the low Nett Acid Generation (NAG) and high Nett Neutralising Potential (NNP), managing the ash through backfilling is considered feasible; furthermore
- The low permeability and hydraulic conductivity of ash will allow little to no seepage through the newly formed ash layers once allowed to settle and thus the environmental concentration of contaminants entering the receiving environment will be low and easily diluted through natural processes.

9.1.2.2 Paste Backfilling

There are two types of paste backfilling; non-cemented which Sheshpari (2015) describes as the most cost effective method and the cemented paste backfill which is the most popular of the two. The most cost effective paste backfilling method is not used for backfilling underground mining operations because of liquefaction issues (Sivakugan *et al*., 2015). Cemented paste backfilling is seen as good waste management option as it places the tailings back into the ground (Ercikdi *et al*., 2017).

Paste backfilling involves mixing mining waste with flyash, cement materials and adding water on a proportional basis (Chang et al., 2014) to crease a paste. The past requires a limited amount of water and is considered to be extremely thick. The addition of water on a proportional basis is important to ensure that the mixture is the desired consistency and that it can be transported from the mixing plant, underground (Ercikdi *et al*., 2017).

Belem and Benzaazoua (2004) speaks to the advantages of paste backfilling being the support it grants to the pillars and walls of the underground operations as well as assisting in keeping the roof intact as stated by Coates (1981).

Paste backfilling has specific densities that must be achieved. The specifics of this engineering process are explained by Ercikdi *et al.* (2015) as being a "mixture of fine process tailings (75–85% solids by weight), a hydraulic binder (3–9% by total dry paste weight) and mixing water for a solid density of 70–80% by weight." The density of paste is similar to that of a cement thickness and the technology or methodology of pumping the paste is similar to that of the concrete industry (Masniyom, 2009).

There are also various options of pipes that are used for pumping the mixture underground (Masniyom, 2009), and depending on which one is used, the pipes can be susceptible to bursting and causing spillages due to the thickness of the paste. The paste backfill option is expensive because of the engineering input required, additionally significant maintenance is required to ensure the paste continues to fill the underground mine voids. New infrastructure and a large amount of energy is needed to ensure that the paste is mixed to the required density and that it is pumped successfully underground.

Although Hydraulic backfilling is the preferred option it should be noted that paste backfill may also be utilised to backfill some of the underground voids when required.

9.1.3 Infrastructure Sites

The proposed pipeline routes has been selected largely on existing pipeline routes and along existing servitudes, both on privately owned land, as well as land owned by Sasol Mining. This section of the pipeline routes has, where possible, been adjusted to avoid environmentally sensitive areas such as isolated rocky ridges and wetlands and kept on Sasol Mining owned land as far as is practical. The specialist studies confirmed that this route is the preferred option as the impacts will be reduced by the fact that the servitudes are already in place and therefore seen as already impacted.

The preferred pipeline routes utilises pipelines that are currently being used, or have previously been used, for transporting ash slurry under Sasol Sigma's previous Water Use Licence (Ref No. WUL no. 20021165) which expired in 2010.

It should also be noted that the proposed pipeline routes shown in this BAR has already been authorised in accordance with the IWUL granted for the proposed ash backfilling project (Ref No. 10/C22K/CGIJ/4608). Therefore should an alternative route be proposed for this BAR, the already authorised IWUL will need to be amended which is not considered to be a feasible option at this stage of the proposed project.

9.1.4 Ash Transportation Methods

Two methods can be considered to transport the ash from the ash supplier to the underground voids to be backfilled.

9.1.4.1 Truck and Shovel

A truck and shove method can be utilised to truck the ash from the ash supplier to the areas where the backfill will be undertaken. The ash once at the area to be backfilling will then be made into ash slurry and pumped underground. No pipelines will be constructed in this alternative method. If no pipelines are constructed this reduces the possibility of potential pipeline bursts and discharges to the environment. However, if the truck and shovel alternative is utilised roads will need to be constructed to the various boreholes to be utilised for ash backfilling which can have an environmental impact however it would be noted that existing roads would be utilised as far as possible. Multiple batching plants will need to be constructed at each borehole where the ash and water will be combined to pump underground which will result in additional infrastructure and impact to the environment at each borehole. Additionally the trucks would need to drive over areas which have already been remediated and can have a direct impact on the success of the rehabilitation efforts. Increase dust and noise impact would be anticipated with this alternative method. Additional risks of spillages from trucks transporting the ash would be increased. The use of heavy vehicles can also pose a health and safety risk to both the land users as well as the animals located within the mining lease area. While the trucks are utilising the roads, a risk of erosion along the road would be anticipated.

It should however be noted that in some cases it may be proposed that the truck and shovel method will be utilised where it may not be practical to construct pipelines. Additionally this may be considered to be a cheaper alternative.

9.1.4.2 Pipelines (Preferred Method)

The preferred means of transporting the ash slurry is via a pipeline which will be constructed to the various boreholes to pump the ash underground. Although a risk of potential pipeline breakage resulting in spillage is a possibility, with correct mitigation measures and effective maintenance this risk can be reduced. Additionally, the pipeline construction will have a smaller impact footprint compared to construction of a road. The dust and noise impacts would be removed as well as the health and safety risk. This can therefore be considered as the preferred alternative as less impact to the environment is anticipated.

9.1.5 No Go Project Alternative

Should the Environmental Authorisation not be granted, Ash Backfilling will not be undertaken therefore the risk of subsidence will continue to remain a significant to both Sasol and the surrounding community. It has been determined that if no mitigation measures are implemented subsidence will definitely occur. This will result in a collapse of the land to the underground mine workings which will have a negative impact on the environment and health and safety. The loss of land will negatively impact on the community and will thereby reduce the land currently being used for agricultural purposes.

Should the project not go ahead, SO will need to build another surface fine ash dam to manage the ash, if the ash is not utilised elsewhere. These facilities have several environmental and health impacts associated with them.

The no go option has also been assessed per each environmental aspect. The “no-go” option also takes into consideration the effects of subsidence caused by no backfilling of the voids and the subsequent possibility of subsidence occurring. Table 9-1 provides the impact that may occur should the ash backfilling project not be commenced with.

Table 9-1: No Go Alternative – Description of the associated impact per environment aspect

Environmental Aspect	No Go Alternative – Description of the Associated Impact
Aquatic Ecology	The current land use associated with the river course is urban and heavy industrial activities. Based on the current survey the aquatic conditions are seriously modified as a result of water quality modification. Due to the presence of weirs and various land use patterns, sedimentation is occurring within the catchment area, the quality and availability of freshwater habitats are being negatively affected (Mantel et al., 2010). Additionally, the removal of water effects the volumes and flow velocities within the associated water courses, thereby affecting the available habitat structures as well as altering the flow-depth scenarios, affecting the biotic structures of the system. During the low flow assessment severe sedimentation was also found at site SAS5, impacting on natural aquatic habitat. If the project does not go ahead the potential for subsidence exists which will result in the following: ▪ Modification of riparian zones via urban encroachment and industrial activities; ▪ Sedimentation from surrounding land use patterns; and ▪ Subsidence.
Fauna and Flora	The current land use in the project area is mostly farming and industrial. The more natural areas have been overgrazed and signs of bush encroachment and erosion (due to vegetation removal) occur in the study area. The overstocking that has occurred has resulted in degradation of the vegetation, resulting in a loss of plant abundance (habitat) and diversity. The loss of biodiversity is gradual within the already disturbed areas, such as the agricultural fields therefore the actual effect on biodiversity will not be significant should ash backfilling not occur. However, the following impacts have been identified should the no-go option be selected: ▪ Loss of Secondary Grassland; ▪ Loss of Degraded Woodland/Savanna; ▪ Loss of Riparian Vegetation; ▪ Loss General Biodiversity; ▪ Fragmentation and Edge Effect; and

Environmental Aspect	No Go Alternative – Description of the Associated Impact
	▪ Alien vegetation colonisation.
Wetlands	Subsidence has already occurred and will continue to occur in the absence of backfilling. Continued subsidence will result in loss of wetland habitat including some peat areas and a disruption to the hydrological links between wetland systems on sites. Additionally, continued agricultural activities on site will result in the degradation of wetlands, thus reducing biodiversity, increasing \ erosion and reducing the capacity of wetlands to provide services such as nutrient cycling, water purification and flood attenuation.
Heritage	Should ash backfilling not occur the impacts associated with subsidence will continue to remain a significant risk. Therefore, should subsidence / pillar failure occur beneath any heritage resources, the resource will be lost to the underground workings and have a negative significant impact on cultural heritage within the area.
Groundwater	Ash backfilling is recommended to avoid leaving a void in the mine out areas that can lead to subsidence. Should the no go option be selected subsidence may result in fracturing of the overlying stratigraphy and increased geological permeability, resulting in impacts to the groundwater and surface water environment. The occurrence of subsidence may be subject the following impacts to the groundwater environment in affected areas: ▪ Increased groundwater recharge, estimated to reach 9% of the MAP at the shallow weathered aquifer and 5% at deeper fractured aquifers (Vermeulen and Usher, 2006); ▪ Increased chances of the occurrence of decant and increased decant rates; and ▪ Should a contamination plume immerge within the mined out areas; expansion of the potential contamination plume into the overlying aquifers in areas where it would not have been expected.
Surface Water	The current land-use activities within the proposed ash backfilling area are mainly agriculture in the form of maize and livestock farming, industrial and mining related activities in the form of Old Sigma workings and current sand mining. However, it must be recognised that impacts on the catchment quantity and quality are already prevalent from the current land uses before the ash backfilling project has commenced. Currently existing activities pose several impacts to water quality as discussed below: ▪ Continued agricultural activities will increase water quality impacts within the Leeuspruit and Rietspruit catchments this will specifically emanate from the use of fertilisers for agriculture. Consequently, farming and livestock rearing could result in water quality deterioration from enrichment of water by

Environmental Aspect	No Go Alternative – Description of the Associated Impact
	nutrients; ▪ Current sand mining activities and farming activities promote sediment transfer to the streams resulting in the increase of TDS. This exposes the surface water within the catchments to contamination from the underground mining water; and ▪ Previous ash backfilling resulted in the spillage incident of ash into the Leeuspruit. These impacts are localised to the seepage zone and downstream on the Leeuspruit. As indicated above, the surface water resources have already been significantly impacted. Based on various models the locations of where subsidence will occur, if no mitigation measures are implemented have been identified and found to be along the river systems. Therefore, should the ash backfilling not be commenced with there is a definite chance that the Leeuspruit and the Rietspruit will subside which will result in the loss of surface water to the underground workings. The loss of surface water can impact on the Vaal River quantity being received and also result in significant negative impacts to the surrounding farmers and water uses which relay on the water resource.

10 Details of the Public Participation Process Followed

A Public Participation Process (PPP) is a statutory requirement in terms of the NEMA. The main objective of PPP is to provide a platform for the applicant, Interested and Affected Parties (I&APs) and relevant organs of state to work together to enable the relevant authorities to make an informed decision on the project. Through the PPP, I&APs are able to contribute local knowledge and raise comments applicable to the project planning and design.

The PPP consists of three phases, namely:

- Formal project announcement;
- Public comment period for the draft BAR; and
- Announcement of the Decision (granting or not granting of the Environmental Authorisation by the DMR).

The activities undertaken during each phase are described below. All PPP documentation which has been distributed to I&APs has been incorporated within Appendix C.

10.1 Formal Project Announcement

As part of the announcement phase, details of the project together with availability of the Draft BAR were provided to stakeholders. Below are the key activities undertaken for the PPP Announcement Phase.

10.1.1 Identification of Stakeholders

Stakeholders interested in or affected by the project were identified by means of the methods indicated below:

- Conducting Windeed and related desktop searches in and around the project area to verify land ownership and occupancy and obtain landowner contact details;
- Use of Sasol Sigma Defunct Colliery existing stakeholder databases;
- Responses on the distribution of the Background Information Document (BID), site notices or newspaper advertisement placed; and
- Telephonic consultations with landowners to identify additional I&APs.

Stakeholders for the project were grouped into the following categories:

- **Government:** National, Provincial, District and Local authorities;
- **Landowners and occupants:** Directly affected, adjacent or indirectly affected landowners and occupants;
- **Parastatals:** Such as Transnet and SANRAL;
- **Non-Governmental Organisations (NGOs):** Environmental and social organisations; and
- **Business:** Small and medium enterprises, mining and industrial companies.

A stakeholder database was compiled and has been updated throughout the environmental regulatory process (see Appendix C 1).

10.1.2 Public Participation Media

Considering the legislative requirements and good practice, the following methods have been implemented to make project information available to stakeholders.

- **Background Information Document:** a BID which included a project description, information about the relevant legislation, the competent authorities and details of the appointed EAP was prepared and distributed on 16 July 2018. The BID was also accompanied by a Registration and Comment Form for stakeholders to use for formal registration as I&APs or to submit comments. Information regarding the availability of the Draft BAR was also provided, and I&APs were asked to comment. The BID has been included in Appendix C 2.
- **Newspaper advertisement:** a newspaper advertisement was placed in the Sasolburg Ster and Vaalweekblad, on 11 to 12 July 2018 and 11-13 July 2018 respectively, which is a local newspaper that distributes to Sasolburg and surrounding areas. The advert was published in English and included a brief project description, information about the relevant legislation, the competent authorities, details of the appointed EAP, registration process for I&APs, and information

regarding the availability of the Draft BAR for public comment. Evidence of the placement of the newspaper is included in Appendix C 3.

- **Site notices:** Site notices were put up at various places on 16 July 2018. The site notices contained a brief project description, information about the relevant legislation, the competent authorities and details of the EAP, registration process for I&APs and information regarding the availability of the Draft BAR for public comment. Evidence of the placement of these site notices will be included in the Final BAR.

- **Announcement Letter with Comment and Registration Form:** A letter was sent in English which contained information about the proposed project, applicable legislation and competent authorities, details of the EAP, information about availability of the Basic Assessment Report for public comment. A Registration and Comment Sheet was also provided for stakeholders to use for formal registration as I&APs or to submit comments;

- **Focus Group and One-on-one Discussions**: Due to various stakeholders and different landowners within the study area, focus group and one-on-one discussions were utilised during this process in order to obtain comments and to identify any issues raised by individuals.

  - Landowner one-on-one meetings: Directly affected landowners and the majority of the adjacent landowners were consulted by means of one-on-one meeting during which project details were provided, discussions were held to obtain comments and to identify additional landowners. A map was also used as part of the discussions to provide landowners with a reference to locality and recognisable landmarks. Key comments from attendees included, but isn't limited to the following:

    - Confirmation of project timelines and infrastructure locations;
    - Details of the pipeline routes and the construction of the pipelines;
    - Existing impacts on groundwater within the area; and
    - Existing impacts on water reservoirs and impacts on fauna and flora

  - **Stakeholder Meeting**: A meeting was held with the directly affected Local Municipality of Metsimaholo in order to engage with the authorities on the project and re-introduce the scope of work. This meeting allowed us to understand key concerns and obtain further comments. Key comments from attendees included, but isn't limited to the following:

    - Existing dust and noise impacts to be reduced before commencement of this project;
    - Clarification around water usage for the purposes of this project;
    - Construction of boreholes in order to access groundwater; and

- Jobs for the local community during construction and operation of the project.

The Draft BAR was made available for a public comment period of 30 days from 16 July 2018 to 15 August 2018 at the Zamdela and Sasolburg Public Library and on the Digby Wells website: www.digbywells.com (under Public Documents). Comments were received from I&APs regarding the project during this period. The comments were incorporated within this Final BAR and include in Appendix C 7. The Draft BAR has been subsequently updated to reflect a final version. The Final BAR was submitted to the DMR on 30 August 2018. The Final BAR has also been made available to I&APs on the Digby Wells website. I&APs were informed of the availability of the Final BAR by means of a letter (email and SMS) on 30 August 2018. This enabled I&APs to verify that their comments have been captured and responded to accordingly.

10.1.3 Public Participation Activities undertaken

Table 10-1 below provides a summary of the PPP activities undertaken thus far, together with referencing materials included as annexures in Appendix C.

Table 10-1: Public Participation Activities

Activity	Details	Reference in Report
Identification of stakeholders	Stakeholder database was developed which represents various sectors of society, including directly affected and adjacent landowners, in and around the project area.	Appendix C 1: Stakeholder Database
Distribution of BID	A BID with registration and comment form was emailed and posted to stakeholders on 16 July 2018. An SMS was also sent to stakeholders on 16 July 2018 announcing the availability of the draft BAR.	Appendix C 2: BID, letter with registration and comment sheet
Placing of newspaper advertisement	An English advert was placed in the Vaalweekblad and Sasolburg on 11 July – 13 July and 10- 16 July 2018 respectively	Appendix C 3: Advertisement
Putting up of site notices	Site notices were put up at the project site, Zamdela and Sasolburg Public Library and Sigma Defunct Colliery (3 Shaft) on 16 July 2018.	Appendix C 4: Site Notice
Announcement of the Draft BAR availability	Announcement of availability of the Draft BAR was emailed and SMS to stakeholders together with the formal project announcement on 16 July 2018. Copies of the Draft BAR were available to stakeholders at Zamdela and Sasolburg Public Library. The Draft BAR was available on the Digby Wells website: www.digbywells.com (under Public Documents). *(The comment period for the Draft BAR was from 16th July 2018 to 15th August 2018)*	Appendix C 5: Correspondence

Activity	Details	Reference in Report
Stakeholder Engagement one-on-one discussions and focus group meeting	One-on-one discussions were held with directly affected landowners and stakeholders. The discussions took place during the legislated 30-day period comment. All comments recorded during the discussions have been placed into the Comments and Response Report. *(23 July 2018 until 27 July 2018)*	Appendix C 6: Stakeholder Consultation
Announcement of the Final Basic Assessment Report	The Final Basic Assessment Report has been submitted to Department of Mineral Resources (DMR). A notification for availability of the Final Basic Assessment Report was emailed to all stakeholders on the database on 30 August 2018 The Final Basic Assessment Report has also been made available on www.digbywells.com under Public Documents.	Appendix C 5: Correspondence
Obtained comments from stakeholders	Comments, issues of concern and suggestions received from stakeholders will be captured in the CRR once received. It should be noted that the comments previously received from the previous Environmental Authorisation Process competed in 2013 has been incorporated within this CRR.	Appendix C 7: Comment and Response Report

10.2 Decision-Making

Once the competent authority has made a decision regarding the project, results thereof, together with information about the regulated appeals procedure, will be communicated to stakeholders as prescribed under the NEMA legislation. Notification to stakeholders will be done by means of a letter via email and post.

10.3 Summary of Issues raised by I&APs

A summary of the comments received during the previous environmental authorisation processes are included in Appendix C 7. The table also provides the response given to all comments raised previously. Once comments are received for this environmental authorisation process the comments will be included into this report.

Table 10-2: Comment and Response Report

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project Registration	In Sasolburg at sigma mining if possible can I be registered as concern resident mazibuko	Enoch Mazibuko	Resident	10-Jul-18	Email	Good day, Thank you for your email and interest in the project. Please note we have registered you on the database for further notifications. Feel free to contact us should you require anything.
Groundwater	The underground water is contaminated.	CAP Weilbach	Landowner for Kruidfontein	23-Jul-18	One-on-one discussion	The proposed project involves the pumping of ash mixed with water underground in areas where a significant risk of subsidence has been identified to stabilize the underground workings. An Environmental Authorisation (EA) Process has been undertaken to obtain the required authorisation to proceed with the project. In 2014 an EA was received however it lapsed and therefore no activities for the proposed project will be commenced with until this EA is granted. It should

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	Did this project affect the water on my neighbours farm?	CAP Weilbach	Landowner for Kruidfontein	23-Jul-18	One-on-one discussion	however be noted that a Waste Management Licence (WML) and Integrated Water Use Licence (IWUL) has been granted by the various government departments for the proposed project. Ash backfilling has been undertaken by Sasol in the past under its previously approved IWUL which lapsed more specifically beneath the R59. Any groundwater contamination which may have been experienced historically is not related to this specific project. Groundwater monitoring is undertaken on a quarterly basis to determine the groundwater and surface water quality by Sasol. The results indicate that the groundwater quality have stabilised and no significant contamination in groundwater has been experienced except for one borehole which could be related to the geology or third party factors unrelated to Sigma. It should also be noted that the groundwater quality utilised by farmers will not be impacted by the proposed project as the ash will be pumped into the mine void with the ash settling at the bottom of the void. The groundwater in the mine void does not influence the groundwater utilised by farmers in the area (Refer to Groundwater specialist study Appendix I).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water Use Licence	Why do you need the water use licence	CAP Weilbach	Landowner for Kruidfontein	23-Jul-18	One-on-one discussion	The activities proposed to be undertaken by the ash backfilling project trigger Section 21 c , g, i and j under the National Water Act, 1998 (Act No. 36 of 1998). ■ Section 21 (c): impeding or diverting the flow of water in a watercourse; ■ Section 21(g): disposing of waste in a manner which may detrimentally impact on a water resource ■ Section 21 (i): altering the bed, banks, course or characteristics of a watercourse ■ Section 21 (j): removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people In accordance with this legislation an IWUL is required prior to the project commencing. An IWUL application with its associated IWWMP for the proposed ash backfilling project was submitted to the DWS on 3 March 2014. An IWUL was granted along with its amendments by the DWS on 11 October 2017 (Licence No. 10/C22K/CGIJ/4608). (Refer to Part B Section 4.3 of the BAR).
Water	The river is full of dead fish.	CAP Weilbach	Landowner for Kruidfontein	23-Jul-18	One-on-one discussion	It is understood that dead fish have been reported in the Vaal River which has been specifically related to the discharge of sewage as well as other contaminates from various industries. It is not anticipated that the ash backfilling project will have a significant negative impact on the surface water and aquatic life within the Vaal River. However should a spillage occur which can result in an impact to surface water, mitigation measures have been proposed and will be implemented by Sasol (Refer to Part A Section 12.1 of the BAR).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Request of information	Please can you show me a location of where any mining would take place so I can see where I can mine in future	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Sasol Sigma Defunct Colliery was an operational mine in the 1950s and ceased all mining activities in 2006. No further mining activities by Sasol is proposed to be undertaken in this area. Plan 5 shows the areas which have been mined historically as well as were subsidence is anticipated.
PP dates	What is the latest due date for this process?	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	The EA application was submitted to the Department of Mineral Resources on 30 May 2018. The public participation process was commenced with from 16th July 2018 to 15th August 2018. The Final BAR was submitted to the DMR for consideration on 30 August 2018. The Final BAR will be made available for final review from the 30 August 2018 on the Digby Wells website.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Flora	There is a nature conservation where there are secretary birds and their breeding is becoming extinct.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	As part of this project, flora and wetlands have been investigated to determine the current status of the environment and to determine any potential ecological sensitivity to be avoided and/or mitigated. The study focused specifically on where the pipeline is proposed to be located as well as the impact associated with the ash backfilling. No applications have been submitted in terms of NEM:BA for the project as no protected species were identified along the pipeline routes and therefore permits are not required to relocate them. The findings of the flora and wetlands assessments, in the form of the impacts and the proposed mitigation measures for the project are detailed in Part A: Section 15 and Part B: 5 and 6 of the BAR. The project is not anticipated to impact on any protected species. No protected species were identified during the site visit. It is however noted that a small portion of the pipeline is located in both Critically Biodiversity Areas as well as Ecological Support Areas. The impact associated from the proposed project is not anticipated to have a significant negative impact on the fauna and flora.
Water	I never wanted to make water an issue but two or three farmers say they are not happy.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Thank you for your comment, this will be noted.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	All I ask is that water be supplied to me too please. I am willing to work with Sasol	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Sigma Colliery historically provided water to land owners where it was legally and/or contractually obliged to do so. It is noted that Sasol still provide water to these selected farmers however, as the mine has ceased all operation, Sasol are now in the process of drilling new boreholes for farmers previously impacted by the mine. The aim is to provide farmers with a sustainable solution where Sasol will no longer supply farmers with water if a suitable alternative sources (quality and quantity) is able to be provided. It is not anticipated that the project will have an impact on farmers water supply.
Fauna	There is a planned Game Camp that needs to be established and water needs to be supplied.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Your comment is noted. The proposed Sasol Sigma ash backfilling project will be undertaken to stabilise underground mine workings which are considered to have a high potential for land subsidence which can result in a health and safety impact. The proposed Sasol Sigma ash backfilling project will create a safer physical environment for residents in nearby areas which in turn will positively impact on the proposed game camp. No impact to groundwater utilised by the proposed game camp is anticipated
Water	Sasol must construct a pipeline to my property to supply water like my neighbouring farmers	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Sasol Mining provides water to land owners where it is legally and/or contractually obliged to do so.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Socio-economic	Please can Sasol provide opportunities of work.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	The ash backfilling project will generate approximately 60 - 90 employment opportunities during the construction phase. The construction phase will be approximately twelve months. The operational phase will generate approximately 20 - 30 employment opportunities. During decommissioning phase a total of approximately 20 – 30 employment opportunities will be generated. Should the EA be granted, Sasol will ensure equal opportunities are provided to all contractors wishing to provide services for the proposed project, to submit tenders for the completion of the work. More information on Vendor Registration form is available on Sasol website which must be completed to become a Sasol supplier. Every potential supplier or service provider has the right to apply to be listed on the Sasol supplier Database. Please contact Sasol Shared services on 086 0104 777 for more information.
Project description	Will the old shafts be used during this project.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	The shafts which were previously utilised to access the underground workings have been demolished and all shafts have been sealed with a cement caps. These shafts will not be affected or utilised by the proposed project. The ash slurry will be pumped underground via a borehole which will be drilled into the underground workings.
	Tharina once called and said there was subsidence with a 4m base deep and there were cracks- what happened to	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	It is acknowledged that subsidence has occurred in certain areas around the mine in the past which have been and will continue to be remediated by Sasol Mining. The aim of the project is to stabilise the underground workings and prevent this from happening in the future.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	that before the ash was used to stabilize.					
Agriculture	I am currently ploughing and planting mealies.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	The proposed project should not have any impact on daily activities undertaken by farmers in the area. However, notifications will be distributed to all I&AP should an EA be received and once the project is commenced with. Open communication between Sasol Mining and I&APs will be undertaken throughout the project to provide feedback.
Shaft	In the past there were many references to this shaft thing so the government officials only want to see this shaft when they come and do site visits, my suggestion is to stop referring to it as a shaft	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Shafts previously utilised to access the underground workings have been decommissioned where all infrastructure has been removed and the shaft has been sealed. The DMR are required by law to view what closure steps Sasol Mining have undertaken to ensure the correct process has been followed as part of the closure process. Only once the DMR consider the shaft closure to be acceptable will site visits to the shafts cease. It should also be noted that the sealing of the shafts are not considered to be a part of this project for ash backfilling.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project description	How will the drilling take place, we need to be consider the wild animals because one shock will get them terrified.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Boreholes will be drilled to access the underground workings to pump the ash slurry underground. Drilling will be undertaken utilising a drill rig to drill the borehole. A steel casing will be utilised which will be placed into the drilled borehole to prevent collapse as well as potential contamination from the ash slurry while it is pumped underground. It is noted that fauna and flora currently are located in the area and therefore mitigation measures proposed in the BAR aims to reduce the impact associated with the project on these animals. Additionally noise mitigation measures will also be implemented to ensure the drilling noise level is reduced (Ref to Section 14 of the BAR).
Additional Information	Sasol can buy over the whole camp if they want too.	Louis Barnard	Landowner for Kruidfontein	23-Jul-18	One-on-one discussions	Thank you for the comment this information will be provided to Sasol Mining for consideration. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.
Project description	The longwall method was done at Sasol so why do you want to do backfilling	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	Longwall mining was utilised to extract coal in the past from the underground workings which would have resulted in an intentional collapse however in some cases the collapse did not occur or bord and pillar mining was also utilised. Areas where bord and pillar mining was undertaken has been determined to be susceptible in some areas to the risk of subsidence. The proposed underground mitigation measures (ash backfilling project) aims to reduce the risk of subsidence in these areas (Refer to Section 5 of the BAR) by increasing support of the pillars.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	The dolomite is broken and this is connected to the aquifer	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	In accordance with the groundwater specialist study and various groundwater models done at the Sigma Defunct Colliery it has been determined that the water contained within the underground mine voids does not influence the aquifer utilised by the farmers in the area (Ref Appendix I).
Project description	How many levels will be backfilled	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	The mine void is interconnected therefore no specific level will be targeted but rather the whole underground void.
Water	Why is the water going to the treatment plant if the water is not contaminated	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	The water contained in the underground mine voids which will be pumped out is not considered to be compliant with the water quality standards from the catchment and IWUL (Which has now expired). The water quality in the mine voids have low sulphates and are predominately alkaline. It also has high levels of chloride, sodium, potassium and aluminum. This water is thus considered to be contaminated and will need to be treated before further water handling can take place (Ref to Section 11.7 of the BAR and Appendix I).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project description	The idea is from what I understand with this process is that the water will be pumped, then it water will be sucked out to make slurry and then backfill	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water) the water is proposed to be sourced from SO. Ash Slurry will be pumped from the Sasol Ash pump station at SO, to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The water that will be pumped will be reutilised into this process. Excess water pumped from the underground workings that is not reutilised into the process will be sent for treatment at a water treatment plant (Refer to Section 5.2.3 of the BAR).
Additional Information	Subsidence has occurred and may potential occur in certain areas. Sasol have decommissioned houses on various properties to reduce the health and safety risk associated with subsidence. My concern is what if the pipeline is located in areas where subsidence could occur and damage the pipeline.	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	The pipeline is not considered to be a permanent structure and therefore once the mine void has been backfilled the pipeline will be removed. However, the location of the pipeline will be placed strategically to ensure no damage to the pipeline occurs which could potentially result in an ash spillage.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Additional Information	When do you expect construction to start on the project?	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	The EA application was submitted to the Department of Mineral Resources on 30 May 2018. The public participation process was commenced with from 16th July 2018 to 15th August 2018. The Final BAR was submitted to the DMR for consideration on 30 August 2018. The Final BAR will be made available for final review from the 30 August 2018 on the Digby Wells website.
Request of information	Can I receive a copy of these comments and answers to them	Alan Peeters	Landowner of Saltberry Plain	23-Jul-18	One-on-one discussions	Your request has been noted. The final Comment and Response Report (CRR) will be emailed to all I&AP as well as incorporated within the Final BAR which has been submitted to the DMR for consideration.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Request of information	With the Ash backfilling project there has already been contamination to the groundwater that is why there is water from the local municipality being provided to us.	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	During mining of the Sigma Colliery, dewatering was undertaken to gain access to the underground mine voids and to ensure a safe mining environment. The dewatering resulted in the loss of access to groundwater resources by certain farmers in the area. Sasol Mining subsequently provided alternative water sources to these farmers. Since the ceasing of the mining activities the Sigma underground mine began to fill with water. Monitoring data show that the groundwater levels for both the mine void and aquifer above the mine void has stabilised. Sasol are now in the process of drilling new boreholes for farmers previously impacted by the mine. The aim is to provide farmers with a sustainable solution where Sasol will no longer supply them with water if a suitable alternative source (quality and quantity) is able to be provided. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	There has been previous contamination of the groundwater again.	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	A hydrocensus was completed in 2016 where groundwater quality samples were taken. Based on the results of the 12 boreholes that were samples seven boreholes were within acceptable limits. One of the boreholes had elevated chloride, magnesium and calcium however this is attributed to the natural geology and the remaining boreholes had been contaminated with nitrate which is attributed to the use of fertilizers from farmers. No significant groundwater contamination is noted within the sigma mining right area which is currently being utilised by farmers. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	We were told tests are being conducted	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	Monitoring data shows that the groundwater levels for both the mine void and aquifer above the mine void has stabilised. Sasol are now in the process of drilling new boreholes for farmers previously impacted by the mine. The aim is to provide farmers with a sustainable solution where Sasol will no longer supply farmers with water if a suitable alternative sources (quality and quantity) is able to be provided. Water sampling is being undertaken by Digby Wells to determine whether the groundwater quality abstracted from the newly drilled boreholes is compliant with drinking water standards and suitable for human consumption. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Groundwater	During the borehole testing there was sediment that ceased from the pump and three weeks this then happened again, so it is not true that the water doesn't have contamination.	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	A hydrocensus was completed in 2016 where groundwater quality samples were taken. Based on the results of the 12 boreholes that were samples seven boreholes were within acceptable limits. One of the boreholes had elevated chloride, magnesium and calcium however this is attributed to the natural geology and the remaining boreholes had been contaminated with nitrate which is attributed to the use of fertilizers from farmers. No significant groundwater contamination is noted within the sigma mining right area which is currently being utilised by farmers. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.
Request of information	Where are the MIP results of the ash testing.	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	A geochemistry and waste classification specialist study on the ash slurry has been undertaken. The purpose of this environmental geochemical evaluation and waste classification is to determine the environmental risks associated with using ash as backfill material. The results of the waste classification and geochemistry evaluation is provided in Appendix K of the BAR

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
General	To me ash backfilling project isn't a question of the DEA but from the mine getting to the mine dump. Since Sasol is decommissioning why is there a concern of ash back filling, what is the motivation now?	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	As a result of the historic underground mining activities which were undertaken at the Sigma Defunct Colliery, the potential for pillar failure has been identified which can lead to potential environmental impacts on surface. Ash backfilling is considered to be one of the mitigation measures to be implemented to assist in the stabilisation of the underground workings to prevent surface instability which could result in subsidence. The proposed ash backfilling project is crucial to the success of the remediation efforts and to ensure compliance with the EMPr and Closure Plan. It is important to reiterate that the purpose of the project is to ensure effective protection: ■ Of natural resources on site (e.g. soil, water, biodiversity etc.) and the surrounding environment; and ■ To minimise any potential health and safety risks to the surrounding community. Furthermore, the commencement of the ash backfilling project will result in the following: ■ Prevent the possibility of pillar failure which can result in subsidence; ■ Reduce the negative impacts associated with historical mining on the community living in close proximity to the mine; ■ Create an environment that is left in a safe manner that is not harmful to the people or the environment; and ■ Ensure a sustainable land use is achieved.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	Ash back filling contaminates the water!	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.
	Historically water leaks along the pipelines which supply my farm with water have been experienced. What is the integrity of the pipelines? Is there a concern that the pipeline may leak or even burst discharging ash slurry to the environment?	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	The proposed pipeline will be made of HTPE. The pipeline will not be a permanent structure and will be removed once the underground workings have been backfilled. Maintenance will be undertaken on a regular basis to ensure the pipelines do not leak or even burst. Should a spillage occur it will be cleaned up and remediation measures implemented (Refer to Section 5 and 6 of the BAR).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	There is a risk in this process. The ash of the water with the existing pillars applies pressure from the ash because of the subsidence. There are impacts from the pillars the concern is the pressure that will apply to the subsidence.	Lukas Erasmus	Landowner of Tweelingfontein,Gouverneurs and Weltevreden	24-Jul-18	One-one-one discussion	The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water) the water is proposed to be sourced from SO. Ash Slurry will be pumped from the Sasol Ash pump station at SO, to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The water that will be pumped will be reutilised into this process. Excess water pumped from the underground water that is not reutilised into the process will be sent for treatment at a water treatment plant (Refer to Section 5.2.3 of the BAR). Mitigation measures proposed in Part B Section 5 and 6 will be implemented to prevent further impact to surface water or groundwater. It must however be noted that the aim of this project is to prevent subsidence from occurring.
	I would like to know the baseline of the water	Suzanne van Dyk	Home occupier on Begisnel Farm	24-Jul-18	One-one-one discussion	A CD was provided to the I&AP on the day of the one on one meeting. It is however noted that the baseline for groundwater and surface water is incorporated into Section 11.7 and 11.8 of the BAR. Additionally further information has been attached in Appendix I and J.
Flora	There are grass owls/grasslands (called vlei in Afrikaans) I am not sure if this was picked up during the assessment	Suzanne van Dyk	Home occupier on Begisnel Farm	24-Jul-18	One-one-one discussion	A Fauna and Flora Specialist Study which was conducted for this project specifically indicates that Grass Owls are located within the project area (Appendix F). Mitigation measures included in Part B Section 5 and 6 provides measures to be implemented to ensure the impact associated with the proposed project on the fauna and flora environment is minimised.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project description	I wasn't aware there would be potential pipelines towards this side. Why are the pipelines on the Zaaiplaats?	Dirk Strydom	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	The location of the pipeline route is provided in Plan 4 of the BAR is in relation to Plan 5 which indicates the areas of subsidence. The ash slurry is proposed to be pumped into the underground workings to prevent potential pillar collapse. The ash slurry will only be pumped underground where a significant risk of subsidence has been identified.
Ground Stability	The project intends to stabilize the ground but this ash backfilling will not bring about stability	Dirk Strydom	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	Ash backfilling is considered to be one of the mitigation measures to be implemented to assist in the stabilisation of the underground workings to prevent surface instability. Several other mitigation measures have and will also be implemented to reduce the risk associated with subsidence. This includes surface mitigation measures (River Diversion (undertaken as a separated environmental authorisation process) and decommissioning of infrastructure in areas identified to potentially subside.
Project description	Where will the pipelines be located?	Dirk Strydom	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	The location of the pipeline route is provided in Plan 4 of the BAR
Project description	On the Die Pan portion I just want to make sure which side the pipeline is proposed	Dirk Strydom	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	The location of the pipeline route is provided in Plan 4 of the BAR

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	There are mercury levels in the water.	Jaco Burger	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	A hydrocensus was completed in 2016 where groundwater quality samples were taken. Based on the results of the 12 boreholes that were samples seven boreholes were within acceptable limits. One of the boreholes had elevated chloride, magnesium and calcium however this is attributed to the natural geology and the remaining boreholes had been contaminated with nitrate which is attributed to the use of fertilizers from farmers. No significant groundwater contamination is noted within the sigma mining right area which is currently being utilised by farmers. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.
	The Vaal area is contaminated	Jaco Burger	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	It is understood that the Vaal River is contaminated which has been specifically related to the discharge of sewage as well as other contaminates from various industries. It is not anticipated that the ash backfilling project will have a significant negative impact on the surface water and aquatic life within the Vaal River. However should a spillage occur which can result in an impact to surface water, mitigation measures have been proposed and will be implemented by Sasol (Refer to Part A Section 12.1 of the BAR).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Mining	On portion 12 Sasol promised to not move the mine area and for ten years now they have not been able to move mine again	Jaco Burger	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	Thank you for your comment it has been noted and captured within this CRR. The intention of the project is not to disrupt any businesses currently taking place within the Sigma Mining Lease area. No mining activities by Sasol will be undertaken going forward. Sasol are in the process of obtaining a closure certificate for the Sigma Defunct Colliery.
	On Bersheba Portion 12 I reserve the right to continue with my business independent of the project.	Jaco Burger	Landowner of Zaaiplaats and Brakkuil	24-Jul-18	One-one-one discussion	
Project description	Where is the ash coming from?	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	Ash is proposed to be sourced from the ash supplier being Sasolburg Operations (SO) (previously known as Sasol Infrochem).

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	On Lukas's farm he has problems with the ash filling to the top - how will the filling occur	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water) the water is proposed to be sourced from SO. Ash Slurry will be pumped from the Sasol Ash pump station at SO, to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The water that will be pumped will be reutilised into this process. Excess water pumped from the underground water that is not reutilised into the process will be sent for treatment at a water treatment plant (Refer to Section 5.2.3 of the BAR). Mitigation measures proposed in Part B Section 5 and 6 will be implemented to prevent further impact to surface water or groundwater. It must however be noted that the aim of this project is to prevent subsidence from occurring.
Public Participation Process	Between now and when you're doing your consultation when do you plan to begin.	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	In accordance with the EIA Regulations, 2014 (as amended) Sasol has 90 days to submit the final BAR to the DMR for consideration after the submission of the application form. It is noted that the Final BAR was submitted to the DMR on 30 August 2018. The DMR have 107 days to review the BAR before a decision can be made. Once a decision is made the decision will be communicated to all I&APs giving timeframes regarding the appeal process. Construction may only begin once an EA has been granted and no appeals have been lodged against the decision.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	Compensation should happen for the water that will be used	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	The water will be sourced from SO as well as the water abstracted from the mine voids. No water will be sourced from farmers.
	My pipelines are currently leaking on Alfresco 202 ptn 1 which Sasol is not responsible for however Sasol assist me with any pipeline leaks on Alfresco 202 rem. Sasol should be willing to assist me on both my properties and not only the one Sasol is supply water to?	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	Your comment is noted. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.
General	If you bring the paper for me to read then you must speak the language that is applicable in the area. In a public meeting you are told to speak English, but this can't happen in my household.	CJ Rossouw	Landowner of Zaaiplaats and Brakkuil	25-Jul-18	One-one-one discussion	Your comment is noted. Sollomon Tshili presented the project and explained to him the reasoning for the project in Afrikaans. No further issues were raised regarding language communication.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
General	I just want to express that we are mad at Sasol. We want to move away from the area and Sasol must buy my farm.	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	Your comment is noted and has been communicated to Sasol Mining as well as SMRD.
General	From our side as farmers we are doing the best we can but Die Pan and Doornhoek there was no contractual agreement with the farmers this is why we do not want any activities happening there	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	Your comment is noted. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.
Ground Stability	There is subsidence happening on Doornhoek and Sasol wants to buy us out.	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	It is acknowledged that subsidence has occurred in certain areas around the mine in the past which have been and will continue to be remediated by Sasol Mining. These remediation measures include purchasing farms which are at risk of subsidence. The aim of the project is to stabilise the underground workings and prevent this from happening in the future.
Compensation	Last year when they brought us out they compensated for the harvest they found on the farms but this time they	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	Your comment is noted and has been communicated to Sasol Mining as well as SMRD. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	do not want to do that					
Pipeline route	On Die Pan where you propose to have the pipeline, please note this will not happen (points exactly where he refuses the pipeline to go). This is because I am farming there. Tharina has expressed that activities will not happen on her land. There is work that I need to do on the farms.	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	Your concern has been noted. As part of the BA process alternatives were considered Refer to Section 9 of the BAR. Further consultation will be undertaken by Sasol should an EA be granted for the project. It must be noted that these pipelines are not permanent and once the void has been backfilling the pipeline will be removed from the farm.
Compensation	The land is good there, but we are contemplating to sell everything to Sasol	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	Your comment is noted and has been communicated to Sasol Mining as well as SMRD. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	Shows us on the map that at a certain area there is water why not have the pipeline go that way.	D Crous	Representative at Tharina Boerdery	26-Jul-18	One-one-one discussion	The location of where ash backfilling will be conducted which includes where the boreholes would be drilled to pump the ash underground is predetermined by the potential of pillar collapse. An assessment was undertaken which specifically identified where pillar failure could occur which would result in subsidence. The areas where subsidence could occur are shown in Plan 5 in the BAR. Therefore, alternative locations for where ash backfilling will occur were not investigated.
Heritage	My sister- Tracy tried to save an old heritage house that had estuaries there when I was still in high school but the mine went and mined there.	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Your comment is noted and has been communicated to Sasol Mining as well as SMRD. It is recommended that all grievances with Sasol should be raised and submitted to SMRD. It is SMRD responsibility to ensure that all complaints and concerns are investigated and addressed.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	The drinking water is currently not in a good state for drinking.	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	A hydrocensus was completed in 2016 where groundwater quality samples were taken. Based on the results of the 12 boreholes that were samples seven boreholes were within acceptable limits. One of the boreholes had elevated chloride, magnesium and calcium however this is attributed to the natural geology and the remaining boreholes had been contaminated with nitrate which is attributed to the use of fertilizers from farmers. No significant groundwater contamination is noted within the sigma mining right area which is currently being utilised by farmers. It is noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.
Project description	My main concern is the content in the slurry- I hope Sasol is not trying to get rid of unwanted toxic substances underground	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Ash backfilling is considered to be one of the mitigation measures to be implemented to assist in the stabilisation of the underground workings to prevent surface instability. Although, the ash slurry may impact on the water quality in the mine voids this will not have an impact on drinking water.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	There should be an independent regulatory body that will conduct tests as per a certain requirement to check that the slurry is compatible.	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Digby Wells has been appointed as the independent Environmental Assessment Practitioner to conduct the required specialist studies on the ash slurry which also includes geochemistry and waste classification assessments. In addition to our reports IGS has been contracted by Sasol to undertake regular monitoring of water quality within the mining area. All information is provided to the DMR for consideration prior to a decision being made.
	You need to think about fences that will need to go up during construction phase and also how they need to go back down again	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Appropriate temporary barriers will be erected around the areas being worked in. Sasol will ensure open communication with farmers is established during the ash backfilling project.
Ground Stability	If there is seepage issues all the birds will start dying	Merry Sim	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Measures have been proposed which aim to ensure decant does not occur by means of concurrently abstracting mine water while pumping in ash slurry. It is not anticipated that decant will occur as a result of the proposed project.
Project description	How long will it take to remove the pipelines	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	It is proposed that the pipeline will be constructed within twelve months however a contingency has been provided should delays be experienced (due to economic circumstances, adverse weather conditions or other unforeseen circumstances). Therefore the authorisation to complete the construction phase should be valid for twenty four months. It is unknown how long the ash backfilling project will be undertaken for therefore authorisation should be authorised indefinitely until the ash backfilling project is no longer required and is

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
						decommissioned. Decommissioning is proposed to take approximately six months.
Water	Will Sasol pay for the water should it be contaminated	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Sasol Mining provides water to land owners where it is legally and/or contractually obliged to do so. It is must however be noted that the ash slurry to be pumped underground will and has in the past potentially impacted the groundwater quality within the underground mine voids however this will have no influence on the two aquifers which are located closer to the surface currently being utilised by farmers.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Additional Information	You are aware there is a gated community very close to the Bersheba farm and anything that is new to them makes them feel uncomfortable. They may not be very happy with this project. Invasion of privacy is big thing in that area	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	The proposed Sasol Sigma ash backfilling project will be undertaken to stabilise underground mine workings which are considered to have a high potential for land subsidence which can result in a health and safety impact. The proposed Sasol Sigma ash backfilling project will create a safer physical environment for residents in nearby areas. The Sigma Defunct Colliery surface rights are owned in some areas by farmers which utilise the land for maize and cattle farming. Additionally, game farming is also being undertaken within the Sigma mineral right area. Should subsidence occur, farmers will be directly impacted as the land may be deemed unsafe and may not be able to be utilised for any further farming practices. Subsidence therefore poses a health and safety risk to both people and livestock. Should the project be authorised to commence the use of ash backfilling will stabilise the mine voids and potentially eliminate the risk that subsidence will occur. Additionally it should be considered that if ash backfilling is not undertaken, subsidence will occur which can have a direct impact on the visual landscape at Sigma Defunct Colliery.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project description	When will this project start and when will it end.	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	In accordance with the EIA Regulations, 2014 (as amended) Sasol has 90 days to submit the final BAR to the DMR for consideration after the submission of the application form. It is noted that the Final BAR was submitted to the DMR on 30 August 2018. The DMR have 107 days to review the BAR before a decision can be made. Once a decision is made the decision will be communicated to all I&APs giving timeframes regarding the appeal process. Construction may only begin once an EA has been granted and no appeals have been lodged against the decision.
	It is recommended that I&APs are provided with continuous feedback on the project. An open communication policy must be established. There is concern regarding increased crime levels due to contractors working in the area?	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Sasol will ensure continuous feedback is provided to all I&APs. These will be in the form of letters emailed to the stakeholder database. Additionally Sasol will communicate with each farmer directly affected by the pipeline during construction to ensure security needs are met. Sasol will also ensure that all contractors who are appointed are legally complaint with the various acts that govern employment. Contractors will also be required to ensure compliances with these acts.
	Have specialist studies been undertaken for this project? Has the impacts been assessed?	Tracy Naude	Representatives of Bersheba 1	27-Jul-18	One-one-one discussion	Various specialist studies were completed in 2013 and again updated in 2018. These specialist studies have been used to compile the BAR. The impacts have been assessed by qualified specialists for each environmental aspect.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Project description	When you make reference to a pipeline what do you mean?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Underground mine backfilling is a method utilised to stabilise mining pillars (Sivakugan, N et al, 2015). The proposed underground mitigation measures (ash backfilling project) is aimed at backfilling mine voids where significant risk of subsidence has been identified with ash from the ash supplier being SO. The ash backfilling process will use several pipelines located above ground to transport the ash slurry (comprising 20% fine ash and 80% water, the water is proposed to be sourced from SO from the Sasol Ash pump station at SO, to the mine voids. Return water pipelines (the main one already in place) will be used to dewater the voids, concurrent to backfilling to prevent decant as a result of hydrostatic pressure. The location of the pipeline route is provided in Plan 4 of the BAR is in relation to Plan 5 which indicates the areas of subsidence. The ash slurry is proposed to be pumped into the underground workings to prevent potential pillar collapse. The ash slurry will only be pumped underground where a significant risk of subsidence has been identified.
	Where exactly is the project area?	Masheleni Tshitemeke	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
	What is the purpose of the project to completely shut down the operation?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Sigma Defunct Colliery commenced operations in 1952 and ceased all mining operations in 2006. Sigma Defunct Colliery applied for closure where a closure application and closure report was submitted to the DMR in 2009. Sigma Defunct Colliery began to implement the proposed mitigation measures as per the requirements of the closure plan to address all the significant risks and rehabilitation measures which were required to obtain the needed closure certificate. Jones and Wagener (J&W) were appointed to compile a technical risk assessment report which aimed to identify all the high latent risks which Sigma Defunct Colliery face and rate them in accordance with the Sasol Risk Assessment Methodology. The report proposed mitigation measures to be implemented to reduce the high rated risks to an acceptable level. Ash backfilling is considered to be one of the mitigation measures to be implemented to assist in the stabilisation of the underground workings to prevent surface instability and potential subsidence.
Water	I hear you talk about boreholes is there not a scarcity on water resources	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Boreholes will be drilled to access the underground workings to pump the ash slurry underground. The boreholes will not have any impact upon the aquifers currently being utilised by farmers.
Noise	When you refer to minimal noise impact what does that mean?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Due to the lack of other major sources of noise in the immediate area of the project, as well as the low significance of the impact, the project in isolation is not considered to be a significant contributor to the cumulative noise impact of the area.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Noise / Dust	When you say noise is also manageable what does that mean in relation to Sigma because there are big issues relating to dust. There is a health hazard to the people with the dust issues.	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The preferred method of transporting ash slurry via a pipeline. The dust and noise impacts would be removed as well as the health and safety risks.
Water	The water that will be utilised is it coming from Sasol?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The water will be sourced from SO as well as the water abstracted from the mine voids. No water will be sourced from farmers.
Groundwater	Will there be construction of new boreholes	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	For the ash slurry to be pumped into the underground mined out voids, boreholes will be drilled. These boreholes will be drilled directly into the underground mined out voids.
	Where will water be sourced to undertake the project?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The water will be sourced from SO as well as the water abstracted from the mine voids. No water will be sourced from farmers.
	When you need to drill or construct a new borehole it will not happen in the mine ?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The aim of the project is to drill the boreholes directly into the mine to pump the ash slurry into the mined out voids. The ash slurry will provide a support to the surface above to prevent the possibility of pillar failure resulting in subsidence.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
WUL	I believe the contents of the IWUL will give us direction and the directives given to the water resources and perhaps we may need to have further input in it.	Stephen Molawa	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	An IWUL application with its associated IWWMP for the proposed ash backfilling project was submitted to the DWS on 3 March 2014. An IWUL was granted along with its amendments by the DWS on 11 October 2017 (Licence No. 10/C22K/CGIJ/4608). The conditions stipulated in this IWUL will be adhered to by Sasol Mining once the ash backfilling project is commenced with. Annual audit reports will be submitted to the Department of Water and Sanitation to report on the compliance of Sasol Mining to the conditions of the IWUL.
	There is also the quantity of the water used as a guide from the WUL	Stephen Molawa	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The conditions stipulated in this IWUL will be adhered to by Sasol Mining once the ash backfilling project is commenced with. Specific conditions are given with regards to monitoring of water quality / quantity. Annual audit reports will be submitted to the Department of Water and Sanitation to report on the compliance of Sasol Mining to the conditions of the IWUL. Additionally monitoring (Surface water, groundwater and biomonitoring) as per the IWUL will be implemented to monitor the impact the project may have on these environmental aspects.
Socio-economic	What are the labour forces that are required on this project?	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	The ash backfilling project will generate approximately 60 - 90 employment opportunities during the construction phase. The construction phase will be approximately twelve months. The operational phase will generate approximately 20 - 30 employment opportunities. During decommissioning phase a total of approximately 20 – 30 employment opportunities will be generated.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
General	On the way forward the IDP department will coordinator and provide comments	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Thank you for the contribution to the project, your comments towards this project is invaluable. All comments will be captured on the CRR and submitted to the DMR for review.
General	There was once also a commitment made by Sasol in Zamdela to make sure that the dust is reduced, this at some point was working but now it feels as if those things are not being implemented. Please can this be done as August is a season where there are winds and this will be a problem.	Lindiwe Tshongwe	Metsimaholo Local Municipality	27-Jul-18	Focus Group Meeting	Sasol have several different ventures. This specific project involves the pumping of ash slurry into the underground workings to prevent pillar failure at the Sasol Sigma Defunct Colliery. The mine is not operational and ceased operations in 2006. The proposed project is not anticipated to generate significant amounts of dust. Additionally mitigation measures as proposed in Part B Section 4 and 5 of the BAR will be implemented to ensure the dust generated by the proposed project is mitigated. However you concern is noted and will be submitted to Sasol Mining and SMRD for further consideration.

CATEGORY	COMMENT RAISED	CONTRIBUTOR	ORGANISATION/ COMMUNITY	DATE	METHOD	RESPONSE
Water	Hi Nondumiso, In the previous CRR compiled in 2014. It is indicated that all the water will be taken to Infrochem. Is this still the case and what does this mean? The mine water is contaminated and has a high salt content. The only way to remove salt is via osmoses. Has infrachem an osmosis water treatment plant? And once treated where is the treated water going?	Alan Peeters	Landowner of Saltberry Plain	31/07/2018	Email	Underground water is pumped out to ensure that during the pumping of the ash slurry the water pressures within the mine voids remains constant. The aim is to ensure no build up of pressure occurs to avoid decant. The water utilised for the mixing of the ash will be sourced from SO (which was previously called Infrachem) as well as the water abstracted from the mine voids. The process is considered to be a closed system. Should any excess water be generated this water will be transferred to a licenced facility for further water treatment. No contaminated water will be discharged to the streams.

11 The Environmental Attributes associated with the Alternatives

The following specialist studies were undertaken during the previous basic assessment process completed in 2013:

- Aquatic Specialist Study;
- Fauna and Flora Specialist Study;
- Surface Water Specialist Study;
- Wetland Specialist Study;
- Heritage Specialist Study;
- Noise Specialist Study;
- Topography and Visual Specialist Study;
- Social Specialist Study; and
- Groundwater and Geochemistry Specialist Study.

It is understood that as these studies were completed in 2013 the information contained in the reports may be outdated. Therefore, the following specialist studies have been updated with more relevant information and will be compiled in accordance with the relevant Regulations and Guidelines and will conform to Appendix 6 of GN R 982. A summary of the baseline environment in the project area is provided in the sections below based on these specialist studies.

- Aquatic Specialist Study;
- Fauna and Flora Specialist Study;
- Surface Water Specialist Study;
- Wetland Specialist Study;
- Heritage Specialist Study; and
- Groundwater Specialist Study.

11.1 Climate

Climate data for this report was obtained from the Vereeniging International Weather station (Station Number 043 87843) and was sourced from the South African Weather Bureau.

Sasolburg features a hot, arid climate characterised by warm summers and cold winters. Average daily temperatures vary between 8.9°C in June to 21.7°C in January. Rainfall stations closest to the Sasol Sigma were identified in the DRE and are listed in

Table 11-1.

Table 11-1: Summary of the Closest Rainfall Stations

Station Name	SAWS Number	Record (Years)	Latitude		Longitude		MAP (mm)	Altitude (mamsl)
			(°)	(')	(°)	(')		
Sasolburg (Mun)	0438588_W	46	26	48	27	48	639	1462
Saltberry Plain	0438597_W	35	26	50	27	50	643	1477
Pietershoogte	0438533_W	67	26	52	27	47	646	1482
Zandfontein	0438404_W	31	26	44	27	44	612	1418
Barrage (RWB)	0438315_W	82	26	45	27	41	657	1420
Klein-Leeuwkuil	0438703_W	47	26	43	27	54	628	1430

The design rainfall for the Sigma project site for a 24 hour storm is presented in Table 11-2 . Based on the GNR 704, a 1:50 year 24 hour storm depth should be utilised in planning of water storages. In this case a depth of 104 mm should be considered for the designs.

Table 11-2: Summary of the 24 hour design rainfall depth (mm)

Duration	Return period rainfall (mm)					
	1:5	1: 10	1: 20	1: 50	1: 100	1: 200
24hr	58.5	78.1	91.1	104	121	133

11.1.1 Wind Direction

The wind direction is mostly in a north westerly direction with very little wind coming from the south (Figure 11-1).

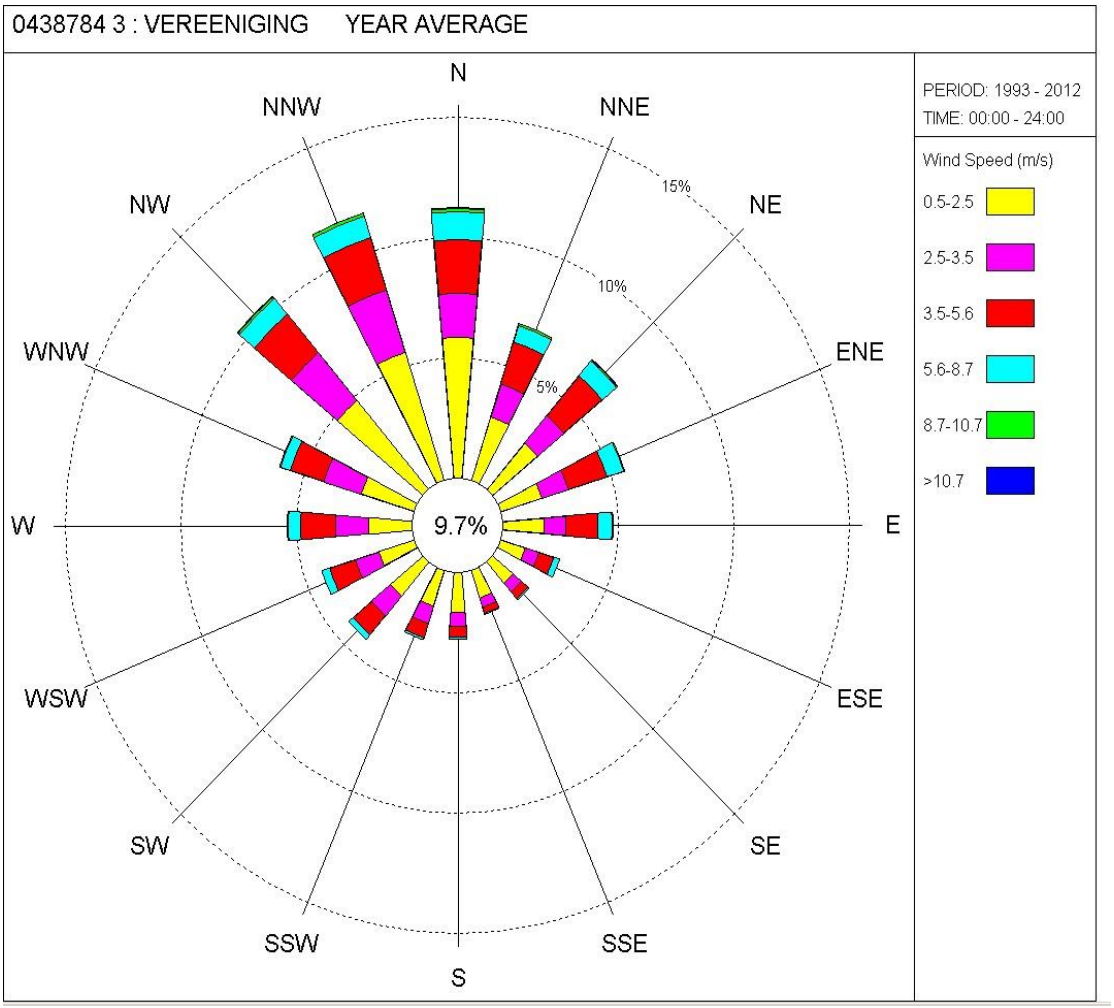

Figure 11-1: Average Wind Speed and Direction (1993-2012) (Vereeniging Weather Station (Station Number 043 87843))

11.2 Air Quality

The Vaal Triangle Airshed is known for its poor air quality and was rightly declared a priority area owing to the mosaic of pollutants (particulates, noxious and offensive gases). Studies have been conducted in the past, and some on-going, looking at the pollutants and possible sources in the Vaal Triangle Airshed.

An air quality management plan for the Vaal Triangle Airshed Priority Area (VTAPA) was developed in 2007 in compliance with the NEMAQA. The status of air quality within the area was assessed for three criteria pollutants (PM_{10}, SO_2 and NO_2) using dispersion modelling. The VTAPA model results were evaluated by comparing highest hourly, daily and annual average model-predicted values and number of exceedances with measured data at selected ambient monitoring stations, taking into account the US-EPA specified range of model uncertainty [-50%; 200%]. It was found that predicted ground level concentrations compared well with measured data for highest hourly and daily averaging periods, but that

annual averaged predictions showed weaker correlation (Vaal Triangle Air-shed Priority Area Air Quality Management Plan – Baseline Characterization 2007).

11.3 Noise

A baseline assessment in 2013 was undertaken at two locations on the western boundary of Sasolburg to determine the current ambient noise levels at the surrounding areas of the proposed Sasol Sigma ash backfilling project. The criteria that were used for the siting of the measurement locations were:

- The locations were the nearest noise sensitive receptors to the main continuous noise source throughout the operational phase; and
- That they served as suitable reference points for the measurement of ambient sound levels surrounding the proposed Sasol Sigma ash backfilling project area. The noise measurement locations cover residential areas that represent a comprehensive soundscape of the urban district of Sasolburg. The measurement location at Leeuspruit Primary School was chosen because it was important to know what the sound level at the school was to determine whether the booster pump station would cause a noise disturbance during school hours.

The list of noise measurement locations can be seen in Table 11-3.

Table 11-3: Noise Measurement Locations

Site ID	Location	Category of receiver	GPS coordinates
N1	Sasolburg correctional services	Urban	-26.817047° and 27.801124°
N2	Leeuspruit Primary School	Urban	-26.827020° and 27.818174°

Noise dispersion modelling software was used to assess whether the noise from the proposed construction and operational activities will impact on the relevant noise sensitive receivers, by comparing the predicted propagating noise levels with the current ambient baseline noise levels.

It was gathered that the existing ambient noise levels on the western boundary of Sasolburg are characteristic of urban surroundings. The noise levels measure between 52dBA and 53dBA during the daytime and between 42dBA and 44dBA during the night time.

11.4 Fauna and Flora

11.4.1 Fauna

Fauna expected to occur on site include assemblages within terrestrial and wetland ecosystems: mammals, birds, reptiles and amphibians. Each of these assemblages occurs within unique habitats, the ecological state of these habitats directly relates to the number of

species found within them. The main habitats occurring in the project area are Woodland/Savannah, Agricultural fields and Secondary Grassland.

11.4.1.1 Mammals

For a desktop review of mammals that could possibly occur within the project area, South African Biodiversity Information Facility (SIBIS) was used. SIBIS is part of South African National Biodiversity Institute (SANBI)'s Integrated Biodiversity Information System. Animal species that were previously recorded within the Free State Province and the project area can be seen in the fauna and flora specialist report. The list also indicated the global and national International Union for Conservation of Nature (IUCN) status, as well as the NEMBA status. By making a comparison between the previously recorded species list and the currently occurring species found during the field survey, the magnitude of impacts resulting in species reduction or loss can be estimated. The Animal Demography Unit's virtual museum of mammal species search produced no results for this Quarter Degree Squares (QDS). Therefore, the Free State list is used to discuss the possible presence of mammals in the study area.

The Red Data species considered for this survey can be seen in Table 11-4. The probability of occurrence was estimated based on habitat requirement and distribution.

Table 11-4: Red Data Species of the Study Area

Common Name	Scientific name	Nemba Status	Potential to occur
African Clawless Otter	*Aonyx capensis*	Protected	Low
South African Hedgehog	*Atelerix frontalis*	Protected	Low
Black Wildebeest	*Connochaetes gnou*	Protected	Medium
Cape Fox	*Vulpes chama*	Protected	Low

11.4.1.2 Mammals found during the field survey

Burrows and holes of small mammals, which can possibly belong to mice, rats, suricates (meerkats), etc. were found during the field survey.

A full species list of mammals recorded can be seen in Table 11-5. All the species listed below were found exclusively in the conservation area.

Table 11-5: Mammal Species Identified during the Field Survey

Family	*Species*	English Name
Bovidae	*Sylvicapra grimmia*	Grey /Common Duiker
Bovidae	*Antidorcas marsupialis*	Springbok
Bovidae	*Aepyceros melampus*	Impala
Bovidae	*Taurotragus/Tragelaphus oryx*	Eland

Family	*Species*	English Name
Bovidae	*Connochaetes gnou*	Black Wildebeest
Herpestidae	*Cynictis penicillata*	Yellow Mongoose
Bovidae	*Oryx gazella*	Gemsbuck
Bovidae	*Alcelaphus buselaphus*	Red Hartebeest
Bovidae	*Damaliscus pygargus phillipsi*	Blesbok
Cervidae	*Dama dama*	Fallow Dear*

11.4.1.3 Avifauna

Birds have been viewed as good ecological indicators, since their presence or absence tends to represent conditions pertaining to the proper functioning of an ecosystem. Bird communities and ecological condition are linked to land cover. As the land cover of an area changes, so do the types of birds in that area (The Bird Community Index, 2007). Land cover is directly linked to habitats within the study area. The diversity of these habitats should give rise to many different species. According to the South African Bird Atlas Project (SABAP2), almost 300 species of birds have been identified in the area; the majority of these birds are comprised of Grassland species. All birds that could be present within QDS 2627DD are listed in the fauna and flora specialist report.

11.4.1.4 Bird species found during the field survey

During the field survey 41 species were observed. Table 11-6 summarizes all species of birds recorded. This list cannot be considered as a complete list as many other birds can be present within any given season or day of the year. During the dry season survey, bird activity was greatly reduced.

Table 11-6: Bird Species Identified during the Field Survey

Species Name	Common Name	Red Data Listing
Haliaeetus vocifer	African Fish Eagle	Not Listed
Polyboroides typus	African Harrier Hawk	Not Listed
Actophilornis africanus	African Jacana	Not Listed
Gallinago nigripennis	African Snipe	Not Listed
Amaurornis flavirostris	Black Crake	Not Listed
Anas sparsa	Black Duck	Not Listed
Ardea melanocephala	Blackheaded Heron	Not Listed
Vanellus armatus	Blacksmith Lapwing	Not Listed
Himantopus himantopus	Blackwinged Stilt	Not Listed

Species Name	Common Name	Red Data Listing
Uraeginthus angolensis	Blue Waxbill	Not Listed
Lamprotornis nitens	Cape Glossy Starling	Not Listed
Passer melanurus	Cape Sparrow	Not Listed
Streptopelia capicola	Cape Turtle Dove	Not Listed
Gallinula chloropus	Common Moorhen	Not Listed
Estrilda astrild	Common Waxbill	Not Listed
Trachyphonus vaillantii	Crested Barbet	Not Listed
Laniarius atrococcineus	Crimsonbreasted Shrike	Not Listed
Vanellus coronatus	Crowned Lapwing	Not Listed
Pycnonotus barbatus	Darkcapped Bulbul	Not Listed
Alopochen aegyptiacus	Egyptian Goose	Not Listed
Lanius collaris	Fiscal shrike	Not Listed
Casmerodius albus	Great White Egret	Not Listed
Nectarinia afra	Greater Doublecollared Sunbird	Not Listed
Ardea cinerea	Grey Heron	Not Listed
Bostrychia hagedash	Hadeda Ibis	Not Listed
Streptopelia senegalensis	Laughing Dove	Not Listed
Merops pusillus	Little Bee-eater	Not Listed
Oena capensis	Namaqua Dove	Not Listed
Ceryle rudis	Pied Kingfisher	Not Listed
Vidua macroura	Pintaled Whydah	Not Listed
Ardea purpurea	Purple Heron	Not Listed
Anas erythrorhyncha	Redbilled Teal	Not Listed
Urocolius indicus	Redfaced Mousebird	Not Listed
Fulica cristata	Redknobbed Coot	Not Listed
Mirafra sabota	Sabota Lark	Not Listed
Threskiornis aethiopicus	Sacred Ibis	Not Listed
Laniarius ferrugineus	Southern Boubou	Not Listed
Ploceus velatus	Southern Masked Weaver	Not Listed
Phalacrocorax lucidus	White breasted Cormorant	Not Listed
Dendrocygna viduata	Whitefaced Duck	Not Listed

Species Name	Common Name	Red Data Listing
Egretta intermedia	Yellowbilled Egret	Not Listed

11.4.1.5 Herpetofauna

No Red Data status amphibians or reptiles were found during the site visit. The complete list of reptiles expected to occur on site can be viewed in Appendix E of the Fauna and Flora Report. The expected list for amphibians in the area produced two thus far unnamed species according to SAFAP (the South African frog atlas project); the expected species are depicted in Appendix F of the Fauna and Flora Specialist Report (Appendix F).

11.4.1.6 Fauna Species of Special Concern

No Red Data species were identified by the PRECIS data for the grid square 2627DD.

11.4.1.7 Plant Species with ethnobotanical uses

Ethnobotany is a branch of botany that places focus on the use of plants for medicines and other practical purposes. The use of native plants for ethnobotanical uses can be detrimental to populations that are overexploited.

South Africa has a rich diversity of medicinal plants that not only have a global significance, but also have a cultural and historical role (Van Wyk *et al.* 2009). There is a rapidly growing concern for conservation of medicinal plants that are dwindling in number due to illegal harvesting (Institute of Natural Resources 2003). This is particularly apparent in rural areas where medicinal plants are overexploited by traditional doctors.

From the list of plant species identified during the field surveys there are nine species (Table 11-7) that have cultural uses. Medicinal plants are important to many people and have been used traditionally for centuries to cure many ailments. Plants have also been used traditionally for other cultural uses, such as building material, and for spiritual uses such as charms.

Table 11-7: Species with Cultural uses Identified within the Project Area

Species Name	Common Name	Uses
Senegalia caffra	Common hook thorn	Dyes and tanning
Vachellia karroo	Sweet thorn	Dyes and tanning
Asparagus laricinus	Wild asapragus	Vegetable
Bidens pilosa	Black Jack	Herbs
Dichrostachys cinerea	Sickle bush	Medicinal uses, dental care, firewood
Gymnosporia senegalensis	Red spike thorn	Medicinal uses
Hyparrhenia hirta	Common thatching grass	Thatching
Opuntia ficus-indica	Prickley pear	Fruits

Species Name	Common Name	Uses
Zea mays	Mielies	Maize

11.4.1.8 Fauna Species of Special Concern

During the site visit no fauna species of special concern was encountered, the conservation area within the Sigma property did contain eleven wild herbivore species, however these are artificially kept and do not represent the natural ecosystem.

11.4.2 Flora

A total of 51 species were recorded from the study site. It is likely that a more in-depth study will record more species. The most common species include *Themeda triandra*, *Seriphium plumosum* and *Digitaria eriantha* which occurred in most sample plots. *Poaceae* (the grass family) is well represented with twenty species, in contrast to the *Cyperaceae* (sedge family) with three species. Much of the site comprises problem species especially *Seriphium plumosum* (bankrupt bush). This species is common in overgrazed areas, as it is unpalatable and becomes the dominant species when palatable grass species are grazed, which allows for the invasion of bankrupt bush.

There are limited numbers of geophyte species including Ledebouria species. There should be higher numbers of such species but livestock grazing has resulted in their removal in large areas.

11.4.2.1 Alien and Invasive Species

Alien plant species have been classified according to National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA), as published in August 2014 (GN R599 in *GG* 37886 of 1 August 2014) into the following categories:

- Category 1a: Species requiring compulsory control;
- Category 1b: Invasive species controlled by an invasive species management programme;
- Category 2: Invasive species controlled by area, and;
- Category 3: Invasive species controlled by activity.

Certain species have different alien invasive categories for different provinces in South Africa. Table 11-8 lists the alien species identified on site as well as their respective alien categories, according to CARA and NEMBA. Plants not listed as Category 1, 2 or 3 plants can still be problem plants, these are also listed below.

Table 11-8 Alien Species Identified on Site

Family	Species Name	Common Name	Category
Agavaceae	*Agave americana*	Century plant	-

Family	Species Name	Common Name	Category
Asparagaceae	*Asparagus laricinus*	Wild asapragus	-
Asteraceae	*Bidens pilosa*	Black Jack	-
Asteraceae	*Mantisalca salmantica*	Mantisalca	-
Asteraceae	*Schkuhria pinnata*	Dwarf marigold	-
Asteraceae	*Senecio latifolius*	Ragwort	-
Asteraceae	*Tagetes minuta*	Tall khakhi weed	-
Asteraceae	*Xanthium strumarium*	Spiny cocklebur	1
Asteraceae	*Zinnia peruviana*	Redstar zinnia	-
Cactaceae	*Opuntia ficus-indica*	Prickley pear	1
Caesalpiniaceae	*Senna pendula var. glabrata*	Easter Cassia	3
Euphorbiaceae	*Ricinus communis*	Castor oil plant	2
Fabaceae	*Indigofera heterotricha*	Hairy indigo	-
Meliaceae	*Melia azedarach*	Chinaberry	3
Papaveraceae	*Argemone ochrolauca*	Mexican poppy	1
Poacea	*Melinis repens*	Natal red top	-
Solanaceae	*Solanum incanum*	Thorn Apple	-
Solanaceae	*Solanum panduriform*	Bitterappel	-

11.4.3 Protected Areas

The Vaal Dam Nature Reserve is situated 35 km east of Sasolburg on the Vaal River in Vanderbiljpark, the Vaal Dam is South Africa's second biggest dam by area and fourth largest by volume. It has more than 800 km of shoreline, spans three provinces - Gauteng, Free State and Mpumalanga. The Vaal Dam Nature Reserve is not expected to be impacted on by the normal procedure of ash backfilling.

The Sigma Ash backfill project area does not fall within any important bird areas. The Sigma ash backfill project site is approximately 40 kilometres from one Important Bird Area (IBA), the Suikerbosrand Nature Reserve. It is not envisaged that the project will have any effect on the above mentioned IBA area.

The study site covers a small portion of the Soweto Highveld Grassland unit National Threatened Ecosystem (Plan 6, Appendix B), which is designated as Vulnerable.

11.5 Aquatic Ecology

A baseline aquatic assessment has been undertaken during the dry- and wet season in both the Leeuspruit and the Rietspruit. The results of the *in-situ* water quality analysis show that

conditions vary from a good state in the Vaal Barrage to poor in the Leeuspruit and moderate in the Rietspruit (during high flows). Previous studies confirm the findings of the current survey. Chemical analysis done in previous studies revealed high concentrations of nutrients (phosphates, nitrates and ammonium), metals (iron, magnesium and manganese) and non-metals (fluoride), thus corroborating the current results of the low flow assessment. This shows that poor water quality from the Vaal Rivers tributaries have the ability to negatively affect the water quality of the Vaal itself.

11.5.1 Habitat

The Index of Habitat Integrity (IHI) assesses the number and severity of anthropogenic impacts and the damage they potentially inflict on the habitat integrity of aquatic ecosystems.

Only a single low flow survey was completed and therefore the results of the IHI should be interpreted with caution. Additionally, the representative sites on the Rietspruit were dry during the low flow survey and only the high flow survey was used to calculate the IHI.

Some of the factors considered for the IHI and the project area are given in Figure 11-2, Figure 11-3 and Figure 11-4.

Figure 11-2: Eutrophication

Figure 11-3: The presence of impoundments such as weirs and road crossings

Figure 11-4: Habitat modification (siltation)

The results of the IHI for the Leeuspruit River and Rietspruit River are presented in Table 11-9.

Table 11-9: Table of IHI results for the Leeuspruit and Rietspruit systems

Leeuspruit		
Component	**Score**	**Description**
Instream IHI %	54.7	Largely modified
Instream Category	D	
Riparian IHI %	56.4	Largely modified
Riparian Category	D	
Rietspruit		
Instream IHI %	55.8	Largely Modified
Instream Category	D	
Riparian IHI %	63.6	Moderately Modifier
Riparian Category	C	

11.5.1.1 Leeuspruit

From the IHI for the reach of the Leeuspruit assessed it can be noted that the instream habitat is in a largely modified condition. The modified instream habitat is a result of habitat modification with most sites assessed affected by eutrophication and severe sedimentation. At Site SAS5, the instream habitat was completely modified through sedimentation of ash and/or sand from the local sand mining operation and industrial activities within the catchment area. The siltation is partially linked to the ash spill that occurred in the area during the 2009-2012 ash backfilling project (Figure 11-5).

Figure 11-5: Photograph depicting the nature of siltation at site SAS5

11.5.1.2 Rietspruit

The results of the Rietspruit indicate a less impacted river system when compared to the Leeuspruit. Riparian vegetation is only moderately modified. The largest concern is the hydrology section, which reflects the issues relating to flow and impoundments. However, this metric should be used cautiously as it is only based on the high flow assessment.

11.5.1.3 IHI conclusion

The findings at this site illustrate the potential negative impacts of the project on the local aquatic ecosystems if a spill should occur. The riparian habitat was found to be in a largely modified condition at the sites visited (all sites) for the project. The predominant impacts associated with this were urban encroachment and river crossings.

11.5.2 Macroinvertebrate Assessment

As a result of aquatic macroinvertebrates integrating the effects of physical and chemical changes in the aquatic ecosystems, they are good, short-term indicators of ecological integrity. Integration of biological indicators (like aquatic invertebrates) with chemical and physical indicators will ultimately provide information on the ecological status of the river (RHP, 2001).

The dominant feature of the invertebrate habitat is the marginal vegetation and sandy substrate which dominates the sites. Limited stones in or out of current biotopes were found

at any of the sites. During the survey aquatic and marginal vegetation was abundant. Flow velocities during the surveys were also found to be low/not discernible during the low flow with flows increasing slightly in the wet season. The results of the IHAS assessment are presented in Table 6-5.

Table 11-10: IHAS Results for the Leeuspruit System 2013

Low Flow				
IHAS Component	**SAS2**	**SAS3**	**SAS4**	**SAS5**
Flow speed (m/s)	DRY	0.3	0.1	0.1
Total score (%)	DRY	57	48	21
Suitability	DRY	Fair	Poor	Poor
High Flow				
IHAS Component	**SAS2**	**SAS4**	**SAS5**	**SAS10**
Flow speed (m/s)	0.1	0.4	-	0.2
Total score (%)	52	48	57	64
Suitability	Poor	Poor	Fair	Fair

During the low flow survey, the Rietspruit was dry. Upon returning during the high flow survey, enough water was present to support aquatic life. The results of the IHAS survey are reported below (Table 11-10).

Figure 11-6: IHAS Results for the Rietspruit High Flow Survey

High Flow			
IHAS Component	**SAS6**	**SAS8**	**SAS9**
Flow speed (m/s)	-	-	0.1
Total score (%)	44	43	59
Suitability	Poor	Poor	Fair

11.5.3 SASS Version 5

The findings of the macroinvertebrate assessment for the system recorded taxa with sensitivity scores ranging from highly pollution tolerant to moderately pollution tolerant.

11.5.3.1 Leeuspruit

According to Kleynhans (2000) the Leeuspruit consists of aquatic biota that is moderately sensitive and of a moderate ecological importance. During the low and high flow surveys (2013/2014), no sensitive organisms were sampled. The absence of these sensitive taxa

confirms the classification of Klenyhans (2000). The SASS 5 results for the two surveys of the Leeuspruit are given in Table 11-11.

Table 11-11: SASS 5 Scores for the Leeuspruit System

Low Flow			
Site	**SAS3**	**SAS4**	**SAS5**
SASS Score	59	41	31
Taxa	14	10	8
ASPT	4.2	4.1	3.8
Category	D	E	E
High Flow			
Site	**SAS4**	**SAS10**	**SAS11**
SASS Score	35	37	13
Taxa	10	11	5
ASPT	3.5	3.36	2.6
Category	E	E	E

Based on the biological banding (Highveld lower) set out below (Table 11-13), the sites were categorised as largely modified at site SAS3 to seriously modified at sites SAS4 and SAS5 in the low flow. Water quality is not seen to improve during the high flow at SAS4. The SASS 5 indicates that the water quality is seriously modified at all of the sites assessed during the high flow

11.5.3.2 Rietspruit

During the low flow (2013) the Rietspruit was dry. However, during the high flow sample, pools of water were located. These contained many aquatic invertebrates of which the results of the SASS 5 sampling are presented below in Table 11-12.

Table 11-12: SASS 5 Scores for the Rietspruit System

Low Flow				
Dry				
High Flow				
Site	**SAS6**	**SAS8**	**SAS9**	**SAS12**
SASS Score	90	53	71	26
Taxa	18	13	17	8
ASPT	5	4.07	4.18	3.25
Category	D	E	E	E

Using the biological banding seen in Table 11-13 the sites are classified as largely modified (SAS6) to seriously modified (SAS8, SAS9 and at the confluence). As mentioned above habitat was seen to be poor to fair which would affect the species richness within this river.

Table 11-13: Highveld Lower Biological Banding

Class	SASS 5 Score	ASPT	Condition
A	>123	>5.6	Natural/unmodified
B	83 - 122	5.5 – 5.8	Minimally modified
C	64 – 82	5.1 – 5.5	Moderately modified
D	51– 63	4.6 – 5.1	Largely modified
E	<50	<4.6	Seriously modified

(Source: Dallas, 2007)

Based on the interpretation guidelines the SASS 5 results at all sites indicate that there is major deterioration in water quality. This has been confirmed in the absence of fish species with sensitive tolerance ranges. Water quality results from chemical and *in situ* analysis correlate with the macro-invertebrate composition. The low SASS 5 and ASPT score is a result of limited habitat availability at all the sampling sites with compounding effects of poor water quality conditions.

11.5.4 Macroinvertebrate Assessment Index

The Leeuspruit system falls within the 11.03 Highveld ecoregion and therefore Macroinvertebrate Response Assessment Index (MIRAI) reference data was available. The MIRAI results are given in Table 11-14.

Table 11-14: MIRAI Results for the 2013 Survey

Component	Leeuspruit
MIRAI (%)	39.57
EC: MIRAI	E
Category	Seriously modified
Component	**Rietspruit**
MIRAI (%)	50.82
EC: MIRAI	D
Category	Largely Modified

Based on the MIRAI, the macroinvertebrate communities associated with the study sites within the Leeuspruit are seriously modified. The modified state of the macroinvertebrate community is primarily due to the absence of expected species that are adapted to unmodified water quality and the stones in current habitat. Several species adapted to high flow velocities and flows between 0.1 m/s – 0.3 m/s were also absent from the current survey however, flow was determined to be adequate and therefore the absence of these species suggests water quality modification.

Based on the results of the MIRAI it can be noted that the modified macroinvertebrate community is a reflection of poor water quality and habitat availability caused by siltation and eutrophication. The Fish Response Assessment Index (FRAI) results confirm this along with the SASS 5 assessment (see below).

In contrast to the water quality issues faced by the Leeuspruit, the Rietspruit has comparatively good water quality and has been primarily impacted on by farming. The major issue is the Rietspruit is the damming and construction of impoundments, which poses a threat to migratory species and removes flow from the system. Pooling occurs and as was seen in the low flow months the riverbed dries up completely. The Rietspruit is seen to be largely modified in terms of MIRAI.

The macroinvertebrate communities associated with the project area are composed of predominantly pollution tolerant species that are adapted to low flow conditions. The results of the SASS 5 and MIRAI indicate that conditions are largely to seriously modified.

The modified conditions have been attributed to alteration of water quality in the Leeuspruit and lack of flow in the Rietspruit, resulting in limited macroinvertebrate habitat.

11.5.5 Fish Assessment

The use of fish as a means to determine ecological disturbance has many advantages (Zhou *et al*., 2008). Fish are long living, respond to environmental modification, continuously exposed to aquatic conditions, often migratory and fulfil higher niches in the aquatic food web. Therefore, fish can effectively give an indication into the degree of modification of the aquatic environment. The RHP uses the FRAI which is based on the preferences of various fish species as well as the frequency of occurrence.

A variety of techniques were applied to sample the available fish species within the project area. These sampling methods included cast nets and electroshocking. During the survey all sampling techniques were applied at all sites where possible and a variety of fish species were captured.

11.5.5.1 Leeuspruit

The expected species of the C22K quaternary catchment is presented in Table 11-15. It should be noted that the expected species list contains several alien invasive species. Species which are present in the Vaal Barrage have also been considered as affected species but not included in the expected species list.

11.5.5.2 Rietspruit

The expected species list for the Rietspruit is the same as the Leeuspruit as it falls within the same catchment. The Rietspruit was only sampled in the wet season due to its dry state during the winter months. Fish were only found closer to the confluence where impoundments and the quantity of water were sufficient to support them.

Table 11-15: Expected Fish Species of the C22K Quaternary Catchment

Fish species	Common name	Captured	
		Low flow	High flow
Enteromius paludinosus	Straightfin Barb	Yes	No
Enteromius trimaculatus	Three spot Barb	No	No
Enteromius anoplus	Chubby head barb	Yes	No
Enteromius cf. neefi	Sidespot Barb	No	No
Clarias gariepinus	Sharptooth catfish	Yes	Yes
*Cyrpinus carpio**	Carp	Yes	Yes
*Gambusia affinis**	Mosquito fish	Yes	Yes
Labeo capensis	Mudfish	No	No
Labeo umbratus	Moggel	No	No
Pseudocrenilabrus philander	Southern mouth brooder	Yes	Yes

Fish species	Common name	Captured	
Tilapia sparrmanii	Banded Tilapia	Yes	No
* Alien species			

The FRAI assessment was adjusted to suit the site specific requirements with the frequencies of occurrence (FROC) of particular species adjusted from the expected species list (Kleynhans *et al*., 2007). The FRAI and FROC have been adjusted according to the following factors:

- Sampling effort;
- Habitat type;
- Cover combination;
- Stream lengths; and
- Altitude.

The results of the fish survey (FRAI) are presented below in Table 11-16

Table 11-16: The combined FRAI results for the 2013/2014 Aquatic survey

Component	Results
FRAI (%)	43.4
EC: FRAI	D
Category	Largely modified

The FRAI results as indicated in the table above indicate that the fish community is in a largely modified state. A total of seven species were captured out of the expected eleven species. Species captured included two alien invasive species, the *Cyprinus carpio* as well as the *Gambusia affinis*. A dominant feature among the current fish assemblage is the tolerance to modified water quality. The species *Enteromius cf. neefi* has a moderate intolerance to modified water quality. The absence of this fish confirms the impacted state of the water quality associated with the Leeuspruit as habitat was available and sampled for this species. All species captured have a tolerance to modified water quality conditions and therefore were able to exist in the modified conditions.

It should be noted that conditions at site SAS5 were altered to such an extent that no fish were sampled from this site in the low flow. However, during the high flow assessment fish were observed in the stream channel. *Cyprinus carpio* and *Micropterus sp.* were observed. Available habitat was covered with fine particulate sediment which covered most available habitat and provided limited cover for aquatic organisms.

Based on the results of the desktop fish study, red data species are present within the affected watercourses (Vaal Barrage) of the project. The species which is protected is *Labeobarbus kimberleyensis* (Largemouth Yellowfish).

Findings of the fish assessment indicate that the community structure of the fish population in the associated sites is in a poor condition due to impacted water quality. Sensitive species such as *Enteromius cf. neefi* which were expected to be present within the water course were not captured during the assessment indicating modified conditions. Additionally, habitat at site SAS5 and downstream from site SAS5 was covered in fine particulate matter.

11.5.6 Integrated Ecological State

11.5.6.1 Low flow

The ecological class of the study components are presented in Table 11-17.

Sites located within the Rietspruit were dry and therefore the ecostatus could not be determined. Although the RHP does not take the water and habitat quality into consideration when determining the ecostatus of a system, it is noted for the purposes of transparency that sites associated with the Leeuspruit had poor water quality in terms of conductivity levels and the presence of eutrophication. The final ecostatus for the associated sites in the Leeuspruit received a final ecostatus of Class D/E. This is an indication that conditions within the associated sites are largely/seriously modified.

Table 11-17: The Ecological Classification of Study Components and the Resulting Ecostatus for the Low Flow 2013 Survey

River	Leeuspruit				Rietspruit
Component	**SAS2**	**SAS3**	**SAS4**	**SAS5**	
Water quality (*in situ*)	DRY	C	C	C	DRY
Habitat	DRY	D	E	E	DRY
Fish	DRY	D			DRY
Invertebrates	DRY	D	E	E	DRY
Ecostatus	DRY	D	E	E	DRY
Ecostatus (River reach)		D/E			DRY

11.5.6.2 High Flow

The high flow results for the ecological classification are presented below in Table 11-18.

The modified nature of the Leeuspruit is due to habitat impacts (sedimentation) and modified water quality. The modification of the Rietspruit is due to the creation of impoundments that has led to a loss of flow and the formation of isolated pools.

When the current study is compared to the ecological and management categories for the quaternary catchments set out in Kleynhans (2000) it is noted that the Present Ecological Status Categories (PESC) of the river reaches in this study are not moderately modified (Class C), but largely/seriously modified (Class D/E). The ecological importance and sensitivity as described in Kleynhans (2000) was moderate. This study sampled aquatic species which were tolerant to modification with some species of importance (*Labeobarbus kimberleyensis*) and therefore, the ecological importance is seen as high. The attainable ecological management class is Class C and management towards this class should continue.

Table 11-18: The Ecological Classification of Study Components and the Resulting Ecostatus for the High Flow 2014 Survey

River	Leeuspruit			Rietspruit			
Component	**SAS2**	**SAS4**	**SAS5**	**SAS6**	**SAS8**	**SAS9**	**SAS12**
Water quality (*in situ*)	B/C	C	C	B	B	B	B
Habitat	C	E	E	D	D	D	D
Fish	D						
Invertebrates	E	E	E	D	E	E	E
Ecostatus	D	E	E	D	D	D	D
Ecostatus (River reach)	D/E			D			

11.6 Geology

Sigma Defunct Colliery lies in the Sasolburg-Vereeniging Coalfield. The stratigraphy of the coalfield is typical of the coal-bearing margins of the Karoo Supergroup.

The succession consists of pre-Karoo rocks (dolomites of the Chuniespoort Group of the Transvaal Sequence) overlain by the Dwyka Formation (2-15 m thickness), followed by the Ecca Group sediments, of which the Vryheid Formation is the coal-bearing horizon. Lava of the Ventersdorp and Hekpoort Groups underlie the coal. The Karoo Supergroup is present over the whole area and consists mainly of sandstone, shale and coal of varying thickness. The Vryheid Formation contains four major coal seams. These seams are named from 1 at the base, 2A and 2B in the centre, and 3 being the topmost seam.

Figure 11-7 illustrates the stratigraphy of the Sasolburg-Vereeniging Coalfield at Sigma Defunct Colliery. The seams mined at Sigma Defunct Colliery are the No 3-seam, and the No 2 A and B seams, which for the purpose of this report, will be treated as one seam.

Dolerite intrusions in the form of dykes and sills are present over the entire coalfield and are responsible for structural complications. At Sigma Defunct Colliery the central and southern sections are intruded by dolerite sills (Sigma Underground Mine Decant Study, 2012).

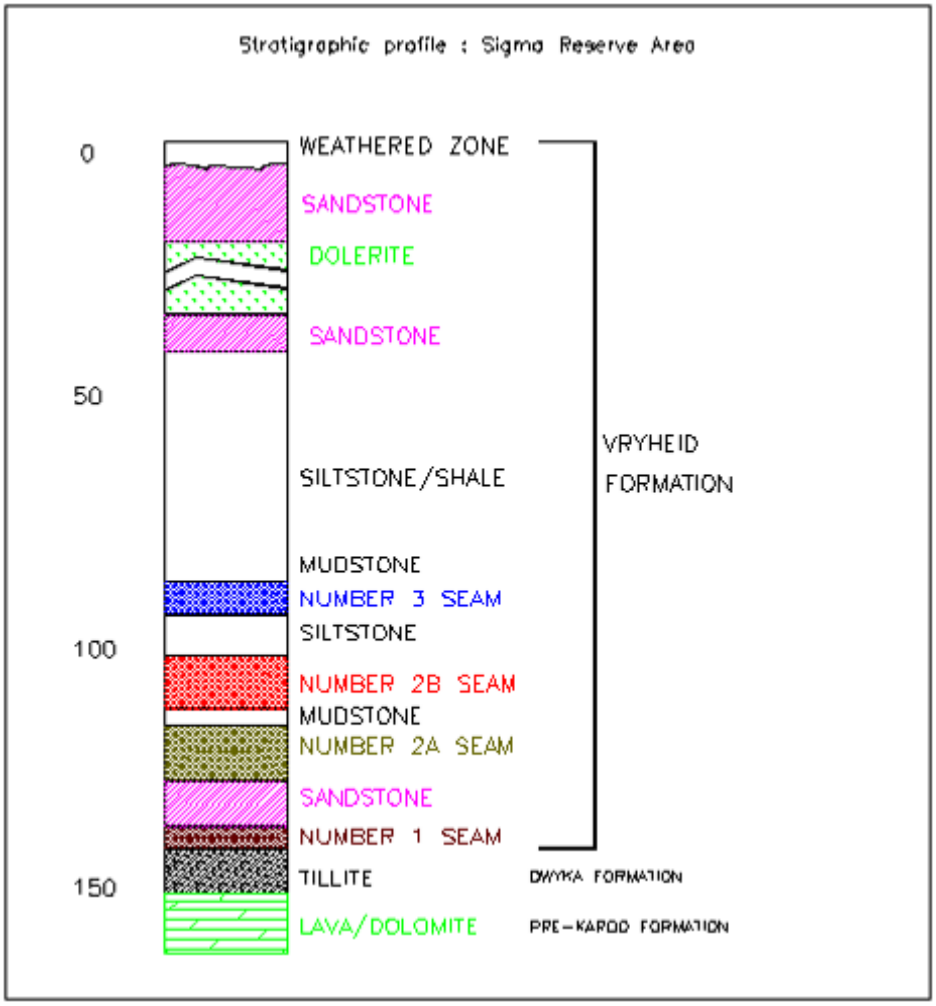

Figure 11-7: Stratigraphy of the Sigma Defunct Colliery

(Source: Sigma Underground Mine Decant Study, 2012)

11.7 Groundwater

The Institute for Groundwater Studies (IGS) has, developed and updated the hydrogeological conceptual model for Sigma project area, for more than 10 years. The decant situation at Sigma has been described in detail by IGS, 2012. This report is not aimed at duplicating the work done in the past. The main focus of this study is to predict and evaluate possible contaminant plume migration from the proposed backfill areas. Hence the main findings of the conceptual model are summarised in this section.

In general, the groundwater regime consists of three aquifer systems:

- The shallow aquifer which comprises of shallow weathered dolerite sheet intrusions, covered by quaternary sediments. Clay, colluvium, alluvium and weathered sandstone define this type of aquifer. Within this aquifer, perched groundwater conditions often occur;

- The intermediate aquifer which comprises of white, arenaceous sandstone, located below the dolerite sill but above the coal seam horizon; and
- The karst aquifer which comprises the dolomitic formation of the Transvaal Supergroup that underlies the Karoo rocks.

Within the Sigma Defunct Colliery, mining activities have changed the natural conditions; as a result, the hydrogeological regime within the mining area is defined by the following groundwater systems:

- The artificial ashfill groundwater system associated with the filling of ash within certain defunct mining areas;
- The natural intermediate groundwater system associated with the Karoo sediments (sandstone), and;
- The artificial mine groundwater system associated with surrounding mined areas- the void zones where mining took place either by bord-and-pillar, high extraction and/or longwall mining as well as subsided areas.

11.7.1 Sigma Underground Conceptual Model

The Sigma underground mine void is underlain by dolomites, which have a very high transmissivity. In the northwest, the mine void is in direct contact with the dolomitic aquifer. Isotope studies indicate that rainfall is the main source of recharge to Sigma underground void. The dolomitic aquifer is also recharged by rainfall, but from a different recharge zone (IGS, 2012).

Selected boreholes used to describe the conceptual model are depicted in Plan 15 in Appendix B. Since 2000, the piezometric level of the dolomite has risen from 1,401 (1996) to 1,422 mamsl (2010) and has remained within that range till recent water level measurements (Figure 11-8). The current dolomitic water level, at 1,422 mamsl, is the same as the level of the Vaal barrage. There is thus a direct link between the level of the dolomitic aquifer and that of the Vaal barrage.

The far southern compartment, represented by borehole UG027 (shown in Figure 11-9), receives recharge from a different recharge zone. This compartment is not hydraulically linked to the rest of the mine and the dolomitic formation (IGS, 2012). The borehole is found to have reached hydrostatic equilibrium.

Sigma underground is filled up with water. The mine filling level of 1,407 mamsl was attained in 2006 (IGS, 2008). During mining, water was flowing from the dolomite aquifer towards the mine floor. Although the mine is flooded, groundwater still flows from the dolomites to mine at an estimated rate of 5,000 m^3/d (IGS, 2012).

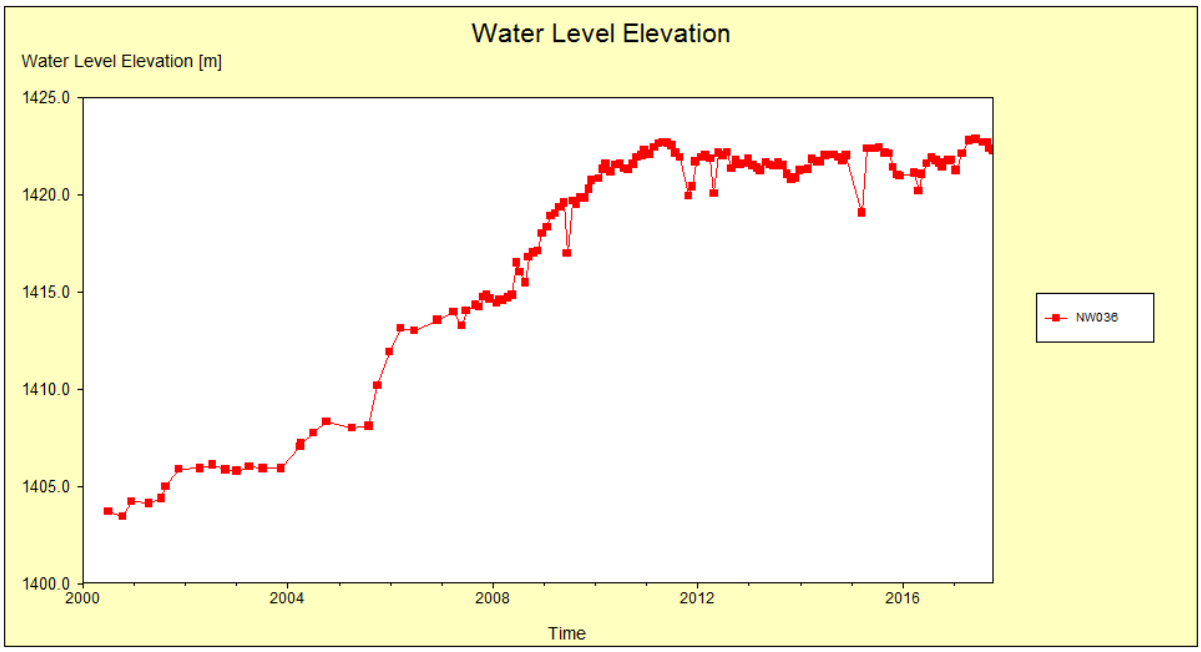

Figure 11-8: Hydraulic Head in the Dolomite

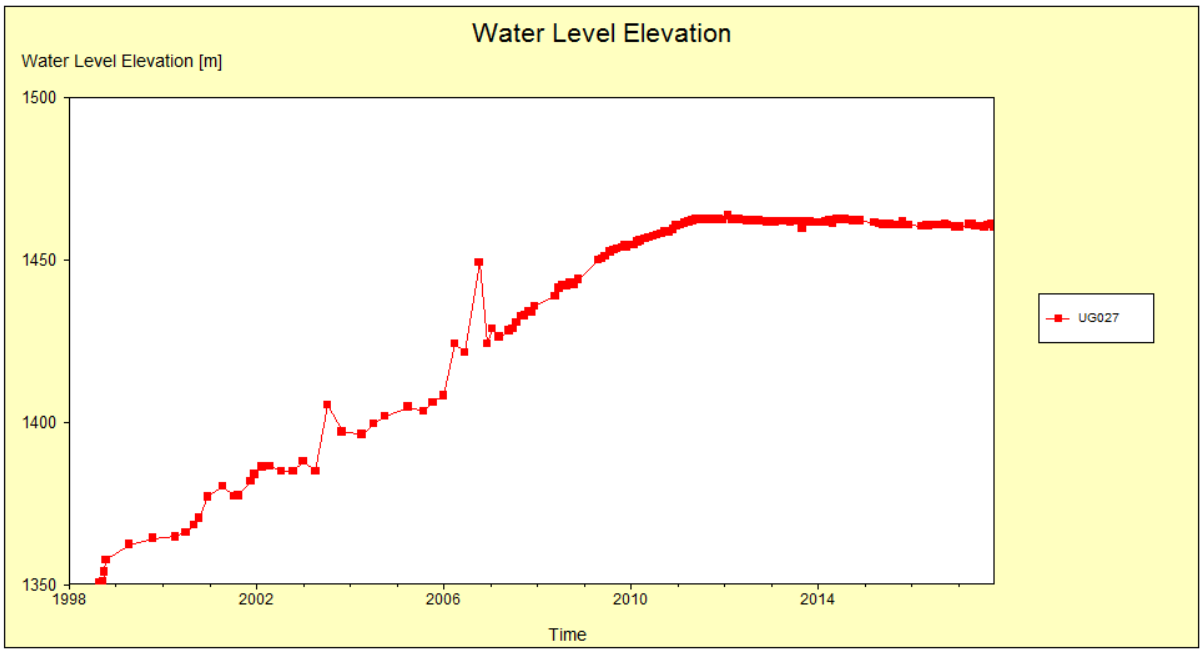

Figure 11-9: Hydraulic Head in UG027

The intermediate aquifer above the mine void was observed to have reached hydrostatic equilibrium conditions in January 2009, as depicted by the water levels in Figure 11-10. Since the mine was flooded, the flux from the overlying aquifer decreased as the mine water level approached the hydraulic head of the intermediate aquifer.

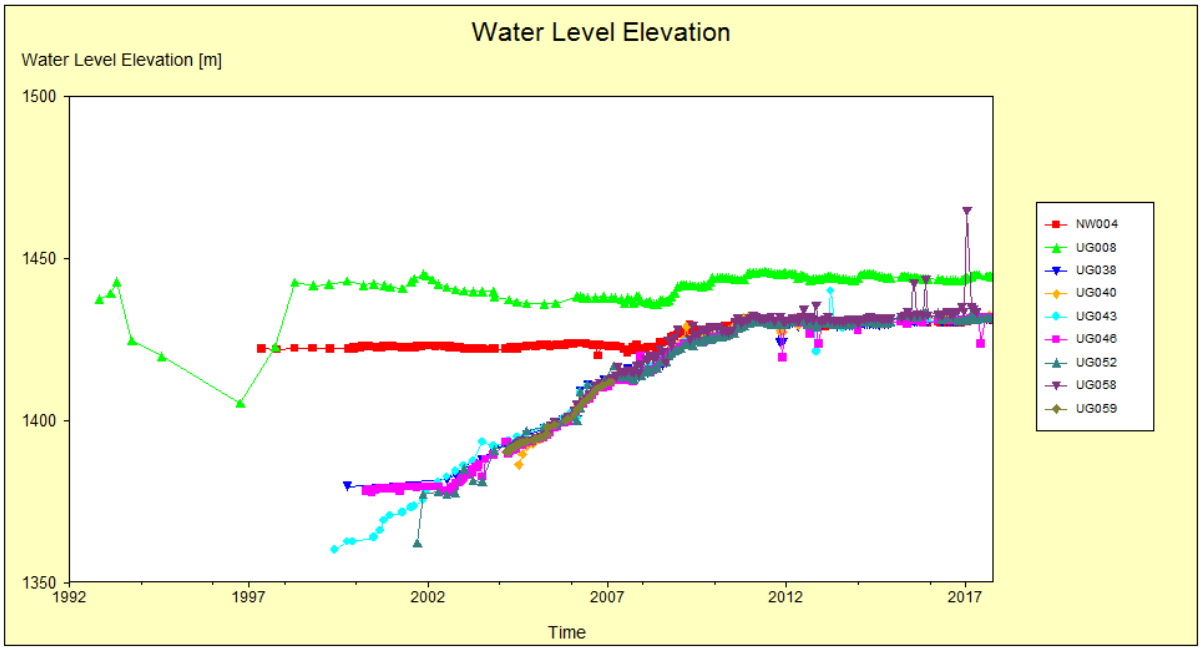

Figure 11-10: Hydraulic Head for Boreholes in Sigma, with NW004 and UG008 in the Intermediate Aquifer above the Mine Void and the Other Boreholes in the Mine System

A large number of boreholes are monitored within the Sigma mining area, the selection of representative boreholes was conducted by prioritizing boreholes included in the WUL for monitoring, taking into consideration the need for the selected boreholes to be widely distributed within the area of interest.

Very low sulphates in the mine groundwater system are observed since 2008, with the exception of UG069. The mine groundwater system is predominantly alkaline. UG069 is exceedingly high in alkalinity, salinity, sulphate, chloride, sodium and potassium, as compared to other borehole locations. UG38 is also found to have significantly high potassium compared to the remaining boreholes. This is likely to be the influence of ash activities. An excessive deterioration in groundwater quality with regards to aluminium concentration is observed to be a concern at UG014, rising from 0.024 (December 2016) to 0.41 mg/L (May 2017). Geochemical assessments conducted by Digby Wells (2014), indicate a potential concern regarding aluminium, this was observed based on the outcomes of the leachate tests conducted to evaluate the impacts of ash backfilling.

In the subsidence areas, recharge from rainfall is a more dominant contributor to water levels than regional groundwater flow. Regional groundwater flow is limited by the transmissivity of the undisturbed rock adjacent to the high extraction area and the hydraulic gradient. Hence most of the recharge to the mine occurs along subsidence areas.

Subsidence areas are potential decant points. Decant has occurred in subsidence areas with elevation of 1,424 mamsl in the vicinity of the Leeuspruit. Without subsidence, the decant elevation at the Leeuspruit is 1,426 mamsl.

In areas of no subsidence, decant is expected in areas where groundwater rises above ground level. Decant could take place at the point of intersection if there is a link between this position and the mine (e.g. a borehole). The rate of decant will be equal to the flux of the mine aquifer towards the top aquifer which will be a function of the direct recharge into the mine aquifer.

There is a possibility that the water level of the mine would increase above the water level of the top aquifer in the vicinity of the ash fill areas. Previous ash filling created artificial pressure around the backfilled areas. The storage of the strata above the mine was not sufficient to compensate for the decrease in void space, and the water that was pumped in with the ash was thus forced to decant. The water level data shown in Figure 11-11 depicts that UG069 has been decanting from September 2009 and is observed to continue up to the latest measured water levels (October 2017). It is recommended that decant should be collected and treated as to avoid having it introducing contamination into surface water bodies, IGS (2017) indicates that this is currently being conducted. IGS (2013) showed that the increase in water levels in the ash backfill boreholes are not related to rainfall events. From an electrical conductivity profiling previously conducted in UG069, after ash filling was ceased, the upper part of the water column is of better quality than deeper down (IGS 2013) as depicted in Figure 11-12.

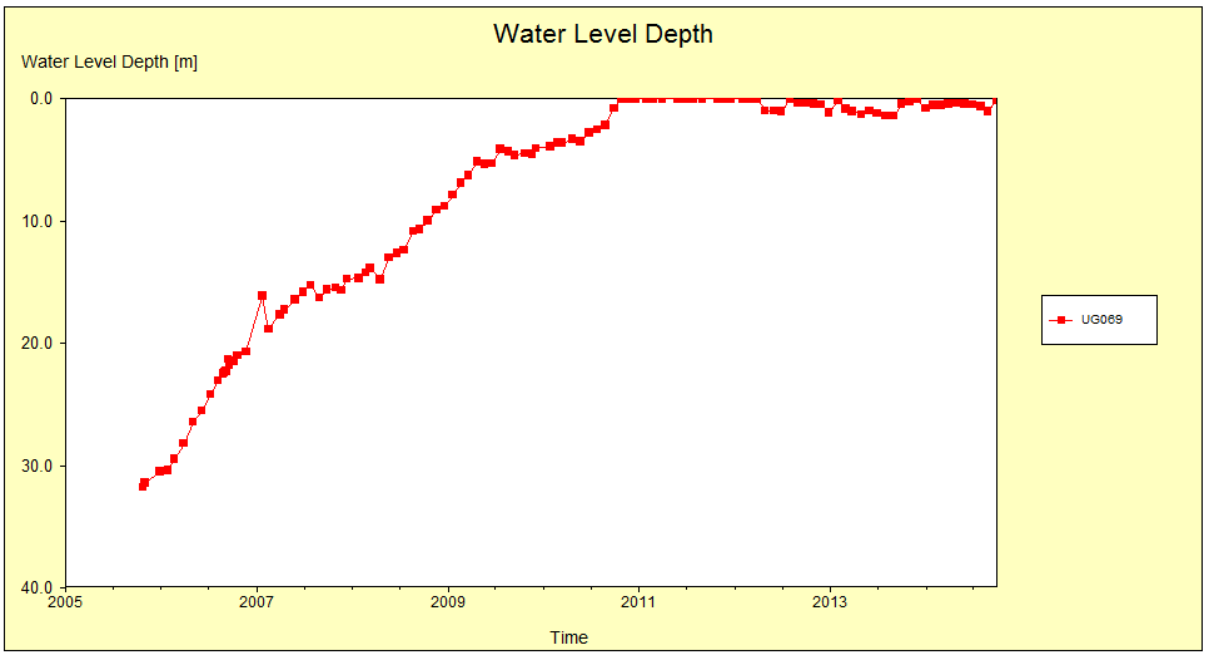

Figure 11-11: Water Level in UG069

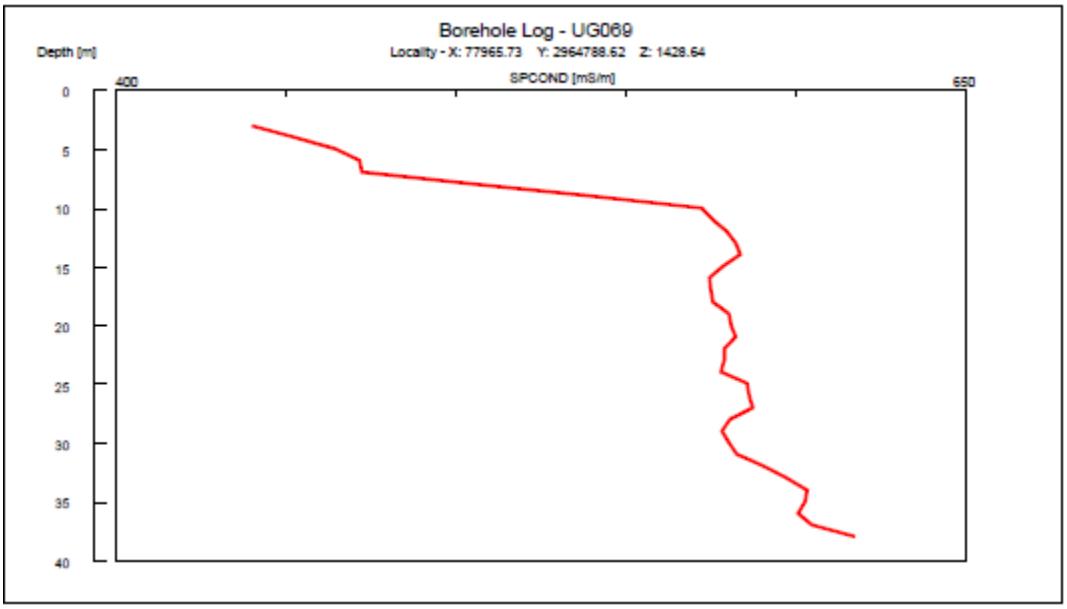

Figure 11-12: Electrical Conductivity Profile for UG069

(Source: IGS, 2013)

The average hydraulic conductivity values for the ash ranges from $5x10^{-3}$ to $5x10^{-7}$ m/d (IGS, 2013). This implies that the backfilled areas act as impermeable groundwater flow boundaries increasing groundwater levels near its vicinity. The probability that the water level of the mine, after backfilling, will increase above the water level of the top aquifer is very small. Due the higher transmissivity of the dolomites in direct connection to the seam floor, the mine water will flow towards the dolomites, than to the top aquifer.

In order to backfill the risk areas, water in the mine voids should be pumped out to provide void space and thus prevent decanting. The ash slurry should be injected into the mine void simultaneously with the water that is pumped out, and in equal volumes, to prevent other problems, such as the collapsing of the mine roof, from occurring.

11.7.2 Wonderwater and Mohlolo Conceptual Model

Plan 16 in Appendix B shows the locality of boreholes used to conceptualise the groundwater environment at Wonderwater and Mohlolo workings.

A direct link between the rehabilitated Wonderwater Opencast Mine and the Mohlolo underground workings has been observed. The coal seam floors are lower at Mohlolo, which implies that most of the water generated in the porous rehab area of Wonderwater, flows towards Mohlolo. The hydraulic properties of Mohlolo Underground are similar to sigma underground (IGS, 2008). Therefore, the following can be concluded:

- The water levels at the opencast have stabilized since 2013, currently ranging at approximately 1,427 mamsl. This means that Wonderwater is totally filled, and the water is decanting into Mohlolo North;

- The water level of the deeper aquifer in Mohlolo South is at 1423 mamsl, and the shallow level at 1429 mamsl. The deep aquifer water levels indicated a steep rise between 2008 and 2011. Since 2011, the water levels in the deep aquifer appear to have stabilised (with 2 anomalous drawdown events which had speedy recovery). It can be assumed that the deep aquifer system has reached hydrodynamic equilibrium;
- The water levels of the deeper aquifer in Mohlolo North are observed to be steadily reaching a hydrodynamic equilibrium with water levels at 1409 mamsl. The shallow aquifer levels are observed to be at a hydrodynamic equilibrium sitting at 1419 mamsl (with negligible fluctuation since 2001), the water table at the shallow aquifer is currently 10 m lower than in the opencast spoils; and
- The water level underground in Mohlolo North is 10 m lower than that of Mohlolo South.

Boreholes WW048, WW039 and WW029 have been selected as representative of water quality at Mohlolo South, Mohlolo North and Wonderwater, respectively. It is found that all constituents are observed to have stabilised in concentration since 2016 (and some earlier), none show alarming deterioration over recent monitoring events.

11.7.3 Groundwater Users

A hydrocensus was conducted in 2012 and another conducted in 2016 by Institute for Groundwater Studies (IGS).

11.7.3.1 Outcomes of Hydrocensus Conducted in 2012

The following is a summary from the Sasol hydrocensus report (Sasol, 2013a).

The majority of the boreholes are equipped with pumps. The types of pumps installed vary from submersible pumps to windmill pumps. The majority of these pumps are not in functional state. Six of the 23 boreholes have no pumping equipment. Five boreholes are currently in use. Four out of the five boreholes are located in Kronenbloem whilst the fifth borehole is located at Beginsil. The borehole depths vary from 6.5 to 81 m.

The mining depths for Sigma defunct ranged between 48 and 75 m on the north eastern compartments. Mining in the western compartments was deeper, in excess of 100 m.

The southern compartments are even deeper, with mining depths between 120 and 190 m. This indicates that mining took place at greater depths when compared to the borehole depths. Hence both shallow and intermediate aquifers are being utilised by the landowners to abstract groundwater.

The depth to water level for the boreholes varied between from 9 and 23 mbgl. The majority of the boreholes have poor yields, below 1 L/s. However, the boreholes at Saaiplaas Farm (SPB4), Kronenbloem (SPB16 and SPB17) and Saltberry (SPB21) have relatively high yields, between 1 and 2 L/s.

Boreholes with low yields that can still be utilised include SPB10 in Kronenbloem and SPB24 in Zwaanenburg. The rest of the boreholes have recommended sustainable yields below 0.5 L/s. These boreholes are very low yielding and can only be pumped for short duration at the recommended pumping rates. It is of utmost importance that the boreholes are given enough time to recover after being subjected to pumping.

Generally, the quality of water from these boreholes is affected by nitrates/ ammonia thus making it unfit for human consumption, unless water treatment with ion exchange is followed. Most of the boreholes are suitable for livestock watering. However, the marginal levels of nitrates in SPB 10 and SPB 24, and iron in SPB4 will not pose any danger to animals (Sasol, 2013a).

11.7.3.2 Outcomes of Hydrocensus Conducted in 2016

During the hydrocensus conducted in 2016; 45 private boreholes were visited. The following is a summary from the Sasol hydrocensus report (IGS, 2016).

Of the 45 boreholes identified during the hydrocensus; 12 were sampled and 22 were measured for water levels. For the rest there was no access to collect a sample or they were dry.

The water levels measured during the hydrocensus range from artesian to 31.77 m with the majority of the water levels deeper than 10 m. The shallower water levels are observed to be concentrated to the eastern portion of the Old Sigma Mining Rights Area on the farms Anthon 130, Peetershoogte 364 and Zwanenberg 366. The water levels of the Sigma monitoring boreholes (shallow & intermediate) ranges between 1.48 m to 28.27 m. The water levels measured in the monitoring and hydrocensus boreholes are within the same range thus indicating that the hydrocensus boreholes also intersect the shallow and intermediate groundwater regime.

The water levels of the Sigma shallow and intermediate groundwater regime are observed to have recovered since mining ceased and the mine left to be flooded, it can be concluded that the water levels of the hydrocensus boreholes have also recovered to their natural state before dewatering activities took place during mining.

Of the 12 sampled boreholes seven are within the acceptable and allowable limits for drinking water standards and suitable for human consumption. AF5 has an elevated electrical conductivity concentration which exceeds the acceptable limit for drinking water standards but is still within the allowable limit. This is probably the result of chloride, magnesium and calcium. These salts are natural to this part of the world being remnants of a marine environment; calcium and magnesium are the primary constituents of dolomitic lime found within sedimentary rock such as sandstone, shale and within some of the coal. Chloride is found abundantly within the shale of the Free State Coalfields.

Boreholes AF5, AF7, Z1 and Z2 have elevated nitrate concentrations exceeding the maximum allowable limit for drinking water standards and not suitable for human consumption. The elevated nitrate concentrations are likely due to fertilizers used by the farmers.

Water characterization of the boreholes is conducted according to the Piper and Stiff diagrams. According to the piper diagram; the hydrocensus boreholes are characteristic of groundwater that varies from calcium-magnesium bicarbonate type water, which is typical of recently recharged water, to sodium bicarbonate type water, which is typical of groundwater with high residence time and subjected to ion-exchange. According to the stiff diagrams the groundwater is predominantly alkaline in nature with most boreholes found to be enriched in calcium and magnesium which is typical of recently recharged water and some enriched in calcium and chloride (AF5 and Z2); chloride enriched water is typical of stagnant water (water with high residence time). These finding are consistent with those observed from the piper diagram.

Aquifer tests were conducted on eight boreholes (AF7, BG3, BP1, BP2, BP7, DH2, Z1 and Z2). Test results indicated that 7 of the 8 boreholes cannot yield enough water to be equipped with a pump and used as a source to abstract groundwater; this was with the exception of BP1.

11.8 Surface Water

11.8.1 Catchment Description

The project area is located within the Water Management Area (WMA) 05 in the Vaal River system. The proposed area is located within the secondary drainage C2 (Vaal River Catchment) in quaternary catchment C22K. The catchment characteristics for the C22K are presented in Table 11-19 are summarised from Water Research Commission (WRC), 2012. The resultant MAR after evaporation and recharge is 3%. Where Mean Annual Precipitation is MAP, Mean Annual Evaporation is MAE and Mean Annual Runoff is MAR.

Table 11-19: Summary of the surface water attributes for the two affected quaternary catchments

Quaternary Catchment	Area (km^2)	Rainfall Zone	MAP (mm)	MAR (mm)	MAR $m^3 * 10^6$	Evaporation Zone	MAE (mm)	% MAP/ MAR
C22K	434	C2C	644	20.9	9.11	11A	1625	3

(Source: WRC, 2012)

There are two tributaries to the Vaal which pass through the Sigma Defunct Colliery project site, with about 17 pipeline crossing locations (Plan 14 in Appendix B) identified. The two main tributaries are the Leeuspruit which drains the upper sections of the project site and the

Rietspruit draining the lower project boundary into the Vaal Barrage. The Leeuspruit and Rietspruit rivers flow parallel to each other towards Vaal Barrage.

The Taaibosspruit drains the area to the east of Sasolburg and is not influenced by the Colliery. At the time of the site visit the Rietspruit was dry whilst the Leeuspruit was flowing. Photos presented in Figure 11-13 below show some sections of the Rietspruit and Leeuspruit during site visit. The Rietspruit presented well-defined dry river channels whilst the Leeuspruit was slow flowing with varying channel shapes. The Kromelmboogspruit flows outside of the project boundary to the west.

Figure 11-13: Photographs of the Leeuspruit (Left) and the Rietspruit (Right) River Channels

The Sasol Sigma project is managed at one of the few Catchment Management Agencies (CMAs) in the Upper Vaal. The Sigma project is situated within the Vaal Barrage Catchment management forums and the Leeu/Taaibosspruit forum. The catchment under the Leeu/Taaibosspruit forum includes the Kromelmboogspruit as the western boundary, the meander in the Vaal River to the east, cutting off just before the Vaal Dam.

The Sigma project site surface topography of the landscape is undulating and sloping towards the Vaal River. Most of the surface is predominantly characterised by slopes in the classes 0 to 3% and lesser extent by slopes of class 3 to 10%. However, the historic mining activities have significantly altered the topography and surface water flow in the north east. Elevation within these river valleys varies from around 1,430 m at the valley bottoms to 1,490 m at the valley tops. Slopes are predominantly flat across the landscape except for isolated pockets of steeper slopes along the banks of the Vaal Barrage and where mining activities have taken place.

11.8.2 Surface Water Quality

The on-going surface water monitoring is conducted at appropriate locations / stream crossings, on the Rietspruit, Leeuspruit and the Vaal River. The ash utilised for ash backfilling is likely to contain specific contaminants, hence variables/parameter of concern

that are analysed as part of the water quality monitoring is based on the constituents of the ash.

The six water quality monitoring locations for the Sigma project are presented in Table 11-20. Water quality sampling is also performed at two other sites located on the Vaal River upstream of the proposed Sigma project.

Table 11-20: Summary of Existing Sigma Surface Water Sampling Points Locations

Location	Farm Name	X - Coord	Y-Coord
Sig/1	Lilian Dale	77815.00	-2964512.00
Sig/2	Saltberry	81819.00	-2972680.00
Sig/3	Beginsel	74889.17	-2968560.83
Sig/4	Kruidfontein	76724.00	-2973912.00
Sig/5	Leeuspruit	83888.00	-2970662.00
Sig/6	Leeuspruit	82500.00	-2970440.00
Vaal Downstream	Vaal Downstream	78057.00	-2960097.00
Vaal Upstream	Vaal Upstream	79920.00	-2960051.00
Ww-Duiker	Wonderwater West Dump Runoff	77681.00	-2961491.00
Ww-Kolgans	Wonderwater	79843.00	-2961512.00
Ww-Hammerkop	Wonderwater	79775.05	-2961567.85
Ww-North Reh Dam	Ww-North Final Void Dam	78913.00	-2960802.00
Ww-South Reh Dam	Ww-South Final Void Dam	78383.00	-2963519.00
Ww-Blesbok	Wonderwater East Dump Runoff	80010.00	-2961637.00

11.8.2.1 Water Quality Descriptions

The water quality report (Refer to IGS, Sasol Mining: Water Monitoring Report of Sigma Colliery Operations, May 2017) discussed all possible impacts of the surface water system by the Sigma Defunct Colliery. It also included the following, for all monitoring points:

- The hydro-chemical status of the water, with trends over time. These trends are classified as:
  - Improving water quality; or
  - Deteriorating water quality;
  - Sideways, if there is no clear indication of the water quality trend
- The impact of the water quality on the area;
- Determination of the long-term sufficiency of monitoring requirements.

11.8.2.1.1 Leeuspruit

Water quality results of the Leeuspruit indicated water with sodium-bicarbonate character; however, SIG/1 downstream is enriched with sulphate (Figure 11-14) with a concentration of 225 mg/l.

The tributary flowing into the Leeuspruit indicates water that changes from a calcium-bicarbonate character to a sodium-bicarbonate character enriched with sulphate (Figure 11-14). There is a definite improvement of water quality in the downstream direction of the Leeuspruit and a deteriorating water quality in the downstream direction of the tributary.

The time graphs for the electrical conductivity, pH, chloride and sulphate for Leeuspruit and its tributary are illustrated in Figure 11-15. Over the past two years, the overall water quality of Leeuspruit remained sideways. The pH values exceeding eight have been recorded in the past at SIG/1 downstream. There are momentary peaks of sulphate concentrations over time (Figure 11-15 and Figure 11-16) which is possibly the result of surface water runoff from the nearby fine ash dams and coal stockpiles.

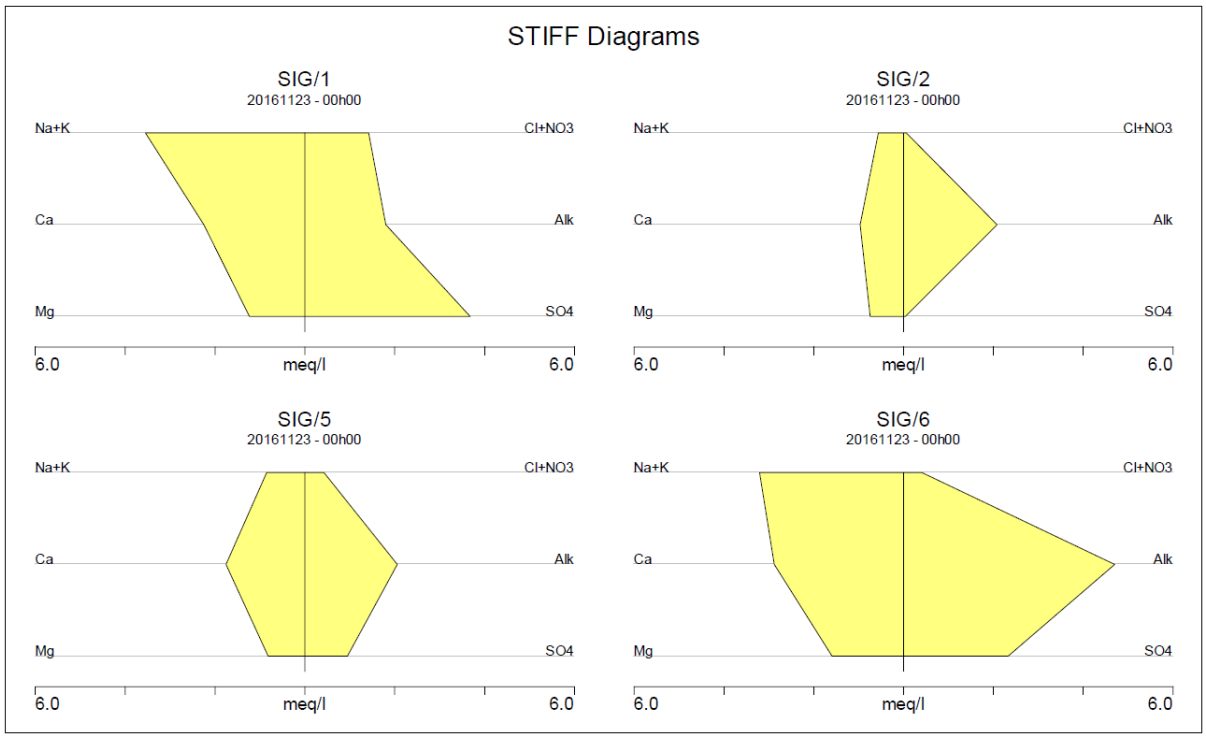

Figure 11-14: Stiff Diagrams Illustrating the Water Quality of Leeuspruit (SIG/1 & SIG/2) and its Tributary (SIG/5 & SIG/6) during November 2016

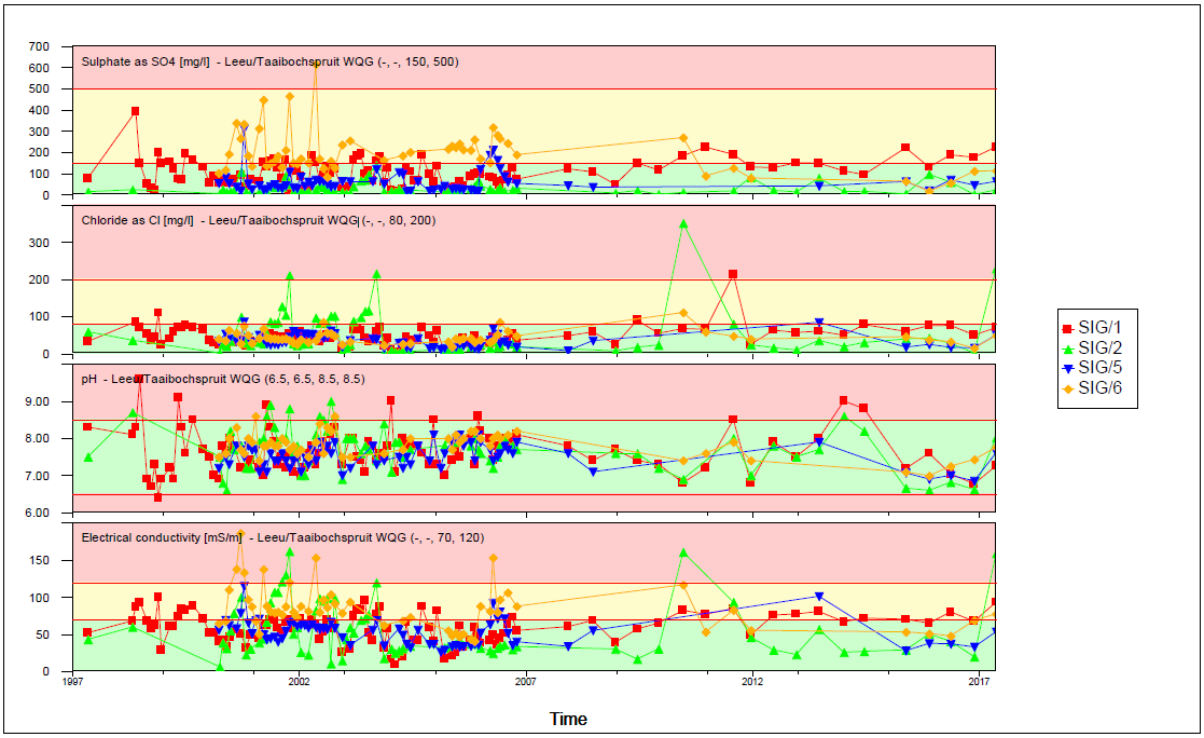

Figure 11-15: Electrical Conductivity, pH, Chloride and Sulphate Time Graphs for Leeuspruit (SIG/1 & SIG/2) and its Tributary (SIG/5 & SIG/6)

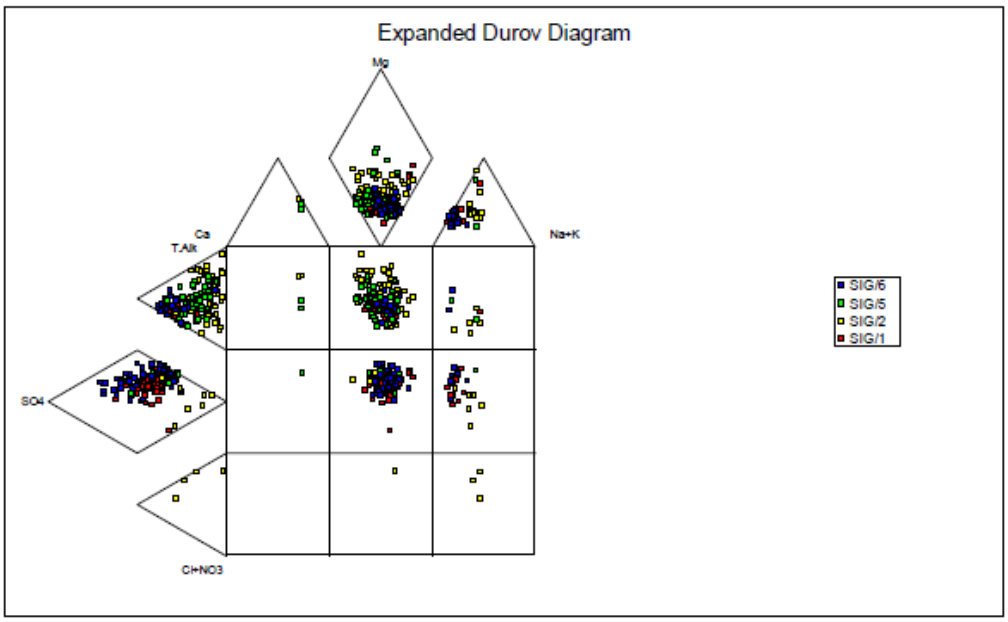

Figure 11-16: Expanded Durov Diagram of the Leeuspruit and its Tributary Illustrating Historic Water Quality Trends

When the Leeuspruit is benchmarked against the prescribed Leeu/Taaiboschspruit Water Quality Guidelines, the parameters that are at unacceptable concentrations are chloride, phosphate and the suspended solids. Phosphate and suspended solids are elevated in the Leeuspruit and its tributary, exceeding the prescribe Water Quality Guideline (WQG). Magnesium and sodium is also slightly elevated at the upstream sample (SIG/2) of the Leeuspruit but is still within the tolerable limit, whereas ammonium at the downstream sample is within the tolerable limit. The elevated constituents are attributed to animal wastes.

The bacteriological analysis result for the Leeuspruit and its tributary sampling points for May 2017 are tabled in Table 11-21. The faecal coliforms of the Leeuspruit and its tributary exceed the prescribed limit for the Leeu/Taaiboschspruit catchment WQG. E.Coli is also detected in the Leeuspruit and its tributary.

Table 11-21: Leeuspruit Water Quality vs. the prescribed Leeu/Taaiboschspruit Catchment Water Quality Guidelines (May 2017)

Site Name	EC	pH	Ca	Mg	Na	K	PAlk	MAlk	F	Cl	NO2(N)
SWQG	**mS/m**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Acceptable	<70	6.5-8.5	N/S	<30	<100	N/S	N/S	N/S	<0.7	<150	<3.0
Tolerable	70-120	N/S	N/S	30-70	100-150	N/S	N/S	N/S	0.7-1.0	150-200	3.0-6.0
Unacceptable	>120	<6.5;>8.5	N/S	>70	>150	N/S	N/S	N/S	>1.0	>200	>6.0
SIG1	93	7.3	69	23	99	16.1	0	167	0.21	70	<0.01
SIG2	159	8.0	107	68	116	87.9	0	510	<0.1	229	<0.1
SIG5	54	7.6	45	11	46	21.8	0	138	0.23	50	<0.01
SIG6	78	7.8	56	18	90	14.0	0	231	0.39	49	0.07

SiteName	NO3(N)	PO4	SO4	Al	Fe	Mn	NH4(N)	TDS	B	Si	Cd
SWQG	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Acceptable	<3.0	<0.4	<300	<0.3	<0.5	<0.5	<1.5	N/S	N/S	N/S	N/S
Tolerable	3.0-6.0	0.4-0.6	300-500	0.3-0.5	0.5-1.0	0.5-1.0	1.5-5.0	N/S	N/S	N/S	N/S
Unacceptable	>6.0	>0.6	>500	>0.5	>1.0	>1.0	>5.0	N/S	N/S	N/S	N/S
SIG1	<0.05	0.65	225	0.141	0.291	0.131	3.13	674	0.407	4.83	<0.003
SIG2	0.02	<1	23	0.071	0.075	0.465	0.32	1143	0.055	10.37	<0.003
SIG5	1.87	0.15	63	0.167	0.109	<0.020	0.08	385	0.075	5.27	<0.003
SIG6	2.26	1.45	114	0.058	0.040	0.034	0.29	585	0.153	5.20	<0.003

SiteName	Co	Cr	Cu	Pb	Turb	COD	Susp. Solids	Phenol	DOC	TOC	
SWQG	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	
Acceptable	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	
Tolerable	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	
Unacceptable	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	
SIG1	<0.020	<0.020	0.008	<0.015	48	137	67	<0.01	17	20	
SIG2	<0.020	<0.020	0.007	<0.015	12	100	16	<0.01	32	36	
SIG5	<0.020	<0.020	0.013	<0.015	3	32	5	<0.01	11	13	
SIG6	<0.020	<0.020	0.008	<0.015	176	266	360	<0.01	8	9	

SWQG - Leeu/Taaiboschspruit prescribed Surface Water Quality Guidelines
N/O – Not specified

11.8.2.1.2 Rietspruit

The water quality of the Rietspruit indicated water with a calcium/sodium-bicarbonate character. The time graphs for the electrical conductivity, pH, chloride and sulphate are illustrated in Figure 11-17. The overall water quality trend for SIG/3 downstream remained sideways over time, whereas the quality at SIG/4 upstream behaves erratic over time. The historic trends for SIG/4 indicate periods of prominent chloride and sulphate rich waters (Figure 11-18). The higher concentrations of chloride and sulphate are probably the result of evaporation during the dry winter season when the salt concentration increases as the water from the stream evaporates.

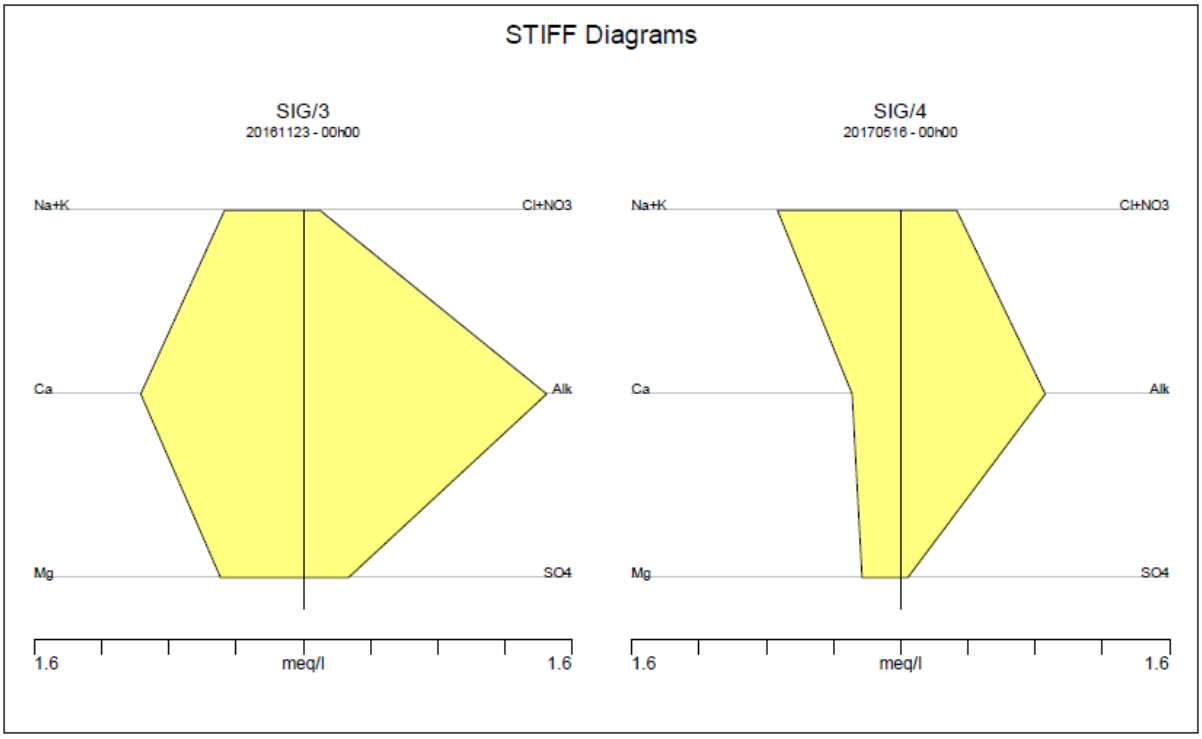

Figure 11-17: Stiff Diagrams of the Rietspruit Upstream (SIG/4) and Downstream (SIG/3) during May 2017

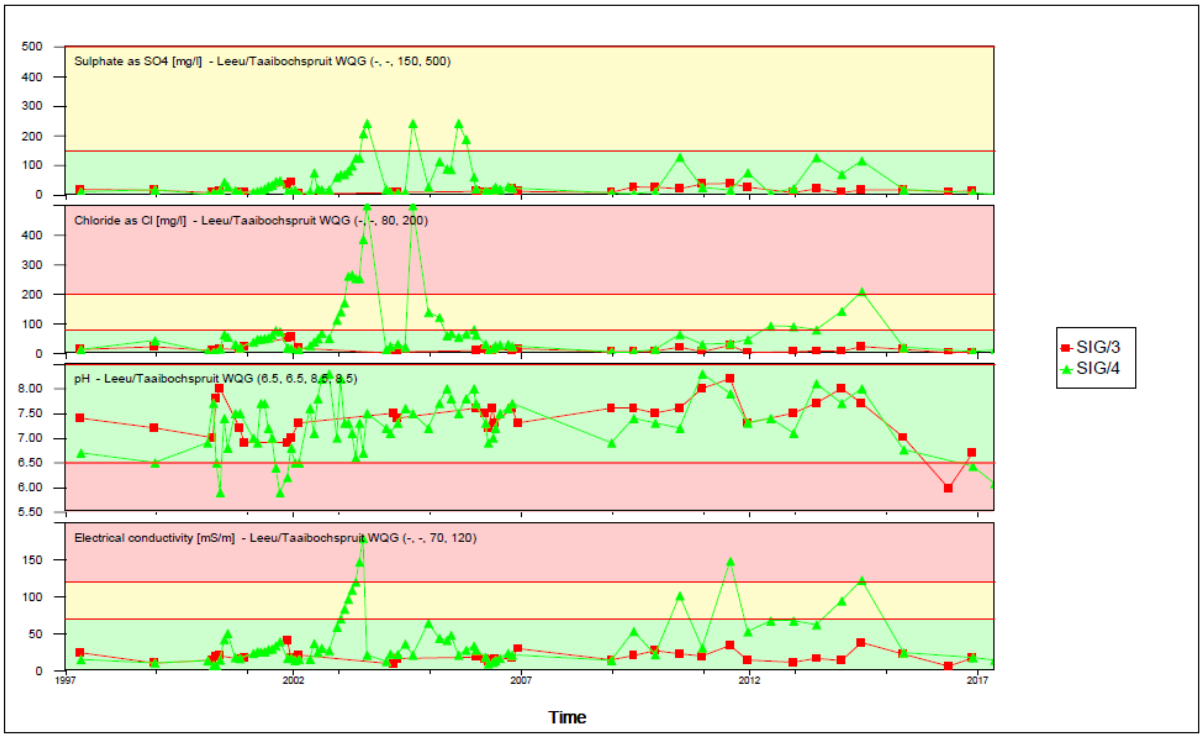

Figure 11-18: Electrical Conductivity, pH, Chloride and Sulphate Time Graphs for the Rietspruit

When the Rietspruit is benchmarked with the prescribed Leeu/Taaiboschspruit WQG, for the Rietspruit upstream and downstream sampling points for May 2017, Aluminium, iron, pH and the suspended solids are the only constituents that exceed the prescribed Leeu/Taaiboschspruit WQG. All the other constituents are well within the prescribed acceptable limits. The faecal coliforms concentration in the Rietspruit exceeds the prescribed Leeu/Taaiboschspruit WQG but is still within the tolerable limit. E.Coli is also detected in the Rietspruit.

11.8.2.1.3 Vaal River Barrage

The latest water quality results for the Vaal River represented by Vaal Upstream and Vaal Downstream, revealed sodium sulphate signatures (Figure 11-19). The upstream sampling point's water quality is generally worse than the downstream sampling point. Thus, indicating that there are other sources influencing the quality of the Vaal River upstream from the Sigma operations.

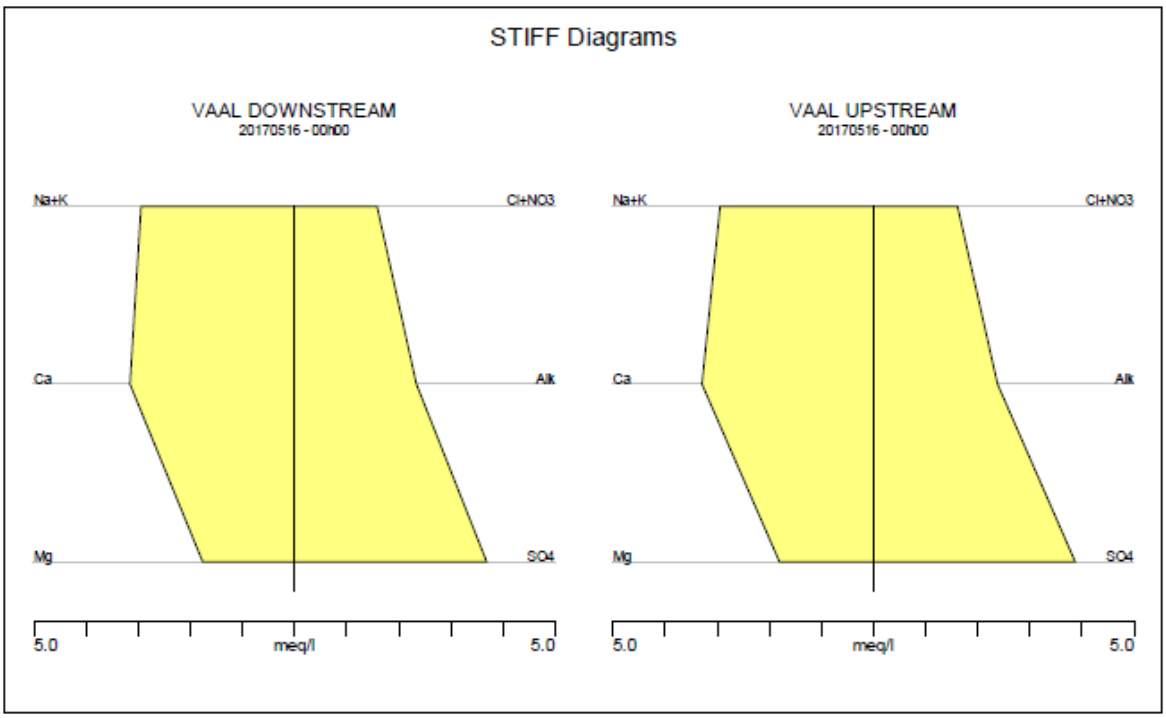

Figure 11-19: Stiff Diagrams of the Vaal River Upstream and Downstream

The historic water quality data as shown in Figure 11-20 reveals the current calcium sulphate signatures from the latest data. The time series Stiff diagrams (Figure 11-21) indicate that the water quality downstream varies between calcium sulphate and sodium bicarbonate water.

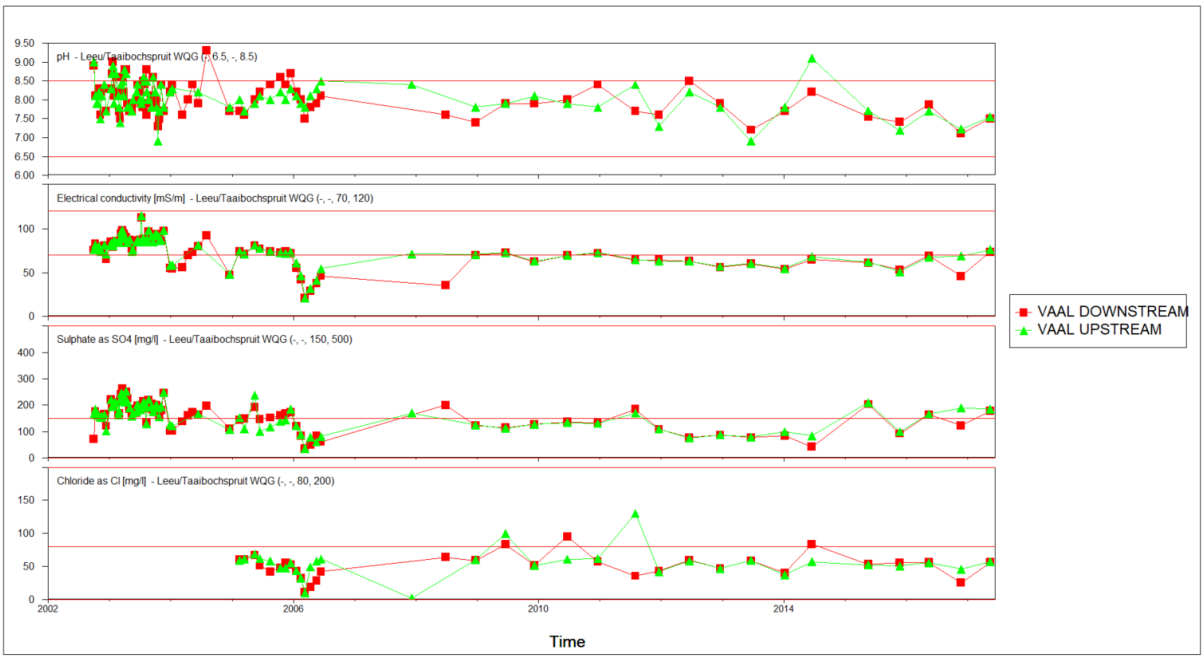

Figure 11-20: Major Cation, Anion and Electrical Conductivity Time Graphs of the Vaal River Upstream and Downstream

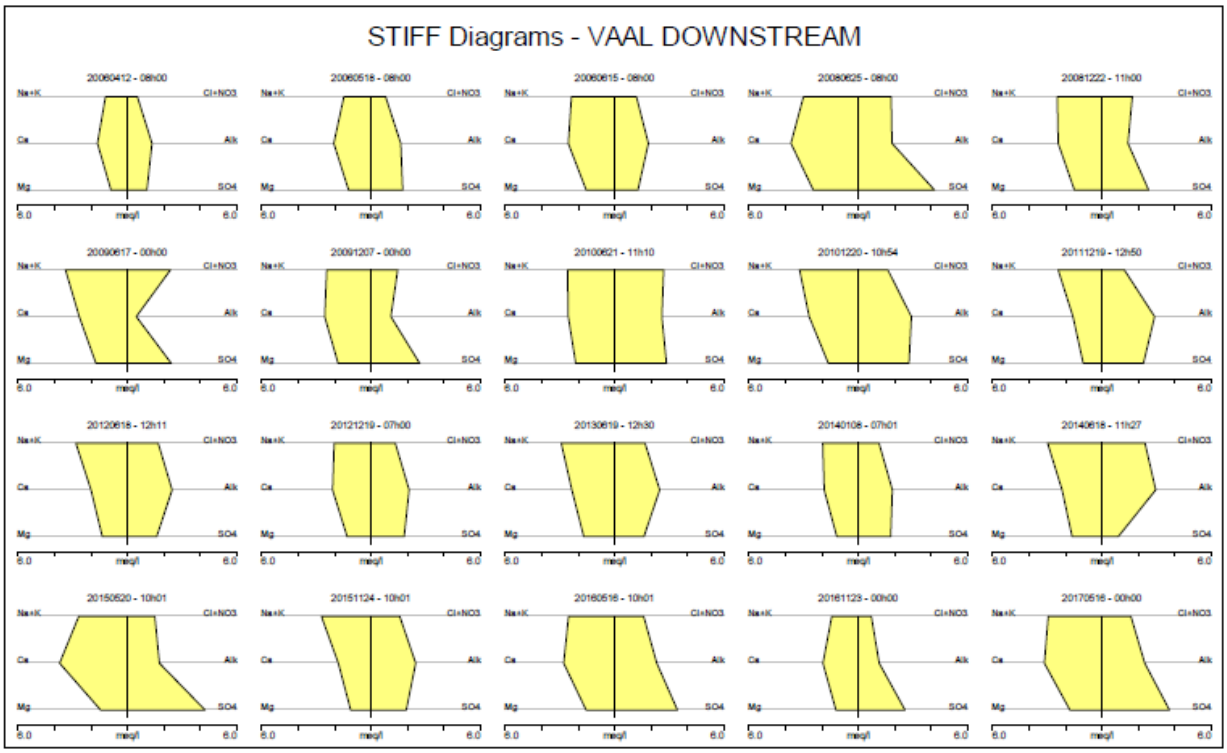

Figure 11-21: Stiff Diagrams of the Vaal River Upstream and Downstream

When the water quality for the Vaal River upstream and downstream sampling points for May 2017 is benchmarked with the prescribed Leeu/Taaiboschspruit Water Quality Guidelines, only phosphate and the suspended solids exceeds the prescribed Leeuspruit/Taaiboschspruit WQG. Nitrate and ammonium is also elevated but within the tolerable prescribed limit. All the other constituents are well within the acceptable range.

Faecal coliforms are elevated but within the acceptable limit. *E.coli* is also detected in the Vaal River.

11.8.2.1.4 Wonderwater Surface Water Dams

It must be emphasized that the Hammerkop and Kolgans Dams were used to store mine water when the mine was operational and now they only collect rain water/runoff. WW-Blesbok and Ww-Duiker are only sampled if there is seepage visible from the old dumps.

The water quality of the Wonderwater surface water dams are all enriched with sulphate. Reh-North Reh Dam (Lake Nussey) and Reh South Reh Dam (Chrissiesmeer) have a magnesium-sulphate character (water qualities are similar). When comparing this current water quality with the historic records, the high sulphate signatures correlates well with that of the past records (Figure 11-23). The high sulphate character (>1 000 mg/l) of the final voids is typical of waters associated with open cast coal mining activities.

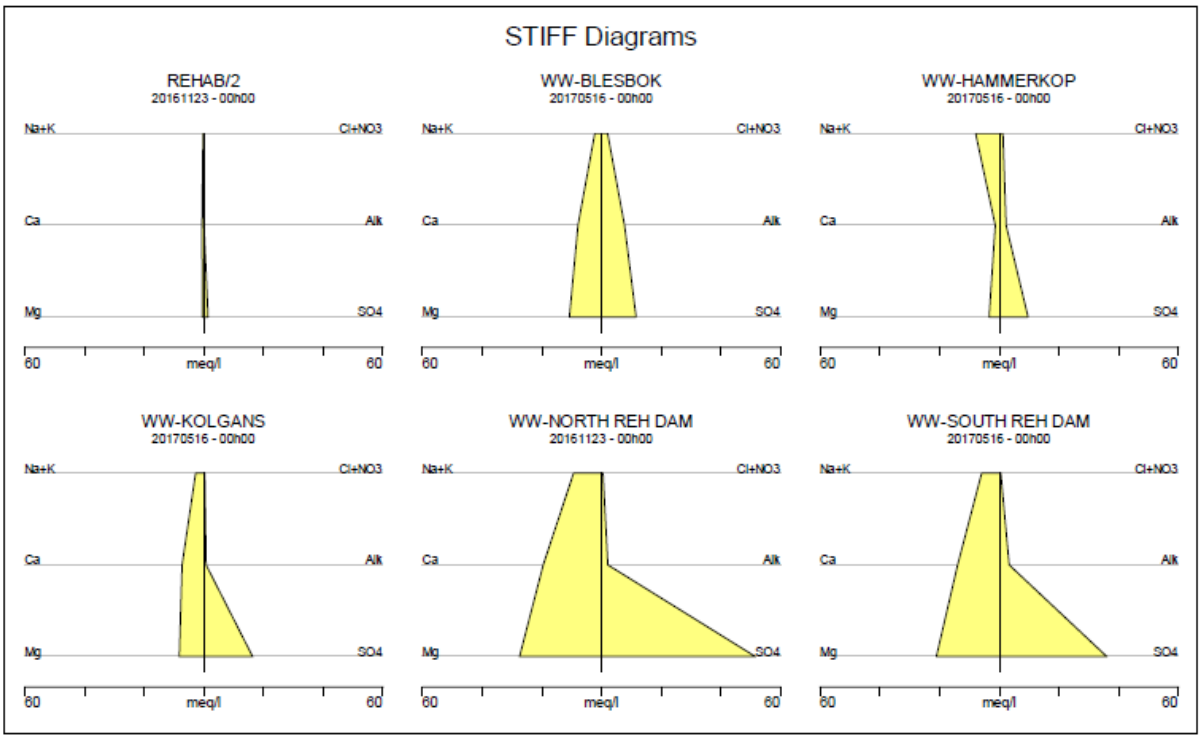

Figure 11-22: Stiff Diagrams of the Wonderwater Surface Water Dams

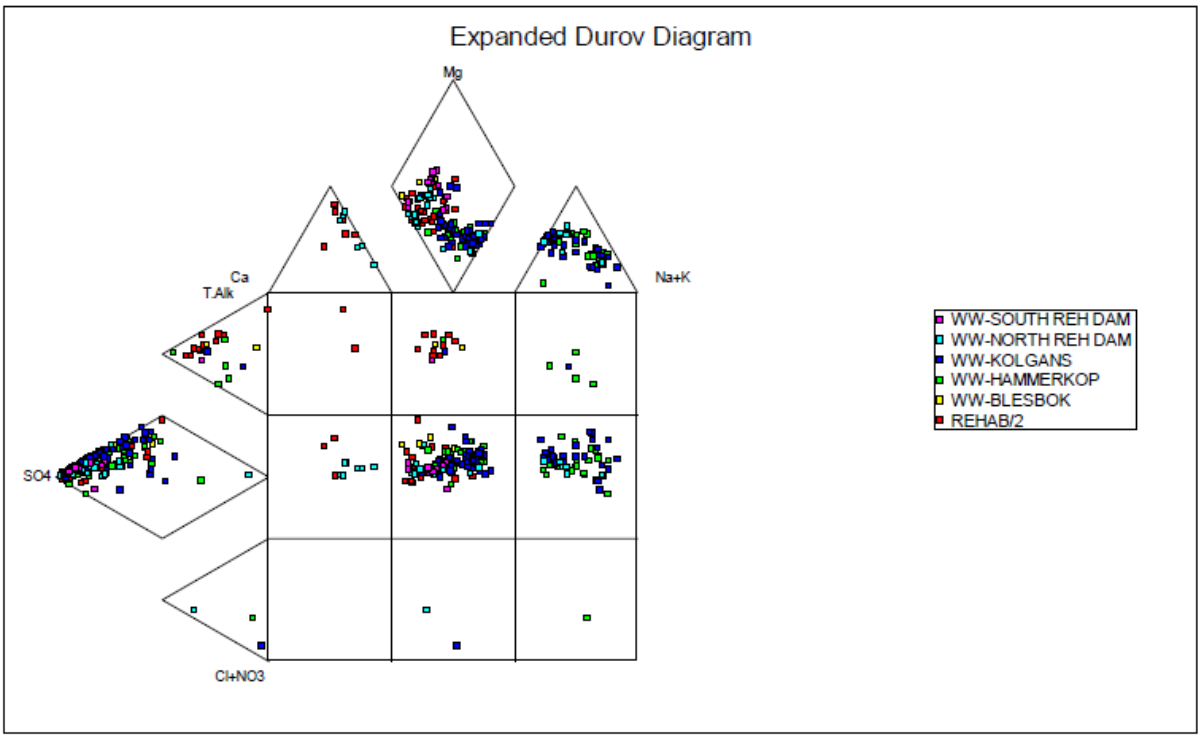

Figure 11-23: Stiff Diagrams of the Wonderwater Surface Water Dams

The time graphs for the electrical conductivity, chloride and sulphate are illustrated in Figure 11-24. The water quality for REHAB/2 remained sideways overtime, whereas there is a deterioration trend observed for all the other surface water dams since 2009. The chloride concentration of WW-NORTH REH DAM, WW-HAMMERKOP and WW-KOLGANS was exceptionally high in June 2014 but has improved to previous values. This may be the result of evaporation, increasing the salt concentration; this is especially the case for WW-HAMMERKOP and WW-KOLGANS. WW-BLESBOK deteriorated over the last six months, indicating that the quality of the runoff water from the Wonderwater East Dump might be affected by the dump to some degree.

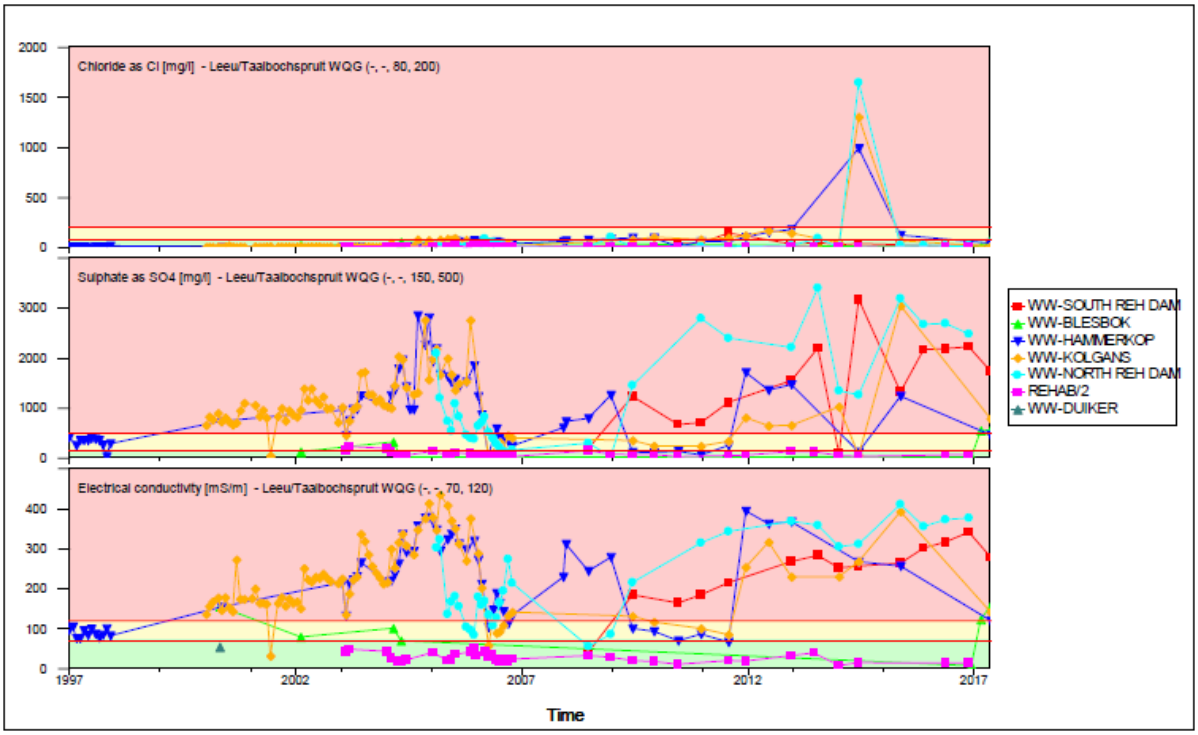

Figure 11-24: Electrical Conductivity, Chloride and Sulphate Time Graphs of the Wonderwater Surface Water Dams

When the water quality for the Wonderwater surface water dams for May 2017 is benchmarked with the prescribed Leeu/Taaiboschspruit Water Quality Guidelines, the quality of the final voids (WW-NORTH & WW-SOUTH REH DAM), WW-BLESBOK and WW-KOLGANS exceeds the prescribed Leeu/Taaiboschspruit WQG. Magnesium and sulphate are the constituents exceeding the prescribed limits. The suspended solids concentration in WW-BLESBOK and WW-HAMMERKOP also exceed the prescribed Water Quality Objectives (WQO). All the other constituents are well within the prescribed acceptable range.

Faecal coliforms exceed the prescribe WQO in WW-BLESBOK. E.coli is also detected in all the Wonderwater surface dams that are being monitored.

11.8.2.2 Surface Water Quality Conclusion

The following conclusions are drawn from the baseline data:

- The major surface water resources draining the project area are the Leeuspruit and the Rietspruit, which flow into the Vaal Barrage;
- The project area falls within quaternary catchment C22K. The catchment was delineated into eleven sub-catchments for hydrological assessments;
- The project area hydrology is altered with catchment characteristics and surface topography already impacted by subsidence, historical opencast mining and sand mining developments;

- Surface water quality is not pristine as several anthropogenic impacts have deteriorated the rivers over the years, these include, sand mining, farming, previous coal mining (in the event of decant), ash backfilling spill years back, informal settlements, urban development as well as burst sewer pipes;
- The water quality results of the Leeuspruit indicates water with a sodium-bicarbonate character with a sulphate enrichment downstream, whereas, the tributary flowing into the Leeuspruit indicates water that changes from a calcium-bicarbonate character to a sodium-bicarbonate character enriched with sulphate. The parameters that are at unacceptable concentrations are chloride, phosphate and the suspended solids. Phosphate and suspended solids are elevated in the Leeuspruit and its tributary, exceeding the prescribe WQG;
- The water quality of the Rietspruit indicates water with a calcium/sodium-bicarbonate character. Aluminium, iron, pH and the suspended solids are the only constituents that exceed the prescribed Leeu/Taaiboschspruit WQG. The faecal coliforms concentration in the Rietspruit exceeds the prescribed Leeu/Taaiboschspruit WQG but is still within the tolerable limit. E.Coli is also detected in Rietspruit;
- The latest water quality for Vaal River represented by Vaal Upstream and Vaal downstream, revealed sodium sulphate signatures. The upstream sampling point's water quality is generally worse than the downstream sampling point. Thus, indicating that there are other sources influencing the quality of the Vaal River upstream from the Sigma operations; and
- The predominant water uses are agriculture (farming and livestock). The runoff water from these activities flows into the Vaal Barrage from the Rietspruit and the Leeuspruit.

11.9 Wetlands

The National Freshwater Ecosystem Priority Areas (NFEPA) strategic spatial priorities for conserving the country's freshwater ecosystems and supporting sustainable use of water resources were considered to evaluate the importance of the wetland areas located within the proposed ash backfilling pipeline route area (Nel *et al*. 2011).

Spatial layers (FEPA's) used include the wetland classification and ranking. Plan 7, Appendix B illustrates the different wetland types recorded according to NFEPA within the project area. The identified wetland areas play important functions such as the enhancement of water quality, attenuation of floods and biodiversity support.

The Free State Biodiversity Plan (2015) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for in national legislation and policy. The Free State Biodiversity Plan was published in 2015, and like those of the other provinces, identifies and maps the protected areas, Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) to aid management guidelines for the Free State. Currently

there is only a terrestrial component for the plan; however, the aquatic component is expected in 2018. The Free State Biodiversity Sector Plan is shown in Plan 8 in Appendix B.

While most of the pipeline servitude is classified as 'degraded' and 'other,' small portions of the proposed pipelines are classified as CBA 1, CBA 2, ESA 1 and ESA 2. This will need to be updated, once the aquatic component is published.

11.9.1 Wetland Delineation

The wetland areas were delineated in accordance with the Department of Water Affairs and Forestry (DWAF) (2005) guidelines, whereby features such as soil, vegetation and topography were considered. The indicators used to assist with the delineation of wetland areas are represented in Figure 11-25 to Figure 11-27 below. Wetlands on site were found to be fed via groundwater (hillslope seepage) as well as surface flow (e.g.: valley bottom systems and floodplains).

According to the wetland definition used in the NWA wetland vegetation is the primary indicator, which must be present under normal circumstances, however, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. Owing to the major disturbance of the soils on site, as well as the large alteration of the landscape due to subsidence, the exact delineation of wetland boundaries was hampered. The wetland delineation represented in Figure 11-25 shows natural wetlands (including those that have been altered). Plan 10, Appendix B shows the areas that have subsided as well as the delineated wetlands. It is highly probable that some surface collapse has resulted in the formation of depressions that now function as wetlands. Subsidence occurs throughout the landscape. A peat wetland was also identified.

Two major wetland systems were identified on site, namely: The Rietspruit system (located in the western portion of the site) and the Leeuspruit system (located in the eastern portion of the site). These systems are tributaries of the greater Vaal Barrage Catchment. A number of ephemeral pans were also identified in addition to wetlands associated with these two systems.

Figure 11-25: Types of Wetlands Terrain

(**A:** depression / pan; **B:** channel of the Rietspruit – floodplain wetland **C:** channel of the Leeuspruit – floodplain wetland)

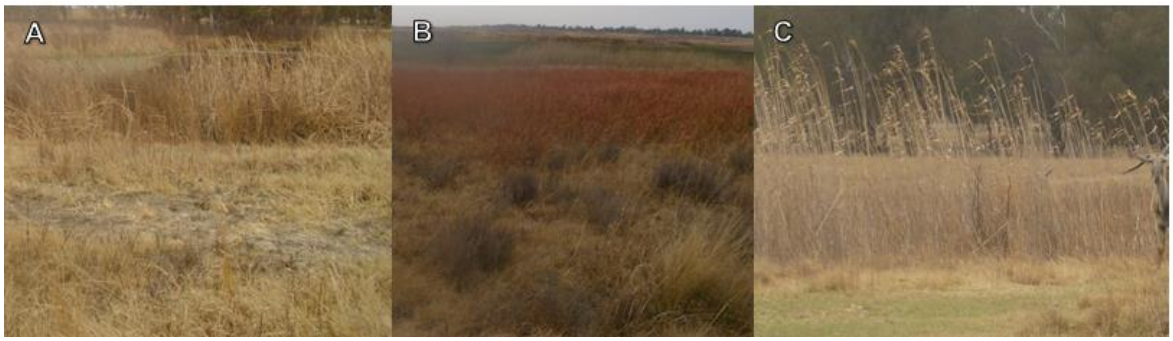

Figure 11-26: Wetland Indicators Used for Delineation – Plant Species

(**A:** Giant Bulrush (*Typha capensis*); **B:** Cotton-wool Grass (*Imperata cylindrica*) and **C:** Common Reed (*Phragmites australis*)

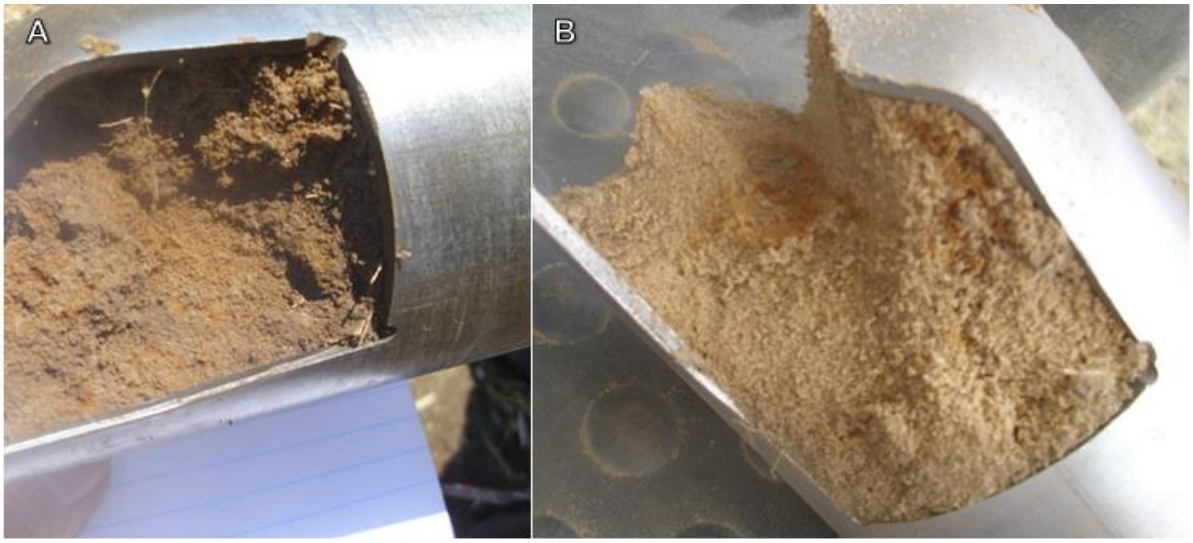

Figure 11-27: Wetland Indicators Used for Delineation – Soil Wetness Characteristics

(**A:** soil mottling and **B:** soil mottling and E-horizon)

11.9.2 Wetland Unit Identification

The wetland units associated with the proposed ash backfilling pipeline were initially identified at desktop level and then ground-truthing was conducted to confirm these findings. Within the project area, there are 1284.8 ha of wetlands. Four hydro-geomorphic (HGM) Units of natural wetland were identified as illustrated in Plan 9, Appendix B.

The identified wetland units within the study area include:

- Depression / Pan;
- Channelled Valley Bottom;
- Floodplain; and
- Hillslope Seep.

Description of these wetland units is provided in Section 7.2.1 of the wetland specialist study (Appendix G)

No depressions / pans are anticipated to be directly impacted by the proposed pipelines and ash backfilling project. Plan 10, Appendix B represents the areas of wetland that coincide with voids that have already collapsed on site. Subsidence is present along both the Leeuspruit and the Rietspruit, resulting in interrupted natural flow as well as reduced rate of recharge.

11.9.3 Ecological Health (Wet-Health)

The general features of the identified wetland units within the project area were assessed in terms of impacts on the integrity of these systems. The identified impacts include activities such as livestock farming, crop cultivation and pasture cultivation. The major impacts are related to mining activities, agriculture and informal settlements surrounding the study area. Wetland integrity on site has been largely altered due to subsidence, resulting in obstruction and redirection of natural water flow. It is expected that the disruption of hydrological pathways due to collapsing of bedrock and unconsolidated sediments has caused a reduction in time taken for wetland recharge (or complete ceasing of wetland recharging). The proposed pipelines for ash backfilling are intended to cross wetlands at 31 points. Some of the impacts identified from the Wet-Health assessment within the project area during the site investigations include:

- Overgrazing and trampling by livestock;
- Gulley and headcut erosion;
- Damming;
- Roads crossing over wetlands (R59 Highway and farm roads); and
- Subsidence throughout the study area.

Rietspruit and Leeuspruit tributaries of the Vaal

Both the Rietspruit and the Leeuspruit tributaries have been reported to have undergone severe pollution and degradation due to industry and mining in the Sasolburg and Vanderbijlpark areas (Wepener *et al.* 2011) as well as agriculture, development and informal settlements. Mafanya (2013) reports that levels of magnesium, nitrate, iron, fluoride, manganese, ammonium and phosphate were elevated in the Leeuspruit. Furthermore, the Rietspruit in particular receives contamination from formal and informal settlement sewage. These inputs contribute to significant deterioration of water quality from the Vaal Dam to the Vaal barrage as a consequence (Coleman and van Niekerk 2007)

The abovementioned impacts have resulted in the deviation of the integrity of wetland areas within the project area from an un-impacted reference state to the current state. The health assessment of the identified wetland systems made use of the indicators: hydrology, geomorphology and vegetation. In addition to impacts on these features, the Rietspruit and Leeuspruit have both undergone significant degradation due to point-source contamination from various industries. The Wet-Health tool is used to assess wetland systems separately but it is important to note that systems form part of an interconnected groundwater regime and cannot be regarded in complete isolation from one another. A summary of the findings

of the Wet-Health Assessment are described in Table 11-22. Plan 11, Appendix B provides the PES for wetlands coinciding with the route for the proposed pipelines.

Table 11-22: A Summary of the WET-Health Scores for the Three Indicator Study Components (Pre-Development)

Wetland System	Module	Health Score	PES Class
Leeuspruit	*Hydrology*	6.5	E↓↓
	Geomorphology	4.3	D→
	Vegetation	5.5	D↓↓
	Overall Score	5.6	D↓↓
Rietspruit	*Hydrology*	7.5	E↓↓
	Geomorphology	5.9	D↓
	Vegetation	5.5	D↓
	Overall Score	6.6	E↓↓
Depression / Pans	*Hydrology*	6	E↓
	Geomorphology	2	C↓
	Vegetation	2.3	C↓
	Overall Score	3.8	C↓

Key: ↑↑ - Improve markedly; ↑ - Improve slightly; → - Remain stable; ↓ - Deteriorate slightly and ↓↓ - Deteriorate markedly

11.9.4 Ecological Functionality Findings

The general features of each wetland unit were assessed in terms of functioning and the overall importance of the wetland systems on site were then determined at a landscape level. The results from the WET-EcoServices tool for the respective wetland units are presented below and highlight that wetlands on site generally provide services that are rated as Moderately Low to Intermediate, where.

- <0.5: Low
- 0.5-1.2: Moderately Low
- 1.3-2.0: Intermediate
- 2.1-2.8: High
- >2.8: Very High.

11.9.4.1 Leeuspruit System

Portions of the Leeuspruit system affected by this project are located within Game Camps. Owing to this the wetland service provision related to tourism and recreation activities were scored Very High. Furthermore, this system scored Very High for services related to sediment trapping, nutrient processing and stream-flow regulation. Maintenance of biodiversity received a High score a large extent of the wetland area associated with this system is open water, providing a water source for birds and animals on site.

11.9.4.2 Rietspruit

Many of the services once provided by this system have been altered from the reference state due to subsidence and development. Wetland service provision was predominantly classified as Low to Moderately Low. Flood attenuation, nutrient processing and toxicant removal were allocated Very High scores.

11.9.4.3 Pan/ Depressions

Pans identified on site were not located in natural areas but were surrounded by maize crops. Pans were either covered by alien plant species or were completely bare. As a consequence, they scored particularly low for service provision due to the lack of vegetation buffer and linkage to any other systems on site. Although pans may act as water points for animals when they are filled, they are ephemeral with regard to seasonality and scored Moderately Low for maintenance of Biodiversity.

11.9.5 Buffer Zones

The buffer zones are a requirement to facilitate the protection of the delineated wetland areas within the project area. The purpose of the establishment of buffer zones is to minimise the anthropogenic impacts associated with the proposed development on the receiving water resources. A buffer zone is defined as:

"*the strips of undeveloped, typically vegetated land (composed in many cases of riparian habitat or terrestrial plant communities) which separate development or adjacent land uses from aquatic ecosystems (rivers and wetlands).*"

A number of explanations have been provided for the establishment of buffer zones, some of the reasons are listed below:

- Reducing the impacts of adjacent land uses on water resource quality and the associated biodiversity, and;
- Sustaining or improving the ability of the water resources to provide goods and services to the current and future water end users within the catchment area.

Any development within the 32m and 100m buffer will require environmental or water use authorisation, respectively (Plan 12, Appendix B). These buffer zones are based on the current statutory requirements.

11.10 Cultural Heritage

11.10.1 Geological Character and Palaeontological Potential

The project area is situated in the Sasolburg-Vereeniging Coal Field which forms part of the Karoo Basin. The Karoo Basin is divided into the Dwyka, Ecca and Beaufort Groups. The site-specific study area is underlain primarily by the sedimentary lithologies of the Ecca Group, specifically those associated with the Vryheid Formation.

These sedimentary rocks are invaded by younger, post-Karoo dolerite intrusions, mainly in the form of sheets (sills). These sediments are underlain by the Dwyka Group tillite (diamictite) which represents the basal unit of the Karoo Supergroup. This diamictite in turn overlies the basal rocks represented either by dolomite of the Malmani Subgroup of the Chuniespoort Group or the lava of the Ventersdorp Supergroup (van Tonder, 1997).

The composition of the sediments of the Vryheid Formation includes shales (often carbonaceous), mudstone, siltstone, sandstone and the economically-important coal seams mined by the Sigma Defunct Colliery. The rocks of the Vryheid Formation are renowned for their wealth of plant fossils, notably of the Gondwanan Glossopteris flora which has been described from the Permian- aged rocks (Rubidge, 2008). This flora is the source of the coal which is mined from the Vryheid Formation in South Africa.

Important plant fossil localities have previously been found in areas close to Vereeniging. Seward (1903), for example, described impression fossils of the plant *Bothrodendron leslii*. Similarly, Rayner (1985) also described lycopods such as *Cyclodendron leslii* found close to Vereeniging.

11.10.2 Early to Later Stone Age (c. 2.5 mya[2] to 1st Millennium CE[3])

Evidence of all three phases of the Stone Age – Early, Middle and Later – are found in the Free State Province. The majority of the recorded sites from the Stone Age from previous studies were limited to scatters of stone tools associated with the Middle Stone Age (MSA, dated between 250 000 years ago to 20 00 years ago) and Later Stone Age (LSA).

The MSA period can be defined by the occurrence of blades and points produced from good-quality raw material. Bone tools, shell beads and pendants, as well as the use of ochre are also present. The LSA is dated to approximately 20 000 years ago onwards and can be characterised by the presence of microlithic technology. Microlithics are produced from very fine-grained materials such as quartz or chert and are often used as composite tools where they are hafted onto sticks for arrows. Evidence of complex societies and ritual practices, including rock art, is present in this period (Deacon & Deacon, 1999).

[2] Million Years Ago

[3] Common Era (CE) refers to the same period as *Anno Domini* (“In the year of our Lord”, referred to as AD): i.e. the time after the accepted year of the birth of Jesus Christ and which forms the basis of the Julian and Gregorian calendars. Years before this time are referred to as ‘Before Christ’ (BC) or BCE (Before Common Era).

11.10.3 Late Farming Community (c. 1500 CE to 1850 CE)

The central regions of South Africa, specifically the southern Highveld, were only settled by the Farming Community agricultural groups fairly late when compared to the northern and eastern parts of the country (Maggs, 1976; Chirikure, et al., 2008). This phase is known as the Late Farming Community (LFC). The southern Highveld is, historically, a relatively inhospitable environment for early farmers to have exploited. The area is generally devoid of trees, subject to sour grass in the winter and experiences extreme differences in temperature. This would have impacted on early farming communities as they were generally dependent on firewood for domestic activities and metalworking, and required wooden poles to construct houses and fences.

The Farming Community societies start appearing on the landscape from the late 15th century, initially associated with Sotho-speakers, but more recently, possibly with Nguni speakers as well (Maggs, 1976; Huffman, 2007; Chirikure, Hall, & Maggs, 2008).

The most visible evidence of the 15th century farmer groups in the general region within which the project area is located are various stonewalled settlements types. The most common of these have been termed 'Type V' by Maggs (Iron Age Communities of the Southern Highveld, 1976). These settlements occur in the north-eastern part of the Free State into southern Mpumalanga as far as Bethal and Ermelo. They were first described by Van Riet Lowe in 1927 in Vegkop. Based on Maggs' aerial surveys, it is evident that Type V settlements cluster around the main river systems such as the upper Vaal River. However, based in Maggs'1974 settlement distribution map (Maggs, 1976, pp. 38-39), no Type V sites have been recorded in the site-specific study area. Two Vredefort Dome or Type Z sites are nearby.

The stonewalling evident at these sites would have been used as cattle and other stock enclosures surrounded by thatch beehive huts (Huffman, 2007). There is some evidence that corbelled huts may have evolved from the thatch beehive design.

Ceramics are most often associated with Farming Community sites. Ceramics stylistic analysis – form and decorative motif – provide a guideline whereby sites can be placed within a relative temporal and cultural context. Tom Huffman (Handbook to the Iron Age: The Archaeology of the Pre-Colonial Farming Societies in Southern Africa, 2007) has collated findings from diverse sites and dates throughout southern Africa that culminated in his comprehensive publication. Based on his analysis, the ceramic facies that are of relevance to the site-specific area are presented in Table 11-23.

Table 11-23: Possible Ceramic Traditions within the Study Area, After Huffman

Facies	Likely date range	Associated settlement type
Ntsuanatsatsi	1450 to 1650	Type N
Uitkomst	1650 to 1820	Klipriviersberg
Makgwareng	1700 to 1820	Type V

Facies	Likely date range	Associated settlement type
Olifantspoort	1500 to 1700	N/A
Thabeng	1700 to 1840	Type Z
Buispoort	1700 to 1840	N/A

(Handbook to the Iron Age: The Archaeology of the Pre-Colonial Farming Societies in Southern Africa, 2007)

11.11 Visual Aspects

The landscape is typical of the South African Highveld with gradual rolling hills and valleys dominating the landscape. Old mining activities, agriculture and industrial buildings encapsulate the landscape evoking a feeling of a landscape that has largely been disturbed. The landscape can be described as ordinary with a weak sense of place.

11.11.1 Visibility, Visual Receptors, Visual Exposure and Visual Intrusion

The visibility of a project is the geographic area from which a project or object is visible (Oberholzer, 2005) and is illustrated by the viewshed model. The viewshed model only considered the topography of the area and did not take into account vegetation or manmade structures that may potentially conceal the pipelines. The viewshed model can therefore be considered a worst-case scenario and assumes that the entire pipelines will be present in the area for the duration of the project, even though the pipelines will be constructed in sections.

Visual exposure is the relative visibility of a project or feature in the landscape (Oberholzer, 2005). Visual exposure of objects decreases exponentially as the distance between visual receptors and the object of visual concern increases. Visual exposure is anticipated to decrease dramatically as one move further away from the pipelines; as the pipelines is relatively small in diameter (300 mm) with a height of 1 m above the ground.

The viewshed indicated that the proposed pipelines may potentially be seen by a number of visual receptors. These include houses and holiday homes located towards the north and northwest, farm houses in the west, and a school and Sasolburg residents in the east. Furthermore, the R59 being a major road connecting the N1 to Sasolburg could potentially be impacted upon.

The visual exposure of the pipelines is expected to be low to negligible on the houses and holiday homes in the north and northwest as they are located more than 250 m from the pipelines, with most being concealed by trees. Farm houses in the west are expected to have a medium to high exposure, while motorists travelling along the R59 will experience a high visual exposure. Sasolburg residents and the school are likely to receive a low to negligible visual exposure as trees are present on the periphery of the town and school.

Visual intrusion is the level of compatibility or congruence of a project with the particular qualities of the area, or its 'sense of place' (Oberholzer, 2005).

Due to the ash backfilling project being located in a disturbed landscape, with existing pipelines and infrastructure present, it is expected that the proposed pipelines will have a low visual intrusion on the surrounding landscape.

11.12 Socio-Economic Environment

11.12.1 Regional Administrative Overview

The project area falls under the jurisdiction of the Metsimaholo Local Municipality (MLM), which is situated in the northern part of the Fezile Dabi District Municipality (FDDM). The FDDM is one of five district municipalities in the Free State Province and its towns are Sasolburg, Deneysville, Oranjeville and Viljoensdrift. Fezile Dabi covers an area of about 21 300 km^2 and has a population of approximately 500 000 people (just less than a fifth of the province's population), resident in 38 different settlements, four of which are farming settlements, 15 formal urban towns, 17 urban townships and two informal urban settlements.

11.12.2 Regional and Local Socio-Economic Overview

The MLM has a total population of just more than 149 000 individuals divided into almost 45 800 households. About 62% of the local municipality's population are resident in the informal settlement of Zamdela. An additional 14% of the MLM's population resides in Sasolburg and 7% in Ward 14 (the ward in which the proposed Sasol Sigma ash backfilling project infrastructure will be located).

11.12.3 Demographic Characteristics

The age distribution in the site-specific and local study areas is largely similar: about a tenth of the population is aged five years or younger, roughly a fifth of school-going age (between six and 18 years), about two-thirds potentially economically active (aged 19 to 65 years), and between 3% and 6% are pensioners (aged 66 to 80 years). A very small percentage of the population (1% or less) is older than 80 years. The gender distribution is equal in all the areas under consideration, with the exception of Zamdela where 51% of the residents are male.

Afrikaans and Sesotho are the dominant languages in both the MLM and the study areas under consideration: Afrikaans is spoken by 73% of residents in Ward 14 and 58% in Sasolburg. Sesotho is the first language of about 70% of the population in Zamdela, as well as about a fifth of Sasolburg's population. English is the first language of about 7% of residents in Sasolburg, 11% in Ward 14, and only 1% in Zamdela.

11.12.4 Education

Individuals resident in Ward 14 and Sasolburg are better educated than those in Zamdela, where only 36% of individuals have either completed their secondary or tertiary education (compared to nearly three-quarters in both Ward 14 and Sasolburg). The proportion of the population with either no schooling (5%), or only some primary schooling (14%) is also much

higher in Zamdela than the other areas. However, indications are that this discrepancy is being addressed among the younger generation, as 94% of individuals in Zamdela aged six to 18 years were attending school in 2011, compared to 96% in both Sasolburg and Ward 14.

11.12.5 Employment and Income

At a local municipal level, 23% of the population between the ages of 15 and 65 is either unemployed or classified as “discouraged work-seekers”, while a further 34% are not economically active. This leaves only 43% of the population actively contributing to the MLM’s economy. These statistics mimic that of Zamdela, where only 40% of residents between 15 and 65 years are employed, 28% either unemployed or “discouraged work-seekers”, and 31% not economically active. In Ward 14 and Sasolburg, 68% and 58%, respectively, are employed. Of those who are employed, almost 90% in Ward 14 and Sasolburg, and 76% in Zamdela are employed in the formal sector, likely due to Sasol Mining being a major employer in the area.

In the local study area, the average household income is lowest in Zamdela, where approximately 14% of households have no income, and a further 30% a monthly income of R1 600 or less. An additional fifth of the population have a monthly income of R3 180 or less.

The income levels of Ward 14 are comparable to that of Sasolburg, where the largest proportion of households receives a monthly income of between R12 821 and R25 630. Despite the higher average household income, these two areas are also confronted with poverty, evidenced by almost 10% of its households not receiving any cash income. Of individuals between the ages of 19 and 64 years, 22% in Ward 14 have no income, 26% in Sasolburg and 47% in Zamdela.

11.12.6 Access to Infrastructure and Services

Sasolburg is the best serviced of the three areas under consideration; almost all the households (99% or more) resident in Sasolburg live in formal dwellings, and have access to electricity, a flush toilet, a refuse removal service and piped-water from a water scheme operated by the municipality or another water services provider. Service provision in Ward 14 is comparable to that of Sasolburg, with the exception of access to piped water and a refuse removal service. As the ward consists of mostly agricultural land, however, this is not necessarily a reflection of poor service provision; it is likely that households in this ward make use of borehole water.

As a lower-income residential area, it is not surprising that service provision is poorer in Zamdela than Sasolburg, although it is by no means unacceptable. More than 95% of household resident in Zamdela have access to electricity, refuse removal and piped water. However, there are more informal settlements in Zamdela (approximately 14% of dwellings), and about one in five households do not have access to a flush toilet.

With regards to housing, the MLM is experiencing a backlog of about 40 000 houses, which is increasing at the rate of about 3 000 houses annually (MLM, 2012). In Zamdela, there is

an estimated need for about 15 000 houses. Both Sasolburg and Zamdela are currently constrained for future growth by the undermined areas and by future mining prospecting opportunities located in and around the town. In response to the housing provision backlog, many people often are drawn to settle illegally on private or public property and provide themselves with inadequate, informal and illegal housing on informal or illegal settlements (MLM, 2012).

11.13 Description of the Current Land Uses

The proposed underground study area is located adjacent to the town of Sasolburg in the Fezile Dabi District Municipality, Free State Province. It is situated just south of the Vaal River Barrage and west of the R57 highway. The ash backfilling is proposed to be undertaken within the Sigma Dunct Colliery within existing servitudes and already disturbed areas. The land uses which have been identified include the following:

- Underground, opencast coal and sand mining;
- Agricultural (Maize) and Cattle Farming; and
- Roads, powerlines, bridges and railway lines.

11.14 Description of Specific Environmental Features and Infrastructure on the Site

The following environmental features and infrastructure have been identified within the proposed project footprint.

11.14.1 Water Resources

The current water uses are linked to land uses. Identified activities during the fieldwork were:

- Agricultural use for livestock;
- Wildlife;
- Industry;
- Domestic water use at settlements; and
- Sand mining activities in the Leeuspruit catchment.

Downstream impacts of the sand mining are already evident as indicated in Figure 11-28, shown by the murky water with evidence of algal growth. The algal growth can be attributed to the impacts form agricultural activities and sewage bursts in the vicinity and upstream.

The landscape is dominated by maize, wheat and livestock farming in the central, western and southern areas; urban built-up areas to the east and sand mining activities to the north and east.

Figure 11-28: A Location on Leeuspruit Downstream of the Sand Mining and Agricultural Activities at Pipeline Stream Crossing

It is proposed that the pipelines will cross these rivers in multiple locations. Plan 14, Appendix B indicated where the pipelines will cross the Leeuspruit and the Rietspruit. The river systems located within the Sigma Defunct Colliery is considered to be heavily impacted upon due to the mining and farming activities located within the area. Eighteen pipeline stream crossings were identified, with major crossing on the Leeuspruit at an existing conveyor crossing point.

11.14.2 Wetlands

The National Freshwater Ecosystem Freshwater Priority Areas (NFEPA) database identifies the wetlands on site as belonging to category six, implying no particular national significance. There were 1284.8 hectares of wetlands identified on site. Two major wetland systems were identified within the pipeline routes, namely the Leeuspruit and the Rietspruit, both tributaries of the Vaal River. These two systems consist of floodplain, channelled valley bottom and hillslope seepage wetlands. In addition, depressions / pans are found scattered throughout the landscape.

The wetlands on site have undergone considerable alterations from their natural reference state owing to the land use activities within and surrounding them. The major impacts were related to agriculture, sand mining and historical mining activities, development, informal settlements and collapse of unconsolidated surfaces. In addition, the presence of roads crossing wetland areas perpendicularly has caused compaction and impeded natural flow of water. Subsidence occurs throughout the landscape and this may result in the formation of additional artificial wetlands in depressions. Wetlands were grouped according to the wetland systems to which they belong and were allocated Present Ecological State (PES) scores. All wetlands associated with the Leeuspruit were allocated a PES of D, suggesting these systems to be largely modified. Wetlands associated with the Rietspruit were allocated a PES of E (seriously modified) and depression / pans were assigned a C (moderately modified).

With regard to functionality, the EcoServices assessment indicated that wetlands associated with the Leeuspruit provide services related to sediment trapping, nutrient processing, and stream-flow regulation efficiently. The Rietspruit wetlands showed high service provision for flood attenuation, nutrient processing and toxicant removal. Depressions / pans in particular are important habitats for amphibians and water birds. Plan 18, Appendix B identifies all the wetlands that will be crossed by the proposed pipeline routes.

11.14.3 Cultural Heritage

Thirteen previously-completed Heritage Impact Assessment (HIA) reports were reviewed for the study area. These identified a wide range of tangible heritage resources within the general region. Overall, the identified heritage resources were considered to have low CS, with the exceptions of burial grounds and graves and an engraving site.

Van Schalkwyk and Naude (1996) identified MSA, LSA and LFC resources as well as historical burial grounds and structures on the farms Rivierplaats No. 404, Rietfontein No. 123, Uitkomst No. 413, Petronella No. 313 and Boschbank No. 12. These finds included MSA scatters on the surface and one LSA site. The LFC was represented by two stonewalled settlements, possibly linked to the Vredefort Dome / Type Z settlements described by Maggs (1976).

At least one rock art site is known to exist near Vereeniging. This includes the Leeuwkuil engraving site and is discussed by Hollman (1999). The site comprises at least 24 engravings, most of which are eland, but also includes other antelope and one rhinoceros. Leeuwkuil is situated on a small island in the Vaal River north of the Ascot Bridge.

Dreyer (2005a; 2005b) surveyed the farms Grootfontein No. 425, De Rust No. 370 and Amelia No. 518. Historical heritage resources were identified on these farms which includes burial grounds, a memorial and the stone foundations of a historical structure. Van der Walt and Birkholtz (2005) undertook a survey near Vereeniging and noted that the survey area was a focal point for historical mining activity. Their survey showed that the historic structures had been demolished and only remnants remained. In addition, Van der Walt and Birkholtz identified three burial grounds, the ruins of other historical structures including

remnants of an old mine shaft, a rubbish dump and a water tower. They also reported foundations and middens associated with mine workers' housing.

Van Schalkwyk (2006) surveyed the farm Lucina No. 214, during which he noted the presence of demolished structures and a large burial ground.

Van Ryneveld (2007) surveyed the remainder of the farm Mooidraai No. 44 and noted five heritage sites. Of these, four were termed 'contemporary' and were excluded from the assessment. The fifth resource was the foundation of an original farm homestead, which afforded general protection under Section 34 of the NHRA.

Birkholtz and James (2008) completed a survey of the farm Leitrim No 926 during which they identified two heritage resources. These included an original farm werf that was established in 1940 and an associated burial ground.

Rubidge (2008) and Pistorius (2008) undertook an extensive linear survey from Secunda to Sasolburg, focused on the palaeontology and tangible heritage respectively. Rubidge indicated that no fossils are known to exist in the Ventersdorp and Transvaal Supergroups, due to the age of these geological features. Although, Glossopteris is known to occur in the Vryheid group with important localities near Vereeniging, the thick soil layers covering this rock reduces any potential finds. Pistorius identified several historical sites and burial grounds and graves. No resources associated with the Stone Age or Farming Community periods were reported.

Van der Walt (2009) surveyed a portion of the farm Boschbank No. 12 and identified a large burial ground. A large burial ground was also identified on Portion 9 of the farm Reitfontein (Van der Walt, 2011).

Surveys undertaken on the farm Erina No. 121 revealed no heritage resources (Van der Walt, 2008a; Van der Walt, 2008b) or Portion 3 of Wonderfontein 350 (Van der Walt, 2009).

All identified sites are presented in Appendix C of the heritage specialist study (Appendix H). Plan 13, Appendix B provides the location of all identified heritage resources.

The pre-disturbance survey was conducted on 25 September 2013. No tangible heritage resources that could potentially be impacted by the propose project were identified. Similarly, no outcrops of palaeontologically-sensitive rock were noted.

The site had been subject to degradation due to agriculture, urbanisation, mining, industrialisation and expanding road infrastructure.

The survey confirmed that all the proposed pipeline routes are located within existing servitudes or along farm boundary fences. The areas earmarked for ash backfilling and for the drilling of underground voids are located in cultivated fields or old mine workings.

Figure 11-29 to Figure 11-38 below depicts the general landscape as was recorded during the screening survey.

Figure 11-29: Typical natural landscape in Sigma Defunct Colliery project area

Figure 11-30: Open cast pit area and tailings

Figure 11-31: Rehabilitated area between fence and tailings

Figure 11-32: One two buildings in the project area. The pipeline will be placed in the servitude (cf. Figure 11-33)

Figure 11-33: Example of pipe line route on old mine road

Figure 11-34: General view of existing ash pipeline

Figure 11-35: Detail of existing ash pipeline. Note the low impact on the landscape

Figure 11-36: Example of a booster pump station located on the existing pipeline route

Figure 11-37: Detail of area where subsidence has occurred

Figure 11-38: Example of proposed pipeline routes following farm boundary fence

11.14.4 Infrastructure and Facilities

The following infrastructure is currently located onsite:

- Farms with associated infrastructure;
- Bridges and culverts;
- Powerlines to supply power to the various farmers and industries being operated within the mining lease area;
- Regional and secondary roads;
- Historical mining voids, mine dumps and current mining operations (3 Shaft); and
- Rehabilitated areas which include shafts and open cast mining areas.

11.15 Environmental and Current Land Use Map

Refer to the environmental and current land use map Plan 17 in Appendix B.

The landscape is dominated by maize, wheat and livestock farming in the central, western and southern areas; urban built-up areas to the east and mining activities to the north and east. The general topography of the landscape in which the ash backfilling project is located can be described as undulating and sloping towards the Vaal River. The Digital Elevation Model (DEM) and slope models indicated that mining activities have significantly altered the topography and surface water flow in the north and east. Two gradual valleys carrying the Leeuspruit and Rietspruit streams run parallel to each other in a southeast northwest direction towards the Vaal River. Elevation within these river valleys varies from around 1430 m at the valley bottoms to 1490 m at the valley tops. Slopes are mostly flat across the landscape except for isolated pockets of steeper slopes along the banks of the Vaal River and where mining activities have taken place.

Years of underground Mining at the Sigma Defunct Colliery has resulted in large subsided areas with the potential for further subsidence occurring in the future. Ash backfilling along the R59 near Sasolburg has yielded positive results in stabilising the topography (ARQ, 2003). Subsidence is a risk to households, farmers, heritage resources and the environment.

12 Impacts and Risks Identified Including the Nature, Significance, Consequence, Extent, Duration and Probability

This section aims to rate the significance of the identified potential impacts and risks pre-mitigation and post-mitigation. It should be noted that an impact arises from a planned event while a risk arises from an unplanned event. Therefore both risks and impacts have been assessed below to ensure sound environmental management practices.

The potential impacts/ risks identified in this section are a result of both the environment in which the project activities take place, as well as the actual activities. The potential impacts/ risks are discussed per aspect and per each phase of the project i.e. the Construction Phase, Operational, Decommissioning and Post Closure Phases.

The following activities for the proposed ash backfilling project that has been assessed are listed below.

Table 12-1: Project Activities

Project Phase	Project Activity
Construction Phase	▪ Site establishment; ▪ Site clearing, including the removal of topsoil and vegetation; ▪ Construction of the pipeline, including a small maintenance road and pump station; ▪ Drilling of cased boreholes to pump the ash slurry underground; ▪ Construction activities within a water courses and wetlands; ▪ Temporary storage of hazardous products, including fuel; and ▪ Storage of waste.

Project Phase	Project Activity
Operational Phase	▪ Mixing of water and ash to form ash slurry; ▪ Pumping of slurry from the pump station to the underground workings via boreholes; ▪ Transfer of slurry via pipeline within mining lease area; and ▪ Pumping of water from underground workings via the boreholes to water treatment plant.
Decommissioning Phase	▪ Demolition and removal of all infrastructure, including transporting materials off site; ▪ Rehabilitation, including spreading of soil, re-vegetation and profiling or contouring; ▪ Environmental monitoring of decommissioning activities; ▪ Storage, handling and treatment of hazardous products (including fuel and oil) and waste; and ▪ Post-closure monitoring and rehabilitation.

A list of unplanned events that may happen at the project site have been identified and the proposed mitigation plan are listed in Part B Table 10-2.

12.1 Construction, Operation and Decommissioning Phases

The impacts associated with the ash backfilling project construction phase have been discussed in Table 12-2. The impacts associated with the ash backfilling project operational phase have been discussed in Table 12-3 and the impacts associated with the ash backfilling project decommissioning phase have been discussed in Table 12-4.

No heritage resources were identified within the site-specific study area and therefore no direct impact to heritage resources is envisaged. No surface outcrops of the palaeontologically significant layers were identified during the pre-disturbance survey. The project is understood to have superficial surface disturbance. It is therefore unlikely that the Project will impact on the palaeontologically-sensitive layers of the Vryheid Formation. As no impact to heritage resources is envisaged, no impact assessment has been undertaken. However, mitigation measures are proposed which have been incorporated with in Part B Section 5 and 6.

Table 12-2: Impact Assessment Associated with the Construction Phase of the Ash Backfilling Project

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Surface Water	Alteration of the natural hydrology or disturbance of natural stream and flows	2	3	3	6	48	Medium-Low	▪ Prioritize backfill at the potential subsidence areas to reduce or minimize the potential hydrological modifications ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures that allows the pipeline to cross at an elevation above the natural water level	2	3	3	3	24	Low
Construction Phase	Construction of the pipeline and associated clearance activities	Surface Water / Aquatic Ecology	Potential sedimentation and contamination of water from hydrocarbons, as a result of the construction vehicles utilised. This can result in Sedimentation of the associated watercourses and Water quality impairment	3	3	4	6	60	Medium-Low	▪ Develop soil management measures for the construction area/s that will prevent an increased runoff into the associated watercourse, such as the construction of trenches and/or the use of silt curtains; ▪ Erosion control structures and mechanisms, such as surface stormwater drainage systems, should be implemented so as to reduce the potential occurrence of erosion and sedimentation within and adjacent to the associated watercourses; ▪ The disturbance of instream channels and riparian zones must be minimized, where possible; ▪ Vehicles must be maintained according to their maintenance plans; ▪ Stationary vehicles should have a drip tray placed below the machine; ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Surface water draining off contaminated areas containing oil and petrol would need to be channeled towards a sump which will separate these chemicals and oils; ▪ Portable septic toilets are to be provided and maintained (including their removal without sewage spillage) for construction crews outside of the 1-100 year floodline; ▪ Store all litter carefully so it cannot be washed or blown into any of the watercourses within the study area; ▪ Extra precautions should be taken in areas within 500 meters of the Leeuspruit or Rietspruit to prevent any potential impact to the water courses	3	2	4	3	27	Low

[4] Duration
[5] Spatial Scale
[6] Severity
[7] Probability
[8] Significance

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										this includes effective stormwater control measures around the areas where the pipeline is being constructed to prevent sedimentation of the rivers.						
Construction Phase	Construction of the pump booster station	Surface Water	The booster pump station will entail the use of hydrocarbon lubricants for the machine moving parts, which, if not well maintained, could be a source of hydrocarbon contamination. Accidental spillage of hydrocarbon containing materials such as oils or lubricants may occur.	5	3	5	3	39	Medium Low	▪ As the booster pump station already exists (with bunding and foundations), clean-up kits for accidental spillage must be available on-site to prevent the spread of accidental spillages and associated impacts. ▪ The mine personnel must be trained for clean-up of and report hydrocarbon containing material spillages.	5	3	2	1	10	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of wetland area is anticipated to occur due to excavation during construction of the proposed ash backfilling pipeline, as the wetlands will be intersected at 31 points.	5	3	3	7	77	Medium-High	▪ The pipeline may not be constructed within 100 metres of a wetland buffer with the exception of the various wetland crossing; ▪ Pipeline crossings over wetlands should be above ground on supports so that any damage to the pipes can be detected and minimal wetland area is removed for the pipeline construction; ▪ Erosion control measures should be implemented by re-seeding bare areas of wetland and grassland buffer strips with mixed seed spray of indigenous sedges and grasses;	5	1	1	7	49	Medium-Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of Wetland vegetation	5	3	3	5	55	Medium-Low	▪ The pipeline route should be designed in such a way that the route of existing infrastructure such as roads and bridges is utilised so that further infringement of infrastructure into the wetland is avoided. ▪ Ensure minimal wetland area is removed for the pipeline construction.	5	1	1	5	35	Low
Construction Phase	Construction of the ash backfill pipeline will lead to the direct loss of the vegetation on site.	Fauna and Flora	Loss of Plant Communities	3	3	3	5	45	Medium-Low	▪ The pipeline route should follow existing roads, servitudes and pipeline routes as far as possible. ▪ The areas of Moderately High Sensitivity (wetlands and riparian edges) and Medium (Secondary Grassland and Degraded Woodland/Savanna) must be avoided ▪ All Highly Sensitive Areas should be avoided and these include all Wetland and Riparian habitat on site. ▪ Restrict access to areas that are not to be disturbed from the pipeline construction ▪ Ensure an alien invasive species management plan is compiled and implemented to prevent the spread of invasive species along the pipeline route.	3	3	2	5	35	Low

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										▪ Keeping clearing of vegetation to a minimum. Excessive vegetation clearance must not be permitted.						
Construction Phase	The construction of the backfill pipeline will result in the loss of certain biodiversity aspects.	Fauna and Flora	Loss of biodiversity	3	3	3	5	45	Medium-Low	▪ If encountered all Species of Special Concern (SSC), as well as the immediate habitat surrounding them, should be preserved and construction of the pipeline should be restricted to areas outside of their immediate habitat. ▪ In the case where this is not possible, and all efforts to avoid these areas have been exhausted, permits may be applied for from the provincial authorities to translocate these species. ▪ It is imperative that the habitat in which these species are translocated to is as similar to the donor habitat as possible and is also within close proximity to the site.	3	3	2	5	35	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	5	4	4	4	52	Medium-Low	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation; ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction; ▪ Limit the footprint area of the construction activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas); ▪ If it is unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated; ▪ Ensure that no incision and canalisation of the wetland features present takes place; ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; ▪ Soils which were compacted as a result of construction activities should be ripped/scarified (<300 mm) and profiled; ▪ A suitable Alien Invasive Plant (AIP) control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all freshwater features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;	5	2	2	3	27	Low

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the project area; ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or river courses and their associated zones of regulation. All vehicles must remain on demarcated roads and within the construction footprint; ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All spills should be immediately cleaned up and treated accordingly; ▪ Wetlands should be monitored weekly during construction; and ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.						
Construction Phase	Construction of the Pipeline and associated clearance activities	Soil, Land Use and Land Capability	During the pipeline construction, soil erosion and contamination are possible. The soil impacts may be a result of vegetation (where applicable) and topsoil removal for the pipeline and laydown areas, as well as compaction caused by vehicle and machinery onsite.	2	2	4	5	40	Medium-Low	▪ The pipeline must be constructed in sections not exceeding 100m per section. A maximum of three sections may be active at the same time, by the undertaking of one of the following activities per section: ▪ Vegetation Clearance; ▪ Installation of the pipeline; or ▪ Remediation of the footprint. ▪ Where the pipeline has been constructed within the road reserve and no vegetation is present, the area should be rehabilitated and soil compacted. No vegetation is required to be established within these areas; ▪ Suitable stormwater management measures must be implemented to prevent the loss of soil during rainfall events; ▪ All surfaces that are susceptible to erosion shall be covered with a suitable vegetative cover as soon as construction is completed. ▪ Rehabilitation to be monitored on an annual basis for three years on completion of the construction phase; ▪ Areas where vegetation is cleared (either for the pipeline where vegetation is present or for the laydown area), should be rehabilitated with a suitable vegetation cover once constriction has been completed; and ▪ Stockpiling of the pipes to be installed must be limited to only what is required and only be stored	2	2	2	3	18	Low

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										in designated areas to avoid any unnecessary soil compaction.							
Construction Phase	Construction of the Pipeline and associated clearance activities	Air Quality	Dust generated from site clearing, vehicle movement and the construction of the pipeline.	2	3	2	6	42	Medium-Low	▪ The disturbed areas must be kept to a minimum and it is advised to not clear vegetation unnecessarily; and ▪ Water or a chemical dust suppressant should be used to dampen dust generating areas such as areas where soil has been exposed.	2	3	2	4	28	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Groundwater	Contamination of groundwater due to hydrocarbon spillages.	2	2	4	4	32	Low	▪ Machinery should be maintained properly; diesel or other chemicals should be handled appropriately and not spilled. ▪ Re-fueling protocols must also be followed to ensure no diesel is spilled during re-fueling. ▪ Storage tanks must be in a bunded area. ▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed at an acceptable dumping facility. ▪ Construction vehicles and machinery repairs must only take place in designated workshop areas. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Groundwater monitoring, to assess the time series water quality impacts and trends.	2	1	3	1	6	Low
Construction Phase	Drilling of boreholes	Groundwater	Groundwater quality deterioration, due to ash spillage on the surface and leakage through poorly constructed boreholes	2	2	4	4	32	Low	▪ Backfilling boreholes should be constructed with solid casing from the top to end, to avoid cross contamination and transportation of the ash slurry from the backfilling borehole via preferred pathways; ▪ Boreholes should be equipped with lockable security caps; ▪ It is recommended that backfilling boreholes should be drilled in approximately 300 m intervals along the pipeline route. ▪ Once boreholes have been drilled the area around the borehole must be rehabilitated back to its existing state. All evidence of drilling activities must be removed.	2	1	3	1	6	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Social	Creation of jobs during the construction phase of the pipeline	2	3	1	5	30	Low (Positive)	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, construction workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community	2	3	2	6	42	Medium-Low (Positive)

Phase	Activity	Aspect	Impact	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										representatives and local government.						

Table 12-3: Impact Assessment Associated with the Operational Phase of the Ash Backfilling Project

Phase	Activity	Aspect	Impact	D[9]	SS[10]	S[11]	P[12]	S[13]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
Operational Phase	Ash backfilling project	Aquatic Ecology	Effects of impaired water quality on aquatic biota should a sudden burst in the pipeline occur. Coal Ash contains many toxic elements (salts high pH and metals) which are leachable and have the potential to impact directly on aquatic ecology	5	4	7	7	112	High	▪ Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report for Ash Backfilling Methodology); ▪ Surface pipelines should be inspected for leaks on a weekly basis; ▪ Cut off valves should be installed on the pipeline to be operated in the event of a spillage; ▪ All boreholes and potential decant points should be identified and secured before the ash backfilling occurs; ▪ Aquatic bi-annual biomonitoring (wet and dry season) should be conducted for the duration of the project as well as after the project is completed; ▪ If ash spills occur the following mitigation is recommended: ▪ Contain the ash using berms and cut off trenches and create emergency shutoff points that should be activated; ▪ Ash within the river reaches should be removed by mechanical means; and ▪ Investigate potential emergency temporary storage areas should the ash need to be redirected.	4	4	5	3	39	Medium-Low
Operational Phase	Ash backfilling project	Aquatic Ecology	The project has the potential to alter aquatic habitat through the influx of fine particulate matter in the form of ash. Ash, if present near to the river systems, will settle in local river systems and cover available habitat thus reducing diversity and restricting the presence of habitat sensitive species.	5	3	5	4	52	Medium-Low		5	3	5	3	39	Medium-Low
Operational Phase	Ash backfilling project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could	3	6	6	5	75	Medium-High	▪ Surface pipelines should be inspected for leaks on regular basis (weekly); ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures or other material to make sleeves which can contain material from spillages and prevent surface water contamination; ▪ Cut off valves should be installed on the pipeline with pressure sensors, which stop the flow in the event of a spill;	2	3	6	2	22	Low

[9] Duration
[10] Spatial Scale
[11] Severity
[12] Probability
[13] Significance

Phase	Activity	Aspect	Impact	D[9]	SS[10]	S[11]	P[12]	S[13]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
			be seen at the farm dams and surrounding tributaries. ▪ Introduction of pollutants in the form of dissolved metals, suspended solids/ particulate matter and salts form ash slurry							▪ If monitoring of surface or ground water indicates exceedances in accordance with the approved IWUL criteria, an investigation into exceedances must be undertaken to understand the cause and determine if related to ash backfilling. If so then relevant authorities need to be notified within 24 hours and an action plan compiled and implemented. ▪ Monitoring of potential surface water contamination is vital. Local river systems, as well as boreholes should be monitored on a regular basis (Monthly during ash backfilling, Quarterly on completion of Ash Backfilling and Bi-annually when no impacts are detected for a period of three years after the project has ceased); ▪ If ash spills/ leakage occurs the following mitigation is recommended: ▪ Contain the ash as much as possible using berms and cut off trenches; ▪ Ash which is present within the river reaches should be removed by mechanical means; and ▪ Accidental spillages or leaks or pipe bursts should be reported and downstream users cautioned until any potential impacts are remediated; ▪ The IGS report for backfilling methodology (Lukas et al. 2013) indicates that the risk of decant is minimal when using the proposed methodology. However if any emerging decant points are observed during operation, monitoring and mitigation should be implemented weekly until impacts are negated. Backfilling should be carried out under the guidelines of this report. ▪ In the event that decant occurs, it could be collected to prevent it from freely flowing into the catchment and collected and treated before disposal. ▪ Flow meters must be installed at either end of the pipelines to ensure that the same amount of slurry leaving the pump station, enters the underground workings; ▪ These reading should be taken on a daily basis and reported on monthly to Sasol headquarters. Additionally these readings should be incorporated into the quarterly surface and groundwater monitoring report currently being undertaken for Sigma Defunct Colliery which must be submitted to DWS; ▪ Comparisons between the volumes dispensed and received should be made to ensure no leaks in the pipeline have occurred;						
Operational Phase	Ash backfilling project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Changes in the natural pH to alkaline resulting in mobilisation of certain elements	4	5	5	3	42	Medium-Low		2	3	3	2	16	Low
Operational Phase	Ash backfilling project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Water contamination from the underground mine water pumped out, in the case of a burst pipe	4	6	6	5	80	Medium-High		3	3	4	2	20	Low
Operational Phase	Ash backfilling project	Surface Water	The pipeline could impede flows in the catchments where they	4	4	5	5	65	Medium-Low		2	3	2	3	14	Low

Phase	Activity	Aspect	Impact	D[9]	SS[10]	S[11]	P[12]	S[13]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
			traverse streams and drainage lines. Impacts could arise if pipes containing slurry burst and large amounts spill on or close to stream crossings. These could result in particulate matter sedimentation in stream channels which could alter the hydrology.							▪ Should a variation be identified, further investigation must be undertaken to identify the location of the leak. Any leaks in the pipeline must be repaired immediately. ▪ Dirty water may not be permitted to be discharged to the environment.						
Operational Phase	Ash backfilling project	Surface Water	A positive impact where the topography can be maintained; further reducing natural landscape modifications.	5	6	4	7	105	Medium-High (Positive)	▪ No mitigation measures required as it is considered to be a positive impact	5	6	4	7	105	Medium-High (Positive)
Operational Phase	Ash backfilling project	Wetlands	Leakages in the pipeline at one of the 31 wetland crossing points may result in surface water contamination due to heavy metals that may be contained in the fly-ash. This can result in chemical contamination of wetlands and reduces its functionality	6	6	6	5	90	Medium-High	▪ It is recommended that the methodology proposed for backfilling by IGS (Lukas et al. 2013) is adhered to in order to prevent spillage into wetland areas as far as possible. All voids located in proximity to wetlands that contain boreholes or subsided areas should not be filled unless the risk of indicates that this risk of spilling into the wetland has been investigated. ▪ All pipeline crossings over wetland areas should be monitored for spillage weekly and any damage or spillage should be reported and addressed with urgency.	2	2	4	3	24	Low
Operational Phase	Potential spills or leaks from pipeline infrastructure and resulting disturbance to soils	Flora and wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of sensitive species; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	5	4	4	4	52	Medium-Low	▪ All erosion noted within the operational footprint as a result of surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan; ▪ A suitable AIP control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all wetland features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines; ▪ All spills from maintenance vehicles or leaks from the pipeline should be immediately cleaned up and	5	2	2	2	18	Low

Phase	Activity	Aspect	Impact	D[9]	SS[10]	S[11]	P[12]	S[13]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										treated accordingly; and ▪ Monitor all systems for erosion and incision						
Operational Phase	Ash backfilling project	Soil, Land Use and Land Capability	Loss of vegetation along the pipeline route resulting in soil erosion	6	1	3	5	50	Medium-Low	▪ Continuous inspections of the pipeline route should be undertaken to ensure that soil erosion has not occurred along the pipeline route; and ▪ Areas where erosion has occurred should be rehabilitated.	6	1	2	3	27	Low
Operational Phase	Dewatering	Groundwater	Groundwater quantity impact	5	3	3	5	55	Medium-Low	▪ It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows. ▪ The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash. ▪ During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level.	5	2	1	3	24	Low
Operational Phase	Ash backfilling project	Groundwater	Groundwater quality impact	3	2	6	5	55	Medium-Low	▪ After the ash backfilling commences, the pipeline should be inspected for any potential leak. A monitoring system to continuously monitor the flow between the pump station and the ash backfilling borehole should be installed. ▪ Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes. ▪ For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1. Thus the ash material is non-acid forming. Consequently, backfilling of ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation.	2	2	6	2	22	Low

Table 12-4: Impact Assessment Associated with the Rehabilitation and Decommissioning Phase of the Ash Backfilling Project

Phase	Activity	Aspect	Impact	D[14]	SS[15]	S[16]	P[17]	S[18]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Surface Water / Aquatic Ecology	Potential contamination of water from hydrocarbons, as a result of the vehicles utilised during decommissioning.	3	2	4	6	48	Medium-Low	▪ Care should be taken not to impact areas that have remained un-affected throughout the life of the project. ▪ On-going remediation should be conducted throughout the decommissioning and closure phase. Only the removal of remaining infrastructure and re-shaping the final topography should occur during the closure phase. ▪ Repairs on vehicles and machinery utilised during decommissioning and rehabilitation must only take place in the designated workshop areas. ▪ Vehicles must be maintained according to their maintenance plans. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Continuous post-closure monitoring is required so that drastic deterioration in surface and groundwater quality is detected as soon as it occurs, allowing for mitigation measures to implemented early. Monitoring is recommended to be conducted until satisfactory groundwater quality is reached and thereafter signed off by the relevant authorities. Should an impact be detected through monitoring, affected receptors should be compensated and monitoring programme should be adapted to assess potential changes within the study area. ▪ As an additional consideration, is recommended that geotechnical surveys are undertaken on a regular (every two years) basis to ensure the stability of the potential subsidence areas following the ash-backfilling project.	2	2	4	3	24	Low

[14] Duration
[15] Spatial Scale
[16] Severity
[17] Probability
[18] Significance

Phase	Activity	Aspect	Impact	D[14]	SS[15]	S[16]	P[17]	S[18]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Soil, Land Use and Land Capability	The underlying soil will be compacted and susceptible to erosion. Topsoil will need replacement on the pipeline route. Hydrocarbon spillages from vehicles and machinery used during decommissioning could contaminate soil resources.	2	2	4	5	40	Medium-Low	▪ Immediately clean up any hydrocarbon spills in accordance with the hydrocarbon Standard Operating Procedure (SOP). ▪ Vehicles and machinery must be serviced in bunded areas. ▪ Suitable stormwater measures must be implemented to prevent the loss of soil to soil erosion. ▪ The pipeline should only be removed in sections. Once a certain area has been decommissioned and rehabilitated the next section can be removed to prevent extended impact to soil. ▪ Soil should be stockpiled and utilised to rehabilitate the area once the pipeline has been removed. ▪ Areas should be rehabilitated and vegetation allowed (where vegetation was previously cleared during decommissioning) to grow immediately after the pipeline has been removed;	2	2	2	3	18	Low
Decommissioning Phase	Site access roads and pipeline crossing wetlands, Removal of infrastructure and rehabilitation	Flora & Wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Loss of natural vegetation; ▪ Increased sedimentation; ▪ Increased potential for onset of erosion; ▪ Potential dumping of decommissioned infrastructure in wetland/riparian areas; and ▪ Potential incomplete removal of infrastructure.	5	4	4	4	52	Medium-Low	▪ Limit the footprint area of the decommissioning and rehabilitation activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan. ▪ All soils compacted as a result of decommissioning activities should be ripped/scarified (<300 mm) and profiled. ▪ Permit only essential personnel within the zones of regulation for all freshwater features identified. ▪ Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream. ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines. ▪ Wetlands and their associated zones of regulation are to be clearly demarcated and avoided wherever possible. ▪ An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases. ▪ As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils,	5	2	2	3	27	Low

Phase	Activity	Aspect	Impact	D[14]	SS[15]	S[16]	P[17]	S[18]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
										vegetation clearance should be kept to a minimum. ▪ Monitor all systems for erosion and incision. ▪ All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint. ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All existing litter, debris should be removed from the wetland areas and littering should be prohibited on an ongoing basis; ▪ All spills from machinery should be immediately cleaned up and treated accordingly; ▪ Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility.						
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Air Quality	The extent of impacts depends on the extent of demolition and rehabilitation efforts during decommissioning. Impacts of this activity on the atmospheric environment will be similar to the impacts during the decommissioning and rehabilitation phase. The impacts will be short-term and localised.	2	3	2	6	42	Medium-Low	▪ Vegetation establishment (where vegetation was previously cleared away) must take place on the bare soil to prevent soil erosion and dust creation. ▪ Exposed soil must be kept moist using sprays or water tanks to prevent dust creation before vegetation is established (where vegetation was previously cleared away). ▪ Vegetation (where previously cleared) should be planted during the wet season to ensure vegetation establishment and prevent unnecessary costs.	2	3	2	4	28	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quantity impact	4	3	2	4	36	Medium-Low	▪ If decant occurs it should be collected and treated as to avoid having it introducing contamination into surface water bodies.	4	3	1	3	24	Low

Phase	Activity	Aspect	Impact	D[14]	SS[15]	S[16]	P[17]	S[18]	Rating (Pre Mitigation)	Mitigation Measures	D[4]	SS[5]	S[6]	P[7]	S[8]	Rating (Post Mitigation)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quality impact	5	2	3	4	40	Medium-Low	▪ Quarterly groundwater monitoring of the proposed boreholes is recommended until satisfactory groundwater quality is reached and groundwater trends reflect stability for a period of three years.	3	2	1	2	12	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Social	Creation of jobs during decommissioning and rehabilitation phase while the pipeline is being removed	2	3	1	5	30	Low (Positive)	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, workers and other service providers will be recruited surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	2	3	2	6	42	Medium-Low (Positive)

12.2 Cumulative Impacts

Cumulative effects caused by the accumulation and interaction of multiple stresses affect the parts and the functions of ecosystems. Of particular concern is the knowledge that ecological systems sometimes change abruptly and unexpectedly in response to apparently small incremental stresses. For purposes of this report, cumulative impacts have been defined as "the changes to the environment caused by an activity in combination with other past, present, and reasonably foreseeable human activities".

12.2.1 Aquatic Environment

The water courses associated with the current project were determined to be in a Class D/E eco-status. Current conditions in the local aquatic systems are modified with predominantly pollution tolerant species present. Therefore, the project will not further degrade the current aquatic conditions as conditions are at current seriously modified. However, the attainable management class for the C22K catchment is Class C and therefore the associated watercourses should be managed in a way in which the Class C can be attained. However, if surface water contamination occurs it could result in the attainable class being lowered. This will have a high cumulative impact in the catchment. However, if the contamination of the watercourses is avoided through careful mitigation and remediation the project will have no impact on the aquatic ecology. Based on the IGS (2013), Proposed backfilling methodology report, decant into surface water is unlikely and therefore the cumulative impact of the project is low.

12.2.2 Fauna and Flora

It is necessary to consider the impacts that the development will have from a broad perspective, by considering land-use and transformation of natural habitat in areas surrounding the site. Cumulative impacts are assessed by considering past, present and anticipated changes to biodiversity.

Albeit the vegetation types present are in a degraded status, the Soweto Highveld Grassland does fall within the study area. The actual effect in this vegetation type will however be low.

The impacts on the ecology of the area will not be significant, if all backfilling processes go according to plan and no spillages occur. It is expected that there will be losses of vegetation and flora along with associated faunal habitat, in the case of spillages. The primary impacts will be the destruction of all vegetation and animal habitat that is affected during such an occurrence.

12.2.3 Surface Water

The area supplied by the Vaal River System stretches far beyond the catchment boundaries of the Vaal River and includes most of Gauteng. It also supports other socio economic activities namely Eskom power stations and on the Mpumalanga Highveld, the North-West and Free State Goldfields, Kimberley, several small towns along the main course of the river,

as well as irrigation all along the main stem of the river and the large Vaalharts Irrigation Scheme (JJ Van Wyk, et al, 2010).

However, several of these existing activities have been key contributors to pollution including salinization of the integrated Vaal River System from sewage return-flows, AMD and diffuse pollution. The issues important in the Vaal River are:

- Salinity – building up of salts – direct impact on quality;
- Nutrients – P and N creating eutrophication problems; and
- Microbiological – health issues from untreated sewage effluent.

The Vaal River is already experiencing deterioration in water quality. Mitigations measures must ensure potential impacts to the already impacted catchment is minimised or prevented. Ash quality and leachates geochemistry should be fully considered even before the backfilling occurs. The cumulative deterioration of water quality in the quaternary catchment will have compounding impacts and water quality deterioration may be felt at a regional scale.

Positive cumulative impacts could be anticipated if the current subsidence is counteracted by backfilling of voids.

12.2.4 Wetlands

The Leeuspruit and Rietspruit tributaries of the Vaal Barrage are heavily impacted systems; in their current state. Further degradation to wetlands associated with these systems should be avoided. In addition to this, although hillslope seepage wetlands are not found extensively on site, the pipelines are intended to cross seeps leading to valley bottom and floodplains. Hillslope seeps are valued because of the ecosystem services, such as water purification, that they provide to society at no cost. The loss of these systems is regarded as very significant due to the rate at which these systems are being lost as a result of development.

12.2.5 Noise

Cumulative impacts should be considered for the overall improvement of ambient noise levels. The project is considered a causative source of noise pollution of low significance during the construction and operational phases. Because of the lack of other major sources of noise in the immediate area of the project, as well as the low significance of the impact, the project in isolation is not considered a significant contributor to the cumulative noise impacts to the area.

13 Methodology used in Determining and Ranking the Nature, Significance, Consequence, Extent, Duration and Probability of Potential Environmental Impacts and Risks

The impact assessment methodology for the proposed Sigma ash backfilling project will consist of two phases, namely:

- Impact identification; and
- Impact significance rating.

In brief, impacts and risks are identified based on a description of the existing and proposed future activities to be undertaken as part of the propose project. The impact assessment and significance ratings are determined for these proposed activities.

The mitigation measures for all impacts and risks will be incorporated into an EMP.

The significance rating process for impacts follows the established impact/risk assessment formula where:

- Significance = Consequence x Probability;
- Consequence = Severity + Spatial Scale + Duration; and
- Probability = Likelihood of an impact occurring.

The weight assigned to the various parameters for positive and negative impacts in the formula is presented in Table 13-1.

Table 13-1: Impact Assessment Parameter Rating out of 7

Rating	Severity		Spatial scale	Duration	Probability
	Environmental	Social, cultural and heritage			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or eco system. Persistent severe damage.	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	International The effect will occur across international borders.	Permanent: No Mitigation No mitigation measures of natural process will reduce the impact after implementation.	Certain/ Definite. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Significant impact on highly valued species, habitat or ecosystem.	Irreparable damage to highly valued items of cultural significance or breakdown of social order.	National Will affect the entire country.	Permanent: Mitigation Mitigation measures of natural process will reduce the impact.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate.	Very serious widespread social impacts. Irreparable damage to highly valued items.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the Project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year.	On-going serious social issues. Significant damage to structures / items of cultural significance.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.

Rating	Severity		Spatial scale	Duration	Probability
	Environmental	**Social, cultural and heritage**			
3	Moderate, short-term effects but not affecting ecosystem functioning. Rehabilitation requires intervention of external specialists and can be done in less than a month.	On-going social issues. Damage to items of cultural significance.	Local Local extending only as far as the development site area.	Medium term 1-5 years.	Unlikely Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants.	Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance (e.g. ad hoc spills within plant area). Will have no impact on the environment.	Low-level repairable damage to commonplace structures.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in the EMP. The significance of an impact is then determined (Table 13-3) and categorised into one of four categories, as indicated in Table 13-2.

Table 13-2: Significance Threshold Limits

Category	Description	Colour
High	108- 147	
Medium-High	73 - 107	
Medium-Low	36 - 72	
Low	0 - 35	

Table 13-3: Probability Matrix

Significance									
		Consequence (severity + scale + duration)								
		1	3	5	7	9	11	15	18	21
Probability / Likelihood	1	1	3	5	7	9	11	15	18	21
	2	2	6	10	14	18	22	30	36	42
	3	3	9	15	21	27	33	45	54	63
	4	4	12	20	28	36	44	60	72	84
	5	5	15	25	35	45	55	75	90	105
	6	6	18	30	42	54	66	90	108	126
	7	7	21	35	49	63	77	105	126	147

13.1 The Positive and Negative Impacts that the Proposed Activity (In Terms of the Initial Site Layout) and Alternatives will have on the Environment and the Community that may be affected

13.1.1 Construction Phase

The impacts associated with the Construction phase of the project are expected to be of Medium to Low significance. The impacts and risks of concern are related to potential hydrocarbon spillages from vehicles and machinery used. The hydrocarbon spillages may negatively impact on soils, surface water, aquatics and wetlands, as well as groundwater resources. Hydrocarbon spillages must be cleaned up immediately to prevent further contamination. Soils are likely to be impacted upon due to the pipelines and vehicles which can lead to soil erosion, although limited to a small spatial scale. Additionally, the construction of the ash backfilling project can have a negative impact on wetlands should no mitigation measures be implemented. Vegetation establishment (where vegetation was previously cleared for the pipeline construction) will remain first priority once the

aboveground pipeline has been constructed and rehabilitated. An impact associated with the drilling of the boreholes during the construction phase to pump the ash slurry underground has also been considered. It is noted that drilling of the boreholes without proper mitigation measures can lead to accidently discharge of groundwater contained within the underground mine voids to the environment. In some cases this water may be considered contaminated depending on the depth at which the boreholes are drilled where by the deeper the borehole is drilled into the mine voids the increase level of contamination (Status Quo Report, IGS, 2017).

13.1.2 Operational Phase

The project poses a high potential risk to the local aquatic ecosystems and wetlands. However, this risk will only occur if ash or ash-water spillages result in contamination, which will negatively impact aquatic conditions through changes in water chemistry as well as aquatic habitat. Based on reports on the proposed backfilling methodology the ash backfilling project is likely to prevent further subsidence and should not decant (IGS, Proposed backfilling methodology 2013). If no ash spills or leakages occur and subsidence is minimised the project will have a beneficial effect (due to stabilization of conditions) on local aquatic ecosystems and wetlands.

Owing to the link to the Vaal Barrage, a major aquatic system, it is imperative that the wetlands identified on site are preserved from any further degradation. Wetlands in general in South Africa are under threat due to development, agriculture, mining and poor management of water resources. The cumulative impacts of loss or degradation of wetlands is considered as significant.

Due to the fact that the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in reestablishment of kinetic sulphide oxidation processes. Mitigation measures have been proposed to prevent the generation of acid water.

13.1.3 Decommissioning Phase

Once the mine voids have been backfilled, the hydrostatic pressure in the backfilled areas will lead to increase in water levels in the mine groundwater system. According to the IGS 2013 study, the water level increase will not be sufficient to cause the mine to decant. As a result, the intermediate aquifer above the mine void will attain hydrostatic equilibrium faster than if there was no backfill.

The surface area of the dolomites in direct contact with the mine floor will be reduced as a result of the backfilling. This will lead to a reduction of influx from the dolomites to the mine voids. In the long run, it is anticipated that groundwater from the mine void will flow towards the remaining dolomites on the mine floor at a rate of 5 L/s. This would only happen if the subsidence risk areas are backfilled.

Since the current subsidence areas will remain as is, most recharge will still occur along the subsidence. All subsidence areas are potential decant points. It is recommended that decant should be collected and treated, and IGS (2017) indicates that this is currently being conducted.

The existing ash backfilling has been proven to be environmentally friendly through on-going monitoring. From a total of 89 boreholes sampled and profiled, almost two thirds of the sulphate values in the boreholes were below 45 mg/L (IGS, 2012). Currently, the water in the mine void is alkaline.

After the mine void has been backfilled with the ash slurry, the pH of the resulting water in the vicinity of the backfilled areas is predicted to rise up to 11.1. Only aluminium will likely be present in the leachate above acceptable standards.

The predicted aluminium plumes in the mine groundwater system 10, 50 and 100 years after backfill are depicted in Figure 13-1, Figure 13-2 and Figure 13-3 respectively.

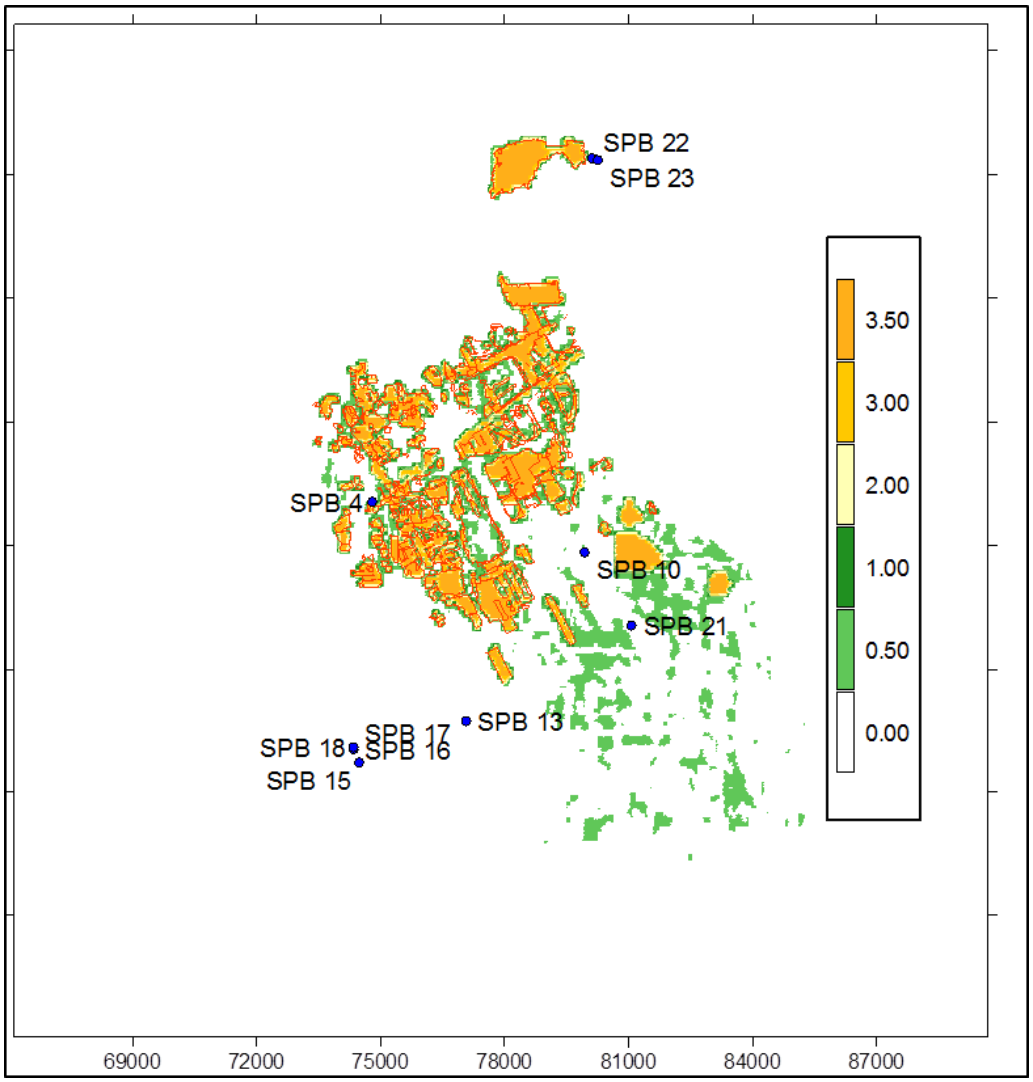

Figure 13-1: Aluminium Plume in Mine Void 10 years after Ash Backfilling

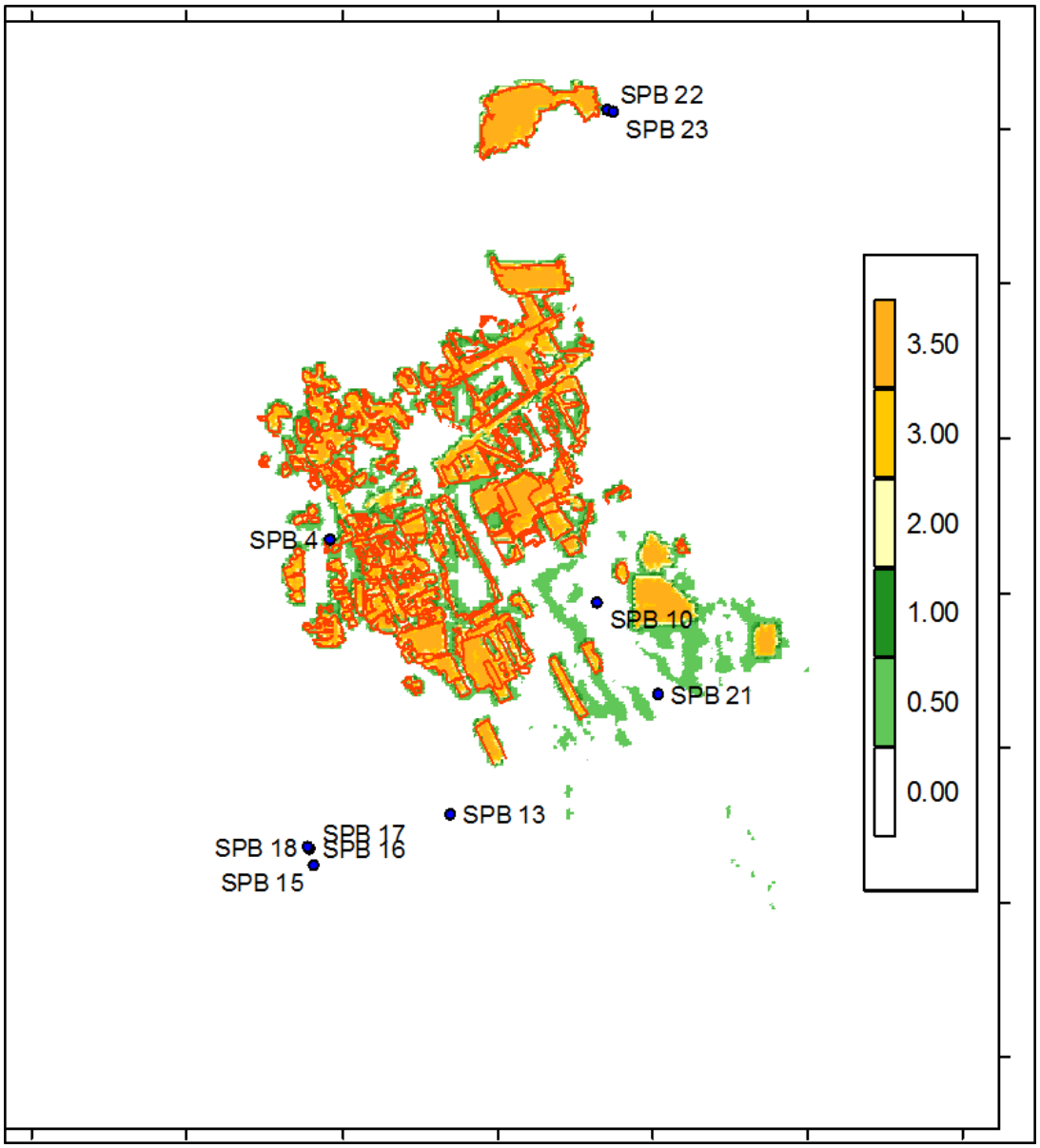

Figure 13-2: Aluminium Plume in Mine Void 50 years after Ash Backfilling

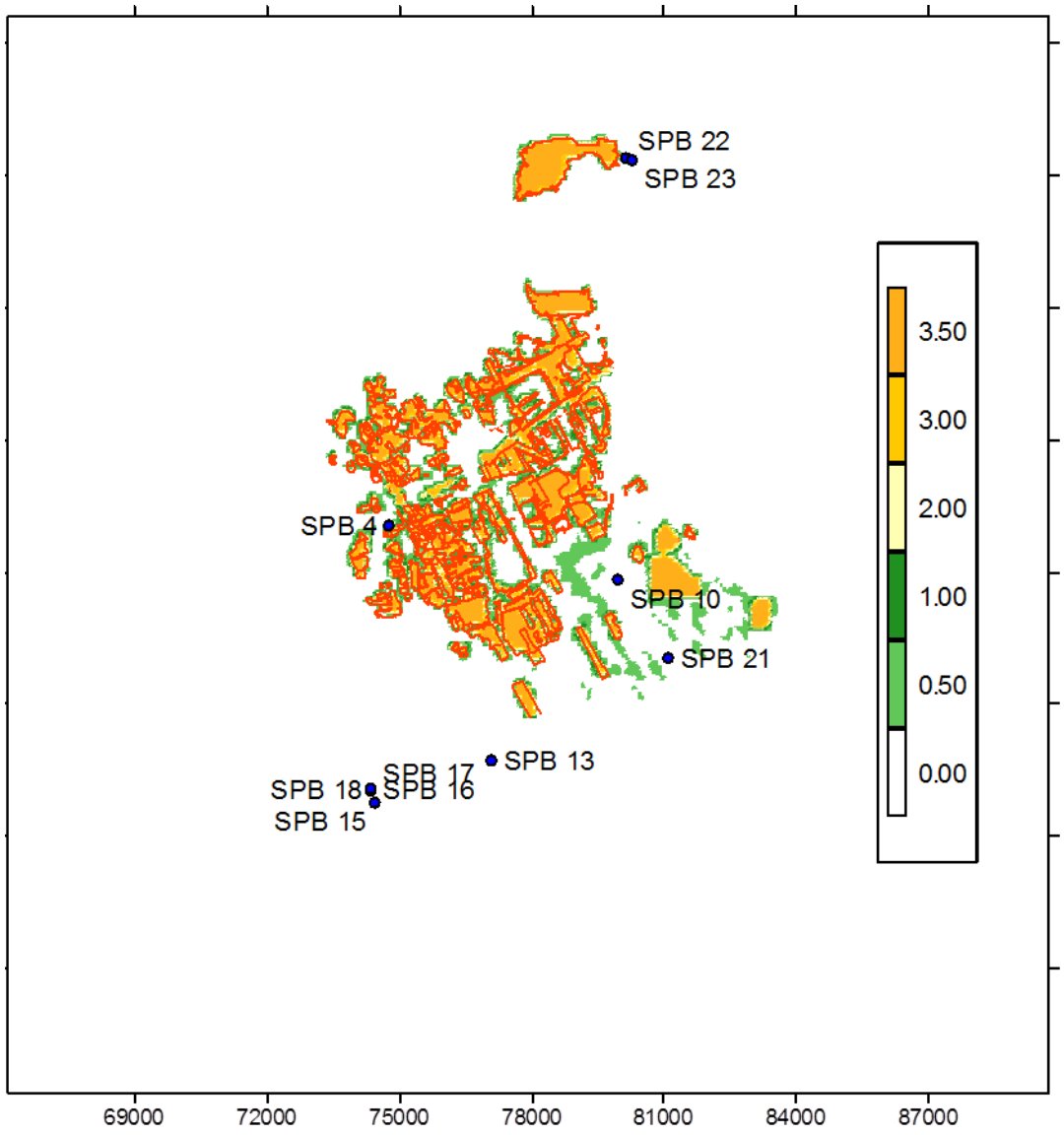

Figure 13-3: Aluminium Plume in the Mine Void 100 years after Ash Backfilling

Soon after the aluminium leaches from the southern backfill areas, the leachate is predicted to move towards the southern compartments by advection. The concentration of the transported aluminium is predicted to range between 0.5 and 1 mg/L. Dilution of aluminium will likely occur as the southern compartments approaches hydrostatic equilibrium with the intermediate aquifer. This will cause the plume to retreat with time as depicted.

The overall movement of the leachate from the backfill will be slow. The plume from each backfill area is predicted to move, on average 150 m only, in 100 years. The rate of movement will be limited by the aquitard nature of the backfilled area. As such the lateral spread of any pollutant from the backfill in the mine groundwater system will be very limited. The leachate is not predicted to diffuse into the intermediate aquifer above the backfill, in concentrations above acceptable limits.

The risk of pollution of boreholes of the farmers situated between the Vaal barrage and the underground mine, is currently very small and this is not expected to change in the foreseeable future.

13.2 The Possible Mitigation Measures that could be Applied and the Level of Risk

Mitigation measures for each identified impact have been proposed and are presented in Section 15.

13.3 Motivation where No Alternatives Sites were considered

Alternatives have been investigated and discussed in Section 9. The most suitable alternatives have been selected based on this investigation to ensure the least environmental impact occurs.

13.4 Statement Motivating the Alternative Development Location within the Overall Site

The proposed pipeline routes has been selected largely on existing pipeline routes and along existing servitudes, both on privately owned land, as well as land owned by Sasol Mining. This section of the pipeline routes has, where possible, been adjusted to avoid environmentally sensitive areas such as isolated rocky ridges and wetlands and kept on Sasol Mining owned land as far as is practical. The specialist studies confirmed that this route is the preferred option as the impacts will be reduced by the fact that the servitudes are already in place and therefore seen as already impacted.

The preferred pipeline routes utilises pipelines that are currently being used, or have previously been used, for transporting ash slurry under Sasol Sigma's previous Water Use Licence (Ref No. WUL no. 20021165) which expired in 2010.

It should also be noted that the proposed pipeline routes shown in this BAR has already been authorised in accordance with the IWUL granted for the proposed ash backfilling project (Ref No. 10/C22K/CGIJ/4608). Therefore should an alternative route be proposed for this BAR, the already authorised IWUL will need to be amended which is not considered to be a feasible option at this stage of the proposed project.

14 Full Description of the Process undertaken to Identify, Assess and Rank the Impacts and Risks the Activity will impose on the Preferred Site (In Respect of the Final Site Layout Plan) through the Life of the Activity

Alternatives were considered with regards to the location of the pipeline routes which has been investigated in detail as described in Section 9. Stakeholders will be given the opportunity during the public review period to provide comment on the alternatives provided in this report. Should comments be received the alternative will be revised where applicable. The impacts and risks discussed in Section 12 are applicable to the final site layout plan (Plan 4 in Appendix B).

15 Assessment of each Identified Potentially Significant Impact and Risk

Table 15-1 provides all identified impacts associated with each phase and each aspect.

Table 15-1: Assessment of Each Identified Potentially Significant Impact

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Surface Water	Alteration of the natural hydrology or disturbance of natural stream and flows	Medium-Low	▪ Prioritize backfill at the potential subsidence areas to reduce or minimize the potential hydrological modifications ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures that allows the pipeline to cross at an elevation above the natural water level	Low
Construction Phase	Construction of the pipeline and associated clearance activities	Surface Water / Aquatic Ecology	Potential sedimentation and contamination of water from hydrocarbons, as a result of the construction vehicles utilised. This can result in Sedimentation of the associated watercourses and Water quality impairment	Medium-Low	▪ Develop soil management measures for the construction area/s that will prevent an increased runoff into the associated watercourse, such as the construction of trenches and/or the use of silt curtains; ▪ Erosion control structures and mechanisms, such as surface stormwater drainage systems, should be implemented so as to reduce the potential occurrence of erosion and sedimentation within and adjacent to the associated watercourses; ▪ The disturbance of instream channels and riparian zones must be minimized, where possible; ▪ Vehicles must be maintained according to their maintenance plans; ▪ Stationary vehicles should have a drip tray placed below the machine; ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Surface water draining off contaminated areas containing oil and petrol would need to be channeled towards a sump which will separate these chemicals and oils; ▪ Portable septic toilets are to be provided and maintained (including their removal without sewage spillage) for construction crews outside of the 1-100 year floodline; and ▪ Store all litter carefully so it cannot be washed or blown into any of the watercourses within the study area; ▪ Extra precautions should be taken in areas within 500 meters of the Leeuspruit or Rietspruit to prevent any potential impact to the water courses this includes effective stormwater control measures around the areas where the pipeline is being constructed to prevent sedimentation of the rivers.	Low
Construction Phase	Construction of the pump booster station	Surface Water	The booster pump station will entail the use of hydrocarbon lubricants for the machine moving parts, which, if not well maintained, could be a source of hydrocarbon contamination. Accidental spillage of hydrocarbon containing materials such as oils or lubricants may occur.	Medium Low	▪ As the booster pump station already exists (with bunding and foundations), clean-up kits for accidental spillage must be available on-site to prevent the spread of accidental spillages and associated impacts. ▪ The mine personnel must be trained for clean-up of and report hydrocarbon containing material spillages.	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of wetland area is anticipated to occur due to excavation during construction of the proposed ash backfilling pipeline, as the wetlands will be intersected at 31 points.	Medium-High	▪ The pipeline may not be constructed within 100 metres of a wetland buffer with the exception of the various wetland crossing. ▪ Pipeline crossings over wetlands should be above ground on supports so that any damage to the pipes can be detected and minimal wetland area is removed for the pipeline construction; ▪ Erosion control measures should be implemented by re-seeding bare areas of wetland and grassland buffer strips with mixed seed spray of indigenous sedges and grasses;	Medium-Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of Wetland vegetation	Medium-Low	▪ The pipeline route should be designed in such a way that the route of existing infrastructure such as roads and bridges is utilised so that further infringement of infrastructure into the wetland is avoided. ▪ Ensure minimal wetland area is removed for the pipeline construction.	Low
Construction Phase	Construction of the ash backfill pipeline will lead to the direct loss of the vegetation on site.	Fauna and Flora	Loss of Plant Communities	Medium-Low	▪ The pipeline route should follow existing roads, servitudes and pipeline routes as far as possible. ▪ The areas of Moderately High Sensitivity (wetlands and riparian edges) and Medium (Secondary Grassland and Degraded Woodland/Savanna) must be avoided ▪ All Highly Sensitive Areas should be avoided and these include all Wetland and Riparian habitat on site. ▪ Restrict access to areas that are not to be disturbed from the pipeline construction ▪ Ensure an alien invasive species management plan is compiled and implemented to prevent the spread of invasive species along the pipeline route. ▪ Keeping clearing of vegetation to a minimum. Excessive vegetation clearance must not be permitted.	Low
Construction Phase	The construction of the backfill pipeline will result in the loss of certain biodiversity aspects.	Fauna and Flora	Loss of biodiversity	Medium-Low	▪ If encountered all SSC, as well as the immediate habitat surrounding them, should be preserved and construction of the pipeline should be restricted to areas outside of their immediate habitat. ▪ In the case where this is not possible, and all efforts to avoid these areas have been exhausted, permits may be applied for from the provincial authorities to translocate these species. ▪ It is imperative that the habitat in which these species are translocated to is as similar to the donor habitat as possible and is also within close proximity to the site.	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands and Fauna and Flora	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for	Medium-Low	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation; ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction; ▪ Limit the footprint area of the construction activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas); ▪ If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated; ▪ Ensure that no incision and canalisation of the wetland features	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
			erosion.		present takes place; ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; ▪ Soils which were compacted as a result of construction activities should be ripped/scarified (<300 mm) and profiled; ▪ A suitable Alien Invasive Plant (AIP) control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all freshwater features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the project area; ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or river courses and their associated zones of regulation. All vehicles must remain on demarcated roads and within the construction footprint; ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All spills should be immediately cleaned up and treated accordingly; ▪ Wetlands should be monitored weekly during construction; and ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.	

Construction Phase	Construction of the Pipeline and associated clearance activities	Soil, Land Use and Land Capability	During the pipeline construction, soil erosion and contamination are possible. The soil impacts may be a result of vegetation (where applicable) and topsoil removal for the pipeline and laydown areas, as well as compaction caused by vehicle and machinery onsite.	Medium-Low	▪ The pipeline must be constructed in sections not exceeding 100m per section. A maximum of 3 sections may be active at the same time, by the undertaking of one of the following activities per section:
					  ▪ Vegetation Clearance;
					  ▪ Installation of the pipeline; or
					  ▪ Remediation of the footprint.
					▪ Where the pipeline has been constructed within the road reserve and no vegetation is present, the area should be rehabilitated and soil compacted. No vegetation is required to be established within these areas;
					▪ Suitable stormwater management measures must be implemented to prevent the loss of soil during rainfall events;
					▪ All surfaces that are susceptible to erosion shall be covered with a suitable vegetative cover as soon as construction is completed.
					▪ Rehabilitation to be monitored on an annual basis for three years on completion of the construction phase;
					▪ Areas where vegetation is cleared (either for the pipeline where vegetation is present or for the laydown area), should be rehabilitated with a suitable vegetation cover once constriction has
						Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
					been completed; ▪ Stockpiling of the pipes to be installed must be limited to only what is required and only be stored in designated areas to avoid any unnecessary soil compaction.	
Construction Phase	Construction of the Pipeline and associated clearance activities	Air Quality	Dust generated from site clearing, vehicle movement and the construction of the pipeline.	Medium-Low	▪ The disturbed areas must be kept to a minimum and it is advised to not clear vegetation unnecessarily; and ▪ Water or a chemical dust suppressant should be used to dampen dust generating areas such as areas where soil has been exposed.	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Groundwater	Contamination of groundwater due to hydrocarbon spillages.	Low	▪ Machinery should be maintained properly; diesel or other chemicals should be handled appropriately and not spilled. ▪ Re-fueling protocols must also be followed to ensure no diesel is spilled during re-fueling. ▪ Storage tanks must be in a bunded area. ▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed at an acceptable dumping facility. ▪ Construction vehicles and machinery repairs must only take place in designated workshop areas. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Groundwater monitoring, to assess the time series water quality impacts and trends.	Low
Construction Phase	Drilling of boreholes	Groundwater	Groundwater quality deterioration, due to ash spillage on the surface and leakage through poorly constructed boreholes	Low	▪ Backfilling boreholes should be constructed with solid casing from the top to end, to avoid cross contamination and transportation of the ash slurry from the backfilling borehole via preferred pathways; and ▪ Boreholes should be equipped with lockable security caps. ▪ It is recommended that backfilling boreholes should be drilled in approximately 300 m intervals along the pipeline route. ▪ Once boreholes have been drilled the area around the borehole must be rehabilitated back to its existing state. All evidence of drilling activities must be removed.	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Social	Creation of jobs during the construction phase of the pipeline	Low (Positive)	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, construction workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	Medium-Low (Positive)
Operational Phase	Ash Backfilling Project	Aquatic Ecology	Effects of impaired water quality on aquatic biota should a sudden burst in the pipeline occur. Coal Ash contains many toxic elements (salts high pH and metals) which are leachable	High	▪ Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report for Ash Backfilling Methodology); ▪ Surface pipelines should be inspected for leaks on a weekly basis; ▪ Cut off valves should be installed on the pipeline to be operated in the event of a spillage; ▪ All boreholes and potential decant points should be identified and	Medium-Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
			and have the potential to impact directly on aquatic ecology		secured before the ash backfilling occurs; ▪ Aquatic bi-annual biomonitoring (wet and dry season) should be conducted for the duration of the project as well as after the project is completed; ▪ If ash spills occur the following mitigation is recommended: ▪ Contain the ash using berms and cut off trenches and create emergency shutoff points that should be activated; ▪ Ash within the river reaches should be removed by mechanical means; and ▪ Investigate potential emergency temporary storage areas should the ash need to be redirected.	
Operational Phase	Ash Backfilling Project	Aquatic Ecology	The project has the potential to alter aquatic habitat through the influx of fine particulate matter in the form of ash. Ash, if present near to the river systems, will settle in local river systems and cover available habitat thus reducing diversity and restricting the presence of habitat sensitive species.	Medium-Low		Medium-Low
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Introduction of pollutants in the form of dissolved metals, suspended solids/ particulate matter and salts form ash slurry	Medium-High	▪ Surface pipelines should be inspected for leaks on regular basis (weekly); ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures or other material to make sleeves which can contain material from spillages and prevent surface water contamination; ▪ Cut off valves should be installed on the pipeline with pressure sensors, which stop the flow in the event of a spill; ▪ If monitoring of surface or ground water indicate exceedances in accordance with the approved IWUL criteria, an investigation into exceedances must be undertaken to understand the cause and determine if related to ash backfilling. If so then relevant authorities need to be notified within 24 hours and an action plan compiled and implemented. ▪ Monitoring of potential surface water contamination is vital. Local river systems, as well as boreholes should be monitored on a regular basis (Monthly during ash backfilling, Quarterly on completion of Ash Backfilling and Bi-annually when no impacts are detected for a period of three years after the project has ceased); ▪ If ash spills/ leakage occurs the following mitigation is recommended: ▪ Contain the ash as much as possible using berms and cut off trenches; ▪ Ash which is present within the river reaches should be removed by mechanical means; and ▪ Accidental spillages or leaks or pipe bursts should be reported and downstream users cautioned until any potential impacts are remediated; ▪ The IGS report for backfilling methodology (Lukas et al. 2013) indicates that the risk of decant is minimal when using the proposed methodology. However, if any emerging decant points are observed during operation, monitoring and mitigation should be implemented weekly until impacts are negated. Backfilling should be carried out under the guidelines of this report. ▪ In the event that decant occurs, it could be collected to prevent it from freely flowing into the catchment and collected and treated	Low
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Changes in the natural pH to alkaline resulting in mobilisation of certain elements	Medium-Low		Low
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream	Medium-High		Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
			crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Water contamination from the underground mine water pumped out, in the case of a burst pipe		before disposal. ▪ Flow meters must be installed at either end of the pipelines to ensure that the same amount of slurry leaving the pump station, enters the underground workings; ▪ These reading should be taken on a daily basis and reported on monthly to Sasol headquarters. Additionally, these readings should be incorporated into the quarterly surface and groundwater monitoring report currently being undertaken for Sigma Defunct Colliery which must be submitted to DWS; ▪ Comparisons between the volumes dispensed and received should be made to ensure no leaks in the pipeline have occurred; ▪ Should a variation be identified, further investigation must be undertaken to identify the location of the leak. Any leaks in the pipeline must be repaired immediately. ▪ Dirty water may not be permitted to be discharged to the environment.	
Operational Phase	Ash Backfilling Project	Surface Water	The pipeline could impede flows in the catchments where they traverse streams and drainage lines. Impacts could arise if pipes containing slurry burst and large amounts spill on or close to stream crossings. These could result in particulate matter sedimentation in stream channels which could alter the hydrology.	Medium-Low		Low
Operational Phase	Ash Backfilling Project	Surface Water	A positive impact where the topography can be maintained; further reducing natural landscape modifications.	Medium-High (Positive)	▪ No mitigation measures required as it is considered to be a positive impact	Medium-High (Positive)
Operational Phase	Ash Backfilling Project	Wetlands	Leakages in the pipeline at one of the 31 wetland crossing points may result in surface water contamination due to heavy metals that may be contained in the fly-ash. This can result in chemical contamination of wetlands and reduces its functionality	Medium-High	▪ It is recommended that the methodology proposed for backfilling by IGS (Lukas et al. 2013) is adhered to in order to prevent spillage into wetland areas as far as possible. All voids located in proximity to wetlands that contain boreholes or subsided areas should not be filled unless the risk of indicates that this risk of spilling into the wetland has been investigated. ▪ All pipeline crossings over wetland areas should be monitored for spillage weekly and any damage or spillage should be reported and addressed with urgency.	Low
Operational Phase	Potential spills or leaks from pipeline infrastructure and resulting disturbance to soils	Flora and wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of sensitive species ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	Medium-Low	▪ All erosion noted within the operational footprint as a result of surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan; ▪ A suitable AIP control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all wetland features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines; ▪ All spills from maintenance vehicles or leaks from the pipeline should	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
					be immediately cleaned up and treated accordingly; and ▪ Monitor all systems for erosion and incision	
Operational Phase	Ash Backfilling Project	Soil, Land Use and Land Capability	Loss of vegetation along the pipeline route resulting in soil erosion	Medium-Low	▪ Continuous inspections of the pipeline route should be undertaken to ensure that soil erosion has not occurred along the pipeline route; and ▪ Areas where erosion has occurred should be rehabilitated.	Low
Operational Phase	Dewatering	Groundwater	Groundwater quantity impact	Medium-Low	▪ It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows. ▪ The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash. ▪ During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level.	Low
Operational Phase	Ash Backfilling Project	Groundwater	Groundwater quality impact	Medium-Low	▪ After the ash backfilling commences, the pipeline should be inspected for any potential leak. A monitoring system to continuously monitor the flow between the pump station and the ash backfilling borehole should be installed. ▪ Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes. ▪ For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1. Thus the ash material is non-acid forming. Consequently, backfilling of ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation.	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Surface Water / Aquatic Ecology	Potential contamination of water from hydrocarbons, as a result of the vehicles utilised during decommissioning.	Medium-Low	▪ Care should be taken not to impact areas that have remained un-affected throughout the life of the project. ▪ On-going rehabilitation should be conducted throughout the decommissioning and closure phase. Only the removal of remaining infrastructure and re-shaping the final topography should occur during the closure phase. ▪ Repairs on vehicles and machinery utilised during decommissioning and rehabilitation must only take place in designated workshop areas. ▪ Vehicles must be maintained according to their maintenance plans. ▪ Stationary vehicles should have a drip tray placed below the	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
					machine. ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Continuous post-closure monitoring is required so that drastic deterioration in surface and groundwater quality is detected as soon as it occurs, allowing for mitigation measures to implemented early. Monitoring is recommended to be conducted until satisfactory groundwater quality is reached and thereafter signed off by the relevant authorities. Should an impact be detected through monitoring, affected receptors should be compensated and monitoring programme should be adapted to assess potential changes within the study area. ▪ As an additional consideration, is recommended that geotechnical surveys are undertaken on a regular (every two years) basis to ensure the stability of the potential subsidence areas following the ash-backfilling project.	
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Soil, Land Use and Land Capability	The underlying soil will be compacted and susceptible to erosion. Topsoil will need replacement on the pipeline route. Hydrocarbon spillages from vehicles and machinery used during decommissioning could contaminate soil resources.	Medium-Low	▪ Immediately clean up any hydrocarbon spills in accordance with the hydrocarbon Standard Operating Procedure (SOP). ▪ Vehicles and machinery must be serviced in bunded areas. ▪ Suitable stormwater measures must be implemented to prevent the loss of soil to soil erosion. ▪ The pipeline should only be removed in sections. Once a certain area has been decommissioned and rehabilitated the next section can be removed to prevent extended impact to soil. ▪ Soil should be stockpiled and utilised to rehabilitate the area once the pipeline has been removed. ▪ Areas should be rehabilitated and vegetation allowed (where vegetation was previously cleared during decommissioning) to grow immediately after the pipeline has been removed;	Low
Decommissioning Phase	Site access roads and pipeline crossing wetlands, Removal of infrastructure and rehabilitation	Flora & Wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Loss of natural vegetation; ▪ Increased sedimentation; ▪ Increased potential for onset of erosion; ▪ Potential dumping of decommissioned infrastructure in wetland/riparian areas; and ▪ Potential incomplete removal of infrastructure.	Medium-Low	▪ Limit the footprint area of the decommissioning and rehabilitation activities to what is essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan. ▪ All soils compacted as a result of decommissioning activities should be ripped/scarified (<300 mm) and profiled. ▪ Permit only essential personnel within the zones of regulation for all freshwater features identified. ▪ Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream. ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage. ▪ Wetlands and their associated zones of regulation are to be clearly demarcated and avoided wherever possible. ▪ An AIP management plan to be implemented and managed for the	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
					life of the proposed decommissioning, rehabilitation, closure and post-closure phases. ▪ As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils, vegetation clearance should be kept to a minimum. ▪ Monitor all systems for erosion and incision. ▪ All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint. ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All existing litter, debris should be removed from the wetland areas and littering should be prohibited on an ongoing basis; ▪ All spills from machinery should be immediately cleaned up and treated accordingly; ▪ Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility.	
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Air Quality	The extent of impacts depends on the extent of demolition and rehabilitation efforts during decommissioning. Impacts of this activity on the atmospheric environment will be similar to the impacts during the decommissioning and rehabilitation phase. The impacts will be short-term and localised.	Medium-Low	▪ Vegetation establishment (where vegetation was previously cleared away) must take place on the bare soil to prevent soil erosion and dust creation. ▪ Exposed soil must be kept moist using sprays or water tanks to prevent dust creation before vegetation is established (where vegetation was previously cleared away). ▪ Vegetation (where previously cleared) should be planted during the wet season to ensure vegetation establishment and prevent unnecessary costs.	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quantity impact	Medium-Low	▪ If decant occurs it should be collected and treated as to avoid having it introducing contamination into surface water bodies.	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quality impact	Medium-Low	▪ Quarterly groundwater monitoring of the proposed boreholes is recommended until satisfactory groundwater quality is reached and groundwater trends reflect stability for a period of three years.	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Social	Creation of jobs during decommissioning and rehabilitation phase while the pipeline is being removed	Low (Positive)	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, workers and other service providers will be recruited surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local	Medium-Low (Positive)

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Mitigation Measures	Rating (Post Mitigation)
					government.	

16 Summary of Specialist Reports

Table 16-1 provides a summary of the specialist studies that were undertaken for the proposed ash backfilling project.

Table 16-1: Specialist Studies that have been undertaken for the project

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
Aquatic Ecology Specialist Study	The final ecostatus for the associated sites in the Leeuspruit is Class D/E. This is an indication that conditions are largely/seriously modified within the associated sites. During the High flow the final ecostatus of the Rietspruit was found to be Class D or largely modified. The modified nature of the conditions in the Leeuspruit is due to habitat impacts due to input of fine particulate material covering habitat upstream and downstream site SAS5 compounded by modified water quality throughout the Leeuspruit. The projects impacts were assessed to be major before mitigation and low after mitigation. The potential for contamination is a concern as coal ash has been found to severely alter aquatic conditions. The cumulative impacts of the project are high if contamination occurs and low if contamination does not occur. Based on the IGS report, proposed Sigma backfilling methodology, 2013 decant will not occur. Recommendations include the establishment of monitoring points on the Vaal Barrage at the confluences for both affected river courses (Rietspruit and Leeuspruit) as well as within the potentially affected water courses. The recommendations for the potential impacts that could occur from the proposed activity include: ▪ Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report for Ash Backfilling Methodology); ▪ Create emergency shutoff points that can be activated if a spill is detected; ▪ Patrol the pipeline daily to visually inspect for leaks; and ▪ Investigate potential emergency temporary storage areas should the ash need to be redirected.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the aquatic ecologist specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Fauna and Flora Specialist Study	As illustrated in this report the study area consists of different levels of sensitivity from a biodiversity standpoint these areas have been delineated and described. It is therefore important that the placement of the pipeline infrastructure is done with these sensitive areas in mind. The opportunity exists however, for the Sigma to contribute to conservation of biodiversity within the region. If efforts are made to initiate conservation of this habitat, and conservation is maintained after the decommissioning of the ash backfilling project, the net impacts on biodiversity will be positive. The biodiversity management actions of the proposed ash backfill project should be focussed on the vegetation units as described in this report. These vegetation units also justify some effort in terms of biodiversity management on the proposed ash backfill project: ▪ Adherence to the mitigation measures as stipulated in the Impact Assessment; ▪ Pipeline infrastructure should be restricted to areas of low sensitivity; ▪ Remediation of areas; ▪ The footprint of the ash backfill pipelines should be as small as possible; ▪ Alien plants must be identified and removed throughout the phases, design a specialist alien plant	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the fauna and flora specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
	monitoring plan; ▪ Monitoring of the fauna and flora present on the project site; ▪ Design and implement a fire management plan.		
Wetland Specialist Study	The proposed ash backfilling project should implement the following mitigation measures: ▪ The methodology for ash backfilling should follow the recommendations outlined by the IGS report (Lukas et al. 2013); ▪ All points along the pipelines that cross over wetlands should be positioned on plinths in order to minimise the impact on the wetland; ▪ A 32m buffer around the pipelines are recommended for the route with exception of the wetland crossings. During construction, the footprint should be as small as possible; ▪ Although wetlands on site are not in pristine condition, a 'no-net-loss' approach should be undertaken for wetlands in this system and efforts should be made to prevent further biodiversity loss within the wetland systems, where Sasol have control over the system's management. The approach should be to raise the PES of D and E for the Leeuspruit and the Rietspruit respectively to a C and D. This can be achieved by drafting a wetland rehabilitation plan, whereby aspects of wetland hydrology, geomorphology and vegetation are focused on; ▪ Erosion control measures should be implemented by re-seeding bare areas of wetland and grassland buffer strips with mixed seed spray of indigenous sedges and grasses; and ▪ It is advised that monitoring take place on a weekly basis during construction in order to detect leakages or damage to pipes as well as any potential decant into wetlands. During operation, monitoring should include an assessment of wetland health every 5 years.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the wetland specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Groundwater Specialist Study	The following recommendations have been made for the operational phase of the ash backfilling project: ▪ It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows. ▪ The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash. ▪ During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level. ▪ After the ash backfilling commences, the pipeline should be inspected for any potential leak. A monitoring system to continuously monitor the flow between the pump station and the ash backfilling borehole should be installed. ▪ Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes. ▪ For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the groundwater specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
	Thus the ash material is non-acid forming. Consequently, backfilling of ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation. The following recommendations have been made for the decommissioning and closure phase of the ash backfilling project: ▪ Once the mine voids have been backfilled, the hydrostatic pressure in the backfilled areas will lead to increase in water levels in the mine groundwater system. The water level increase will not be sufficient to cause the mine to decant. As a result, the intermediate aquifer above the mine void will attain hydrostatic equilibrium faster than if there was no backfill; ▪ The surface area of the dolomites in direct contact mine floor will be reduced as a result of the backfilling. This will lead to a reduction of influx from the dolomites to the mine voids. In the long run, it is anticipated that groundwater from the mine void will flow towards the remaining dolomites on the mine floor at a rate of 5 L/s. This would only happen if the subsidence risk areas are backfilled; ▪ Since the current subsidence areas will remain as is, most recharge will still occur along the subsidence. All subsidence areas are potential decant points. It is recommended that decant should be collected and treated, and IGS (2017) indicates that this is currently being conducted; and ▪ The overall impact of post-closure on groundwater quantity prior to mitigation is minor. If the mitigation measures are applied, the impact will be negligible. ▪ The existing ash backfilling has been proven to be environmentally friendly through on-going monitoring. Currently, the water in the mine void is alkaline; ▪ After the mine void has been backfilled with the ash slurry, the pH of the resulting water in the vicinity of the backfilled areas is predicted to rise up to 11. Only aluminium will likely be present in the leachate above acceptable standards; ▪ Soon after the aluminium leaches from the southern backfill areas, the leachate is predicted to move towards the southern compartments by advection. The concentration of the transported aluminium is predicted to range between 0.5 and 1 mg/L; ▪ Dilution of aluminium will likely occur as the southern compartments approaches hydrostatic equilibrium with the intermediate aquifer. This will cause the plume to retreat with time; ▪ The overall movement of the leachate from the backfill will be slow. The plume from each backfill area is predicted to move, on average 150 m only, in 100 years; ▪ The rate of movement will be limited by the aquitard nature of the backfilled area. As such the lateral spread of any pollutant from the backfill in the mine groundwater system will be very limited. The leachate is not predicted to diffuse into the intermediate aquifer above the backfill, in concentrations above acceptable limits; ▪ Borehole SPB4, at Saaiplaas, which already has high salt loads and is polluted with nitrates, will have increased aluminium, immediately after it leaches from the backfill; ▪ Aluminium concentrations above 0.5 mg/L are not predicted to reach the Leeuspruit throughout the 100 years after backfill. Thus, decant of bad quality water in the Leeuspruit water, after ash backfilling is unlikely; ▪ The water quality in representative private boreholes SPB2, SPB6, SPB21, SPB22 and SP23 will not be affected by leachates from the backfill;		

List of studies undertaken	Recommendations of specialist reports	Specialist Recommendations that have been included in the EIA report	Reference to applicable section of report where specialist recommendations have been included
	▪ All other constituents that are predicted to leach within acceptable standards will not be problematic after backfilling; ▪ The risk of pollution of boreholes of the farmers situated between the Vaal barrage and the underground mine, is currently very small and this is not expected to change in the foreseeable future; and ▪ Borehole SPB4, planned for use, should be clearly written off as a water supply borehole. Sasol should keep supplying the owner of SPB4 with water.		
Surface Water Specialist Study	The following recommendations were made after completion of the specialist study, and can be implemented as follow on work or important points to manage during the project life: ▪ The ash backfilling methodology should follow that by the IGS report (Lukas et al. 2013; ▪ The recommended impact mitigation measures should be implemented to ensure that the identified impacts on water quality and quantity can be reduced or prevented; and ▪ Water treatment technologies should be considered for implementation to the old mine void water from mine dewatering process which will be implemented with the ash backfilling.	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the surface water specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.
Heritage Specialist Study	Given the current state of the cultural landscape, the apparent absence of any significant tangible heritage resource and the limited impact of the proposed Sigma Defunct Colliery ash backfilling project, the following recommendations are made: ▪ SAHRA and HFS must consider granting Sigma Defunct Colliery exemption from further heritage studies inclusive of all complementary specialist studies, for the Sigma Defunct Colliery ash backfilling project, in line with Final Comment[19] passed on the original report; ▪ If granted the exemption should however be subject to periodic monitoring of the construction of the pipelines and ash backfilling activities to ensure that heritage resources are avoided if present; ▪ It must also explicitly be stated that if exemption is granted, it only applies to the Sigma Defunct Colliery project as described in this report – any additional work or deviations may be subject to additional heritage studies; and ▪ In the event that any heritage resources are accidently found during the course of the project, work must cease and appropriate Chance Find Procedures (CFPs) must be implemented. The CFPs are presented in Appendix D of the heritage specialist study (Appendix H).	X - All recommendations have been considered and included in the BAR and EMP.	Mitigation and management measures included in this report were recommended by the heritage specialist, as well as the monitoring programmes. This includes the impact assessment and mitigation measures as discussed in Section 12, as well as the recommendations provided in Part B Sections 5 and 6 and the monitoring provided in Section 8.

Specialist reports have been attached as appendices to this report.

[19] Dated 17 November 2014, accessible at: http://www.sahra.org.za/sahris/node/181881.

17 Environmental Impact Statement

17.1 Summary of the Key Findings of the Environmental Impact Assessment

The key findings of the environmental impact assessment were:

- Minimal impact to the environment is anticipated during construction phase. Wetlands need to be taken into consideration when constructing the pipelines and the proposed mitigation measures need to be implemented;
- Boreholes must be constructed correctly to ensure no groundwater contamination occurs while the ash slurry is being pumped to the underground workings;
- The key findings from the construction, operation and decommissioning of the pipelines are associated with its impact on surface water, groundwater, wetlands and aquatic ecology specifically the Rietspruit and the Leeuspruit which runs through the Sigma Defunct Colliery;
- During the operational phase, the most significant impacts are associated with the potential risk of a pipelines leak which could result in the discharge of ash slurry into the environment;
- The pumping of ash slurry to the underground mine voids can also have an impact on groundwater quality which must be managed through groundwater monitoring. This impact is predicted in both operational (if boreholes are not constructed correct) and post closure phases is mitigation measures are not implemented correctly; and
- In general, the overall impact of post-closure on groundwater quantity prior to mitigation is minor. If the mitigation measures are applied, the impact will be negligible.

17.2 Final Site Map

The infrastructure layout plan for the project is provided in Plan 4 in Appendix B.

17.3 Summary of the Positive and Negative Implications and Risks of the Proposed Activity and Identified Alternatives

Table 17-1 identified all negative impacts associated with the project during the construction, operation and decommissioning phase while Table 17-2 identified all positive impacts associated with the project during the construction, operation and decommissioning phase.

Table 17-1: Summary of all negative Impact for the Project

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Surface Water	Alteration of the natural hydrology or disturbance of natural stream and flows	Medium-Low	Low
Construction Phase	Construction of the pipeline and associated clearance activities	Surface Water / Aquatic Ecology	Potential sedimentation and contamination of water from hydrocarbons, as a result of the construction vehicles utilised. This can result in Sedimentation of the associated watercourses and Water quality impairment	Medium-Low	Low
Construction Phase	Construction of the pump booster station	Surface Water	The booster pump station will entail the use of hydrocarbon lubricants for the machine moving parts, which, if not well maintained, could be a source of hydrocarbon contamination. Accidental spillage of hydrocarbon containing materials such as oils or lubricants may occur.	Medium Low	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of wetland area is anticipated to occur due to excavation during construction of the proposed ash backfilling pipeline, as the wetlands will be intersected at 31 points.	Medium-High	Medium-Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of Wetland vegetation	Medium-Low	Low
Construction Phase	Construction of the ash backfill pipeline will lead to the direct loss of the vegetation on site.	Fauna and Flora	Loss of Plant Communities	Medium-Low	Low
Construction Phase	The construction of the backfill pipeline will result in the loss of certain biodiversity aspects.	Fauna and Flora	Loss of biodiversity	Medium-Low	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands and Fauna and Flora	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	Medium-Low	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Soil, Land Use and Land Capability	During the pipeline construction, soil erosion and contamination are possible. The soil impacts may be a result of vegetation (where applicable) and topsoil removal for the pipeline and laydown areas, as well as compaction caused by vehicle and machinery onsite.	Medium-Low	Low
Construction Phase	Construction of the Pipeline and associated clearance activities	Air Quality	Dust generated from site clearing, vehicle movement and the construction of the pipeline.	Medium-Low	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Groundwater	Contamination of groundwater due to hydrocarbon spillages.	Low	Low
Construction Phase	Drilling of boreholes	Groundwater	Groundwater quality deterioration, due to ash spillage on the surface and leakage through poorly constructed boreholes	Low	Low
Operational Phase	Ash Backfilling Project	Aquatic Ecology	Effects of impaired water quality on aquatic biota should a sudden burst in the pipeline occur. Coal Ash contains many toxic elements (salts high pH and metals) which are leachable and have the potential to impact directly on aquatic ecology	High	Medium-Low
Operational Phase	Ash Backfilling Project	Aquatic Ecology	The project has the potential to alter aquatic habitat through the influx of fine particulate matter in the form of ash. Ash, if present near to the river systems, will settle in local river systems and cover available habitat thus reducing diversity and restricting the presence of habitat sensitive species.	Medium-Low	Medium-Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Introduction of pollutants in the form of dissolved metals, suspended solids/ particulate matter and salts form ash slurry	Medium-High	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Changes in the natural pH to alkaline resulting in mobilisation of certain elements	Medium-Low	Low
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Water contamination from the underground mine water pumped out, in the case of a burst pipe	Medium-High	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Operational Phase	Ash Backfilling Project	Surface Water	The pipeline could impede flows in the catchments where they traverse streams and drainage lines. Impacts could arise if pipes containing slurry burst and large amounts spill on or close to stream crossings. These could result in particulate matter sedimentation in stream channels which could alter the hydrology.	Medium-Low	Low
Operational Phase	Ash Backfilling Project	Wetlands	Leakages in the pipeline at one of the 31 wetland crossing points may result in surface water contamination due to heavy metals that may be contained in the fly-ash. This can result in chemical contamination of wetlands and reduces its functionality	Medium-High	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Operational Phase	Potential spills or leaks from pipeline infrastructure and resulting disturbance to soils	Flora and wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of sensitive species ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	Medium-Low	Low
Operational Phase	Ash Backfilling Project	Soil, Land Use and Land Capability	Loss of vegetation along the pipeline route resulting in soil erosion	Medium-Low	Low
Operational Phase	Dewatering	Groundwater	Groundwater quantity impact	Medium-Low	Low
Operational Phase	Ash Backfilling Project	Groundwater	Groundwater quality impact	Medium-Low	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Surface Water / Aquatic Ecology	Potential contamination of water from hydrocarbons, as a result of the vehicles utilised during decommissioning.	Medium-Low	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Soil, Land Use and Land Capability	The underlying soil will be compacted and susceptible to erosion. Topsoil will need replacement on the pipeline route. Hydrocarbon spillages from vehicles and machinery used during decommissioning could contaminate soil resources.	Medium-Low	Low
Decommissioning Phase	Site access roads and pipeline crossing wetlands, Removal of infrastructure and rehabilitation	Flora & Wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Loss of natural vegetation; ▪ Increased sedimentation; ▪ Increased potential for onset of erosion; ▪ Potential dumping of decommissioned infrastructure in wetland/riparian areas; and ▪ Potential incomplete removal of infrastructure.	Medium-Low	Low

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Air Quality	The extent of impacts depends on the extent of demolition and rehabilitation efforts during decommissioning. Impacts of this activity on the atmospheric environment will be similar to the impacts during the decommissioning and rehabilitation phase. The impacts will be short-term and localised.	Medium-Low	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quantity impact	Medium-Low	Low
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quality impact	Medium-Low	Low

Table 17-2: Summary of all positive impact for the project

Phase	Activity	Aspect	Impact	Rating (Pre Mitigation)	Rating (Post Mitigation)
Construction Phase	Construction of the Pipeline and associated clearance activities	Social	Creation of jobs during the construction phase of the pipeline	Low (Positive)	Medium-Low (Positive)
Operational Phase	Ash Backfilling Project	Surface Water	A positive impact where the topography can be maintained; further reducing natural landscape modifications.	Medium-High (Positive)	Medium-High (Positive)
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Social	Creation of jobs during decommissioning and rehabilitation phase while the pipeline is being removed	Low (Positive)	Medium-Low (Positive)

18 Proposed Impact Management Objectives and the Impact Management Outcomes for Inclusion in the EMPR

The EMPr seeks to achieve a required end state and describes how activities that have, or could have, an adverse impact on the environment will be mitigated, controlled and monitored.

The EMPr will address the environmental impacts during the construction, operational and decommissioning phase of the project. Due regard must be given to environmental protection during the entire project; a number of environmental recommendations are made to achieve environmental protection. These recommendations are aimed at ensuring that the contractor maintains adequate control over the project to:

- Minimise the extent of an impact during the life of the project;
- Ensure appropriate restoration of areas affected by the project; and
- Prevent long term environmental degradation.

19 Aspects for Inclusion as Conditions of Authorisation

It is not foreseen that any additional aspects other that what has been included and discussed in this document, are required.

20 Description of Any Assumptions, Uncertainties and Gaps in Knowledge

This section highlights the assumptions, uncertainties, limitations and knowledge gaps relevant to the various specialist studies undertaken.

20.1 Basic Assessment Report

The following assumptions were made to complete the BAR:

- As no detail engineering designs were available at the time of the BAR compilation it was assumed that the proposed pipeline routes is exceeding 1000 metres in length with various diameters, however the larger ones will have an internal diameter of approximately 0.36 m. The required servitude for construction of the pipeline is 5 m; and
- Information contained in this report was originally compiled in 2013 and has been updated through desktop studies.

20.2 Aquatic Ecology Specialist Study

The following assumptions were made at the time of writing:

- The foundation of this study was based upon data collected at the time of the 2013/14 aquatic biomonitoring cycle and as such, it is assumed that the present ecological state defined at the time of the writing, as well as the subsequent findings of the authors, were still valid at the time of the most recent update and internal review (i.e. June 2018).

The following limitations were expressed at the time of writing:

- The application of the selected assessment indices should be interpreted with caution within the associated wetland-dominated watercourses, as each of the selected indices were primarily designed for application within typical riverine systems with a moderate hydrology and diverse habitat availability.
- The extent of the amendment included within the most recent update (i.e. June 2018) is limited by the on-site observations and conclusions made by the authors at the time of the surveys and as a result, any further changes would need to be supported by desktop-studies and/or founded upon more recent on-site observations.

20.3 Fauna and Flora Specialist Study

The following limitations were encountered during this study:

- The time of the beginning of spring study did not coincide with the flowering time of most plant species;
- Faunal activity is generally low during the time when the detailed study took place; in late September 2013; and
- Avifaunal activity is reduced due to the lack of the summer migrants that generally start arriving in South Africa in October and early November. This also coincides with the breeding of most of the Southern African species.

20.4 Wetland Specialist Study

The following limitations were encountered during this study:

- The field survey for this wetland assessment was conducted at the beginning of spring (September 2013), before the rainy season had begun and as a consequence, most floral species (wetland indicators) were unidentifiable owing to a lack of flowers and identifying features. Hydrophilic plants are an important indicator used for delineation of wetland boundaries;

- A large proportion of the study site had undergone disturbance due to mining-related activities and subsidence. As a consequence, not only were the exact boundaries of some wetlands not precisely determined, but artificial wetlands had formed due to depressions that had developed from subsidence;
- Owing to time limitations, not all of the wetland boundaries identified on desktop level were ground-truthed on site, as the main areas of focus were areas of wetland intended to be crossed by the proposed pipelines. The wetland delineation for the greater area was completed predominantly on desktop level and discrepancies may occur;
- It is also imperative to note that any changes to the wetlands systems within the study boundary after field work had commenced were not considered for this assessment. Any discrepancies as a result of this have not been regarded;
- The wetland delineation was updated in 2017 by Wetland Consulting Services, and it is considered to be correct; and
- The 2018 report update has included a review of the methodologies used to compile the historical report as well as an updated impact assessment based on the proposed activities. No allowances were made for any in-field verification and so some variation from the historical wetland state and the current wetland state may occur. Any further changes would need to be supported by desktop-studies and/or founded in more recent on-site observations.

20.5 Heritage Specialist Study

The following limitations and constraints were experienced in the compilation of this report:

- The original Notification of Intent to Develop (NID) and Heritage Screening Report (HSR) are considered accurate and adequate. This report constitutes an update of the previous report, and no new data was collected and no new pre-disturbance survey was undertaken; and
- Whilst every attempt was made to obtain the latest available information was made in the original HRM process, the reviewed literature does not represent an exhaustive list of information sources for the greater study area. No additional data collection has been undertaken in the compilation of this report.

20.6 Groundwater Specialist Study

The following assumptions and uncertainties were made during the hydrogeological study:

- A numerical groundwater model is a representation of the real system. It is therefore at most an approximation. This implies that there are always errors associated with groundwater models due to uncertainty in the data and the capability of numerical methods to describe natural physical processes;

- Decant is assessed based on the outcomes of studies done by IGS (2012). Sigma Underground Mine decant study; and
- The report is an update of the studies conducted by Digby Wells (2013) Sigma Ash Backfill Groundwater Model Report; updates were solely conducted for the groundwater quality and quantity from the latest available monitoring data.

21 Reasoned Opinion as to whether the Proposed Activity should or should not be authorised

21.1 Reasons why the Activity should be authorised or not

The ash backfilling project aims to address issues associated with the current and future environmentally degraded state of the site and seeks to return the degraded environment back to an acceptable, sustainable state that is close to its original undisturbed natural state.

Sasol Sigma Defunct Colliery stopped operations in 2006. Significant efforts, since then, have been made to rehabilitate the defunct mine to a state that is able to support further development and growth specifically agriculture. As was indicated in the closure plan and EMPr, effort needed to be made to implement mitigation measures to reduce the significant risks which had been identified at the defunct colliery. It was determined that the most significant risk faced by Sasol at the Sigma Defunct Colliery was the risk of subsidence. Subsidence occurs when the land beneath the surface gives way resulting in the ground collapsing into the underground workings. This poses a significant risk to both people and the environment. Ash backfilling as one of the proposed mitigation measures aims to prevent this from occurring. It should however be noted that ash backfilling is not the only mitigation measure proposed by Sasol to address the issues surrounding subsidence. A combination of mitigation measures implemented by Sasol is proposed to reduce the impact and risk of subsidence these include river diversions, demolition of infrastructure located on areas where subsidence could occur and ash backfilling.

Although impacts have been identified from the use of ash backfilling, these impacts are not considered significant and should the mitigation measures proposed be implemented correctly these impacts are considered to have a medium to low impact on the environment. Therefore, it can be concluded that the risk of subsidence and the associated impacts thereof outweighs the impact associated with the use of ash backfilling.

It must also be noted that the proposed project commenced in 2013 and received an Environmental Authorisation in 2014 and an IWUL and WML in 2017. Although the Environmental Authorisation has since lapsed, that it was authorized before should be taken into consideration when making the decision with regards to whether the project should be authorized again.

Additionally, it must be noted that the proposed project is for the benefit of the people living in the area. Sasol will gain no economic benefit from this project as it is a remediation project.

Therefore, based on the information presented in this report, Digby Wells recommends that an authorisation for this proposed project is granted.

21.2 Conditions that must be included in the Authorisation

The following conditions must be included and approved for the EMPr:

21.2.1 Construction Phase

- Ensure that the pipes at stream crossings and wetland crossings are mounted on stilts with concrete structures that allows the pipeline to cross at an elevation above the natural water level;
- Develop soil management measures for the construction area/s that will prevent an increased runoff into the associated watercourse, such as the construction of trenches and/or the use of silt curtains;
- Erosion control structures and mechanisms, such as surface stormwater drainage systems, should be implemented so as to reduce the potential occurrence of erosion and sedimentation within and adjacent to the associated watercourses;
- Surface water draining off contaminated areas containing oil and hydrocarbon would need to be channelled towards a sump which will separate these chemicals and oils;
- Portable septic toilets are to be provided and maintained (including their removal without sewage spillage) for construction crews outside of the 1-100 year floodline;
- Extra precautions should be taken in areas within 500 meters of the Leeuspruit or Rietspruit to prevent any potential impact to the water courses this includes effective stormwater control measures around the areas where the pipeline is being constructed to prevent sedimentation of the rivers;
- The pipeline may not be constructed within 100 metres of a wetland buffer with the exception of the various wetland crossing;
- Ensure minimal wetland area is removed for the pipeline construction;
- The pipeline route should follow existing roads, servitudes and pipeline routes as far as possible;
- Restrict access to areas that are not to be disturbed from the pipeline construction;
- Ensure an alien invasive species management plan is compiled and implemented to prevent the spread of invasive species along the pipeline route;
- Keeping clearing of vegetation to a minimum. Excessive vegetation clearance must not be permitted;
- Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction;

- Soils which were compacted as a result of construction activities should be ripped/scarified (<300 mm) and profiled;
- No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;
- No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the project area;
- No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or river courses and their associated zones of regulation. All vehicles must remain on demarcated roads and within the construction footprint;
- Wetlands should be monitored weekly during construction;
- The pipeline must be constructed in sections not exceeding 100m per section. A maximum of 3 sections may be active at the same time, by the undertaking of one of the following activities per section:
  - Vegetation Clearance;
  - Installation of the pipeline; or
  - Remediation of the footprint.
- Suitable stormwater management measures must be implemented to prevent the loss of soil during rainfall events;
- Rehabilitation to be monitored on an annual basis for three years on completion of the construction phase;
- Stockpiling of the pipes to be installed must be limited to only what is required and only be stored in designated areas to avoid any unnecessary soil compaction;
- Water or a chemical dust suppressant should be used to dampen dust generating areas such as areas where soil has been exposed;
- Groundwater monitoring, to assess the time series water quality impacts and trends;
- Backfilling boreholes should be constructed with solid casing from the top to end, to avoid cross contamination and transportation of the ash slurry from the backfilling borehole via preferred pathways;
- Boreholes should be equipped with lockable security caps;
- It is recommended that backfilling boreholes should be drilled in approximately 300 m intervals along the pipeline route; and
- Once boreholes have been drilled the area around the borehole must be rehabilitated back to its existing state. All evidence of drilling activities must be removed.

21.2.2 Operational Phase

- Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report, 2012 Ash Backfilling Methodology);
- Surface pipelines should be inspected for leaks on a weekly basis;
- Cut off valves should be installed on the pipeline to be operated in the event of a spillage;
- All boreholes and potential decant points should be identified and secured before the ash backfilling occurs;
- Aquatic bi-annual biomonitoring (wet and dry season) should be conducted for the duration of the project as well as after the project is completed;
- If ash spills occur the following mitigation is recommended:
  - Contain the ash using berms and cut off trenches and create emergency shutoff points that should be activated;
  - Ash within the river reaches should be removed by mechanical means; and
  - Investigate potential emergency temporary storage areas should the ash need to be redirected.
- Cut off valves should be installed on the pipeline with pressure sensors, which stop the flow in the event of a spill;
- If monitoring of surface or ground water indicates exceedances in accordance with the approved IWUL criteria, an investigation into exceedances must be undertaken to understand the cause and determine if related to ash backfilling. If so then relevant authorities need to be notified within 24 hours and an action plan compiled and implemented;
- Monitoring of potential surface water contamination is vital. Local river systems, as well as boreholes should be monitored on a regular basis (Monthly during ash backfilling, Quarterly on completion of Ash Backfilling and Bi-annually when no impacts are detected for a period of three years after the project has ceased);
- The IGS report for backfilling methodology (Lukas et al. 2013) indicates that the risk of decant is minimal when using the proposed methodology. However if any emerging decant points are observed during operation, monitoring and mitigation should be implemented weekly until impacts are negated. Backfilling should be carried out under the guidelines of this report;
- In the event that decant occurs, it could be collected to prevent it from freely flowing into the catchment and collected and treated before disposal;
- Flow meters must be installed at either end of the pipelines to ensure that the same amount of slurry leaving the pump station, enters the underground workings;

- These reading should be taken on a daily basis and reported on monthly to Sasol headquarters. Additionally these readings should be incorporated into the quarterly surface and groundwater monitoring report currently being undertaken for Sigma Defunct Colliery which must be submitted to DWS;
- Comparisons between the volumes dispensed and received should be made to ensure no leaks in the pipeline have occurred;
- Should a variation be identified, further investigation must be undertaken to identify the location of the leak. Any leaks in the pipeline must be repaired immediately.
- Dirty water may not be permitted to be discharged to the environment
- All erosion noted within the operational footprint as a result of surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan;
- A suitable AIP control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones;
- Permit only essential personnel within the 32 or 100 m zones of regulation for all wetland features identified;
- No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained;
- No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines;
- It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows.
- The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash.
- During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level.
- Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes.

- For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1. Thus the ash material is non-acid forming. Consequently, backfilling of ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation.

21.2.3 Decommissioning / Post closure Phase

- Care should be taken not to impact areas that have remained un-affected throughout the life of the project;
- Continuous post-closure monitoring is required so that drastic deterioration in surface and groundwater quality is detected as soon as it occurs, allowing for mitigation measures to implemented early. Monitoring is recommended to be conducted until satisfactory groundwater quality is reached and thereafter signed off by the relevant authorities. Should an impact be detected through monitoring, affected receptors should be compensated and monitoring programme should be adapted to assess potential changes within the study area;
- As an additional consideration, is recommended that geotechnical surveys are undertaken on a regular (every two years) basis to ensure the stability of the potential subsidence areas following the ash-backfilling project;
- The pipeline should only be removed in sections. Once a certain area has been decommissioned and rehabilitated the next section can be removed to prevent extended impact to soil;
- Areas should be rehabilitated and vegetation allowed (where vegetation was previously cleared during decommissioning) to grow immediately after the pipeline has been removed;
- Limit the footprint area of the decommissioning and rehabilitation activities to what is essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas);
- All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan;
- No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines;
- An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases;
- Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility;

- Vegetation (where previously cleared) should be planted during the wet season to ensure vegetation establishment and prevent unnecessary costs;
- If decant occurs it should be collected and treated as to avoid having it introducing contamination into surface water bodies; and
- Quarterly groundwater monitoring of the proposed boreholes is recommended until satisfactory groundwater quality is reached and groundwater trends reflect stability for a period of three years.

22 Period for which the Environmental Authorisation is required

It is proposed that the pipeline will be constructed within twelve months however a contingency has been provided should delays be experienced (due to economic circumstances, adverse weather conditions or other unforeseen circumstances). Therefore the authorisation to complete the construction phase should be valid for twenty four months. It is unknown how long the ash backfilling project will be undertaken for therefore authorisation should be authorised indefinitely until the ash backfilling project is no longer required and is decommissioned. Decommissioning is proposed to take approximately twelve months.

23 Undertaking

Please refer to Part B, Section 12 for the complete undertaking applicable to the BAR and EMP sections of this report.

24 Financial Provision

Sasol proposes to obtain environmental authorisation for the proposed construction, operation and decommissioning of the pipeline to transfer ash slurry from the Ash supplier to the Sigma underground workings to ensure stability of the underground mine workings to prevent subsidence from occurring. Therefore the basic assessment process has assessed and provided mitigation measures for the decommissioning and rehabilitation of the pipeline. It should be noted that R 517 Million has been secured through financial guarantee for mitigation measures that are proposed to address the significant risk of subsidence and reduce the risk to insignificant. Of this R 517 Million, R 279 Million has been allocated to the ash backfilling project for construction, operational and decommissioning phases.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

24.1 Explain how the aforesaid amount was derived

The financial provision breakdown is provided in Table 24-1.

Table 24-1: Financial Provision for Ash Backfilling Project

Item Description	Estimated Cost
Capital cost	
Access roads and terraces	R 6 000 000
Boreholes and underground seals	R 73 000 000
Slurry delivery system	R 35 000 000
Return water system	R 27 000 000
Electrical supply and reticulation, and C&I	R 12 000 000
Site rehabilitation costs	R 10 000 000
Sub-total (CAPEX)	**R 163 000 000**
Operational cost	
Electricity costs (extra over disposal to FAD5)	R 4 000 000
Plant and personnel	R 45 000 000
Maintenance costs	R 14 000 000
Sub-total (OPEX) (PV)	**R 63 000 000**
Sub-total (CAPEX + OPEX)	**R 226 000 000**
Contingency (10%)	**R 23 000 000**
Sub-total	**R 249 000 000**
P and G / Overheads (12%)	**R 30 000 000**
Total (Excl. VAT)	**R 279 000 000**

24.2 Confirm that this amount can be provided for from operating expenditure

The financial guarantee of R 279 Million has already been approved and provided for in Sigma Defunct Colliery financial provision for rehabilitation.

25 Specific Information required by the competent Authority

Compliance with the provisions of sections 24(4)(a) and (b) read with section 24 (3) (a) and (7) of the National Environmental Management Act (Act 107 of 1998). The EIA report must include the:-

25.1 Impact on the socio-economic conditions of any directly affected person

A number of positive social impacts associated with the project have been identified and summarised below:

- Creation of jobs during the construction phase of the pipeline;
- Ensure a safe environment which is able to sustain a long term land use;
- Prevent subsidence from occurring which can result in a health and safety impact to the community living on the mining lease area as well as the surrounding community; and
- Creation of jobs during decommissioning and rehabilitation phase while the pipeline is being removed.

25.2 Impact on any national estate referred to in section 3(2) of the National Heritage Resources Act.

In support of the original BA process, Digby Wells completed a Heritage Resources Management (HRM) process in compliance with Section 38 of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA). The resultant report was submitted to South African Heritage Resources Agency (SAHRA) and Heritage Free State (HFS) online via the South African Heritage Resources Information System (SAHRIS[20]) for statutory comment in compliance with Section 38(8) of the NHRA. SAHRA issued Final Comment on this case[21]. The case is considered closed and approved.

No heritage resources were identified during the pre-disturbance survey undertaken on 25 September 2013. No sources of risk to heritage resources were identified in relation project-related activities.

[20] SAHRIS Case ID 5035, accessible at: http://www.sahra.org.za/sahris/cases/sasol-mining-sigma-colliery-ash-backfilling-project.

[21] Dated 17 November 2014, accessible at: http://www.sahra.org.za/sahris/node/181881.

Given the current state of the cultural landscape, the apparent absence of any significant tangible heritage resource and the limited impact of the proposed Sigma Defunct Colliery ash backfilling project, the following recommendations are made:

- SAHRA and HFS must consider granting Sigma Defunct Colliery exemption from further heritage studies inclusive of all complementary specialist studies, for the Sigma Defunct Colliery ash backfilling project, in line with Final Comment passed on the original report;
- If granted the exemption should however be subject to periodic monitoring of the construction of the pipeline and ash backfilling activities to ensure that heritage resources are avoided if present;
- It must also explicitly be stated that if exemption is granted, it only applies to the Sigma Defunct Colliery project as described in this report – any additional work or deviations may be subject to additional heritage studies; and
- In the event that any heritage resources are accidently found during the course of the project, work must cease and appropriate Chance Find Procedures (CFPs) must be implemented. The CFPs are presented in Appendix D of the heritage specialist study (Appendix H).

26 Other matters required in terms of sections 24(4)(a) and (b) of the Act

Section 24(4)(b)(i) of the NEMA (as amended), provides that an investigation must be undertaken of the potential consequences or impacts of the alternatives to the activity on the environment and assessment of the significance of those potential consequences or impacts, including the option of not implementing the activity. The outcome of the investigation has been provided in Section 7 to Section 13 Part A of this Basic Assessment Report.

Part B: Environmental Management Programme Report

1 Details of the EAP

Digby Wells and Associates (South Africa) (Pty) Ltd (trading as Digby Wells Environmental – hereafter Digby Wells) has been appointed as the independent Environmental Assessment Practitioner (EAP) to undertake the EIA process. The details of the EAP are provided in below.

Table 1-1: Contact Details of the EAP

Name of Practitioner:	Mr Danie Otto
Telephone:	011 789 9495
Fax:	011 069 6801
Postal Address	Private Bag X10046, Randburg, 2125, South Africa
Email:	Danie.Otto@digbywells.com

2 Description of the Aspects of the Activity

A summary of the baseline environment in the project area is provided in Part A: Section 11. It should be noted that the flowing specialist studies have been undertaken for the project:

- Aquatic Ecology Specialist Study (Appendix E)
- Fauna and Flora Specialist Study (Appendix F);
- Wetland Specialist Study (Appendix G);
- Heritage Specialist Study (Appendix H);
- Groundwater Specialist Study (Appendix I); and
- Surface Water Specialist Study (Appendix J).

Additional information has been sourced from previous specialist studies undertaken for Sigma Defunct Colliery and in the surrounding areas.

Previous specialist studies which were completed in 2013 and were not updated in 2018 include:

- Geochemistry Specialist Study (Appendix K);
- Noise Specialist Study (Appendix L);
- Social Specialist Study (Appendix M); and
- Visual Specialist Study (Appendix N).

3 Composite Map

The composite plan for the project area, indicating sensitive areas, heritage resources watercourse buffers, is included as Plan 19 in Appendix B.

4 Description of Impact Management Objectives including Management Statements

4.1 Determination of Closure Objectives

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation.

The following points outline the main objectives for rehabilitation and closure:

- Achieve a final land use where no evidence of the pipeline is identified, and that is sustainable and meets both legislative requirements and stakeholder needs.
- Maintain and monitor all rehabilitated areas following re-vegetation;
- Monitor to ensure no impact to the water resources occur once ash backfilling has been completed;
- Comply with local, district and national regulatory requirements; and
- Follow a comprehensive consultation and communication process with all stakeholders.

Rehabilitation and closure objectives have been tailored to the project at hand. Sasol proposes to obtain environmental authorisation for the proposed construction, operation and decommissioning of the pipeline to transfer ash slurry from the Ash supplier to the Sigma underground workings to ensure stability of the underground mine workings to prevent subsidence from occurring. Therefore the basic assessment process has assessed and provided mitigation measures for the decommissioning and rehabilitation of the pipeline. It should be noted that R 517 Million has been secured through financial guarantee for mitigation measures that are proposed to address the significant risk of subsidence and reduce the risk to insignificant. Of this R 517 Million, R 279 Million has been allocated to the ash backfilling project for construction, operational and decommissioning phases.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

4.2 Volumes and Rate of Water Use required for the Operation

Approximately 1816 m^3 per day of grey water plus approximately 430 m^3 per day of clean water will be made available to mix with the ash to create ash slurry which will be pumped to the underground mine voids. The ash slurry to be pumped to the mine voids is estimated to be approximately 2150 m^3 per day of this approximately 334 m^3 per day will be ash which settles in the mine void. It is estimated that a total of approximately 2580 m^3 of water will be pumped out of the underground workings after the slurry has been pumped it. This will be reutilised back into the process.

4.3 Has a Water Use Licence has been applied for

An IWUL application with its associated IWWMP for the proposed ash backfilling project was submitted to the DWS on 3 March 2014. An IWUL was granted along with its amendments by the DWS on 11 October 2017 (Licence No. 10/C22K/CGIJ/4608). The IWUL was granted for the triggering of Section 21 water uses as listed below:

- Section 21 (c): impeding or diverting the flow of water in a watercourse;
- Section 21(g): disposing of waste in a manner which may detrimentally impact on a water resource
- Section 21 (i): altering the bed, banks, course or characteristics of a watercourse
- Section 21 (j): removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people

5 Impacts to be mitigated in their Respective Phases

The following mitigation measures implemented to address the negative impacts associated with the proposed project is described in Table 5-1.

Table 5-1: Mitigation Measures to be implemented per Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Construction Phase	Construction of the Pipeline and associated clearance activities	Surface Water	3 ha	▪ Prioritize backfill at the potential subsidence areas to reduce or minimize the potential hydrological modifications ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures that allows the pipeline to cross at an elevation above the natural water level	General Notice Regulation Number 704 (GN 704) guideline of the National Water Act, Act 36 of 1998	Construction phase
Construction Phase	Construction of the pipeline and associated clearance activities	Surface Water / Aquatic Ecology	3 ha	▪ Develop soil management measures for the construction area/s that will prevent an increased runoff into the associated watercourse, such as the construction of trenches and/or the use of silt curtains; ▪ Erosion control structures and mechanisms, such as surface stormwater drainage systems, should be implemented so as to reduce the potential occurrence of erosion and sedimentation within and adjacent to the associated watercourses; ▪ The disturbance of instream channels and riparian zones must be minimized, where possible; ▪ Vehicles must be maintained according to their maintenance plans; ▪ Stationary vehicles should have a drip tray placed below the machine; ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Surface water draining off contaminated areas containing oil and petrol would need to be channeled towards a sump which will separate these chemicals and oils; ▪ Portable septic toilets are to be provided and maintained (including their removal without sewage spillage) for construction crews outside of the 1-100 year floodline; and ▪ Store all litter carefully so it cannot be washed or blown into any of the watercourses within the study area; ▪ Extra precautions should be taken in areas within 500 meters of the Leeuspruit or Rietspruit to prevent any potential impact to the water courses this includes effective stormwater control measures around the areas where the pipeline is being constructed to prevent sedimentation of the rivers.	GN 704 requirements regarding stormwater management	Construction phase
Construction Phase	Construction of the pump booster station	Surface Water	3 ha	▪ As the booster pump station already exists (with bunding and foundations), clean-up kits for accidental spillage must be available on-site to prevent the spread of accidental spillages and associated impacts. ▪ The mine personnel must be trained for clean-up of and report hydrocarbon containing material spillages.	GN 704 requirements regarding stormwater management	Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	3 ha	▪ The pipeline may not be constructed within 100 metres of a wetland buffer with the exception of the various wetland crossing. ▪ Pipeline crossings over wetlands should be above ground on supports so that any damage to the pipes can be detected and minimal wetland area is removed for the pipeline construction. ▪ Erosion control measures should be implemented by re-seeding bare areas of wetland and grassland buffer strips with mixed seed spray of indigenous sedges and grasses.	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005);	Construction phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	3 ha	▪ The pipeline route should be designed in such a way that the route of existing infrastructure such as roads and bridges is utilised so that further infringement of infrastructure into the wetland is avoided. ▪ Ensure minimal wetland area is removed for the pipeline construction.	▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Construction phase
Construction Phase	Construction of the ash backfill pipeline will lead to the direct loss of the vegetation on site.	Fauna and Flora	3 ha	▪ The pipeline route should follow existing roads, servitudes and pipeline routes as far as possible. ▪ The areas of Moderately High Sensitivity (wetlands and riparian edges) and Medium (Secondary Grassland and Degraded Woodland/Savanna) must be avoided ▪ All Highly Sensitive Areas should be avoided and these include all Wetland and Riparian habitat on site. ▪ Restrict access to areas that are not to be disturbed from the pipeline construction ▪ Ensure an alien invasive species management plan is compiled and implemented to prevent the spread of invasive species along the pipeline route. ▪ Keeping clearing of vegetation to a minimum. Excessive vegetation clearance must not be permitted.		Construction phase
Construction Phase	The construction of the backfill pipeline will result in the loss of certain biodiversity aspects.	Fauna and Flora	3 ha	▪ If encountered all SSC, as well as the immediate habitat surrounding them, should be preserved and construction of the pipeline should be restricted to areas outside of their immediate habitat. ▪ In the case where this is not possible, and all efforts to avoid these areas have been exhausted, permits may be applied for from the provincial authorities to translocate these species. ▪ It is imperative that the habitat in which these species are translocated to is as similar to the donor habitat as possible and is also within close proximity to the site.		Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands and Fauna and Flora	3 ha	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation; ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction; ▪ Limit the footprint area of the construction activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas); ▪ If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated; ▪ Ensure that no incision and canalisation of the wetland features present takes place; ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; ▪ Soils which were compacted as a result of construction activities should be ripped/scarified (<300 mm) and profiled; ▪ A suitable Alien Invasive Plant (AIP) control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all freshwater features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the project area;	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Construction phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
				▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or river courses and their associated zones of regulation. All vehicles must remain on demarcated roads and within the construction footprint; ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All spills should be immediately cleaned up and treated accordingly; ▪ Wetlands should be monitored weekly during construction; and ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.		

Construction Phase	Construction of the Pipeline and associated clearance activities	Soil, Land Use and Land Capability	3 ha	▪ The pipeline must be constructed in sections not exceeding 100m per section. A maximum of 3 sections may be active at the same time, by the undertaking of one of the following activities per section:
				  ▪ Vegetation Clearance;
				  ▪ Installation of the pipeline; or
				  ▪ Rehabilitation of the footprint.
				▪ Where the pipeline has been constructed within the road reserve and no vegetation is present, the area should be rehabilitated and soil compacted. No vegetation is required to be established within these areas;
				▪ Suitable stormwater management measures must be implemented to prevent the loss of soil during rainfall events;
				▪ All surfaces that are susceptible to erosion shall be covered with a suitable vegetative cover as soon as construction is completed.
				▪ Rehabilitation to be monitored on an annual basis for three years on completion of the construction phase;
				▪ Areas where vegetation is cleared (either for the pipeline where vegetation is present or for the laydown area), should be rehabilitated with a suitable vegetation cover once constriction has been completed;
				▪ Stockpiling of the pipes to be installed must be limited to only what is required and only be stored in designated areas to avoid any unnecessary soil compaction.
					▪ Chamber of Mines Guidelines
					▪ CARA
						Construction phase

Construction Phase	Construction of the Pipeline and associated clearance activities	Air Quality	3 ha	▪ The disturbed areas must be kept to a minimum and it is advised to not clear vegetation unnecessarily; and ▪ Water or a chemical dust suppressant should be used to dampen dust generating areas such as areas where soil has been exposed.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004 standards 2009; ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013). ▪ Act, 2004 (Act No. 39 of 2004) – National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Microns Meters (PM 2.5) 2012	Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Groundwater	3 ha	▪ Machinery should be maintained properly; diesel or other chemicals should be handled appropriately and not spilled. ▪ Re-fueling protocols must also be followed to ensure no diesel is spilled during re-fueling. ▪ Storage tanks must be in a bunded area. ▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed at an acceptable dumping facility.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Construction phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
				▪ Construction vehicles and machinery repairs must only take place in designated workshop areas. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Groundwater monitoring, to assess the time series water quality impacts and trends.		
Construction Phase	Drilling of boreholes	Groundwater	3 ha	▪ Backfilling boreholes should be constructed with solid casing from the top to end, to avoid cross contamination and transportation of the ash slurry from the backfilling borehole via preferred pathways; and ▪ Boreholes should be equipped with lockable security caps. ▪ It is recommended that backfilling boreholes should be drilled in approximately 300 m intervals along the pipeline route. ▪ Once boreholes have been drilled the area around the borehole must be rehabilitated back to its existing state. All evidence of drilling activities must be removed.		Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Social	3 ha	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, construction workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Heritage	3 ha	▪ In the event that heritage resources are identified during project-related activities, potential risks to those heritage resources will need to be assessed. This will be achieved through the development and implementation of a Chace Finds Protocol (CFP) prior to the commencement of construction (refer to Section 9 of the heritage specialist study).	▪ The National Heritage Resources Act, 1999 (Act No. 25 of 1999) ▪ Regulations to the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (GN R 548) (SAHRA Regulations)' ▪ SAHRA Minimum Standards: Archaeological and Paleontological Components of Impact Assessment Reports	
Operational Phase	Ash Backfilling Project	Aquatic Ecology	Project area	▪ Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report for Ash Backfilling Methodology); ▪ Surface pipelines should be inspected for leaks on a weekly basis ; ▪ Cut off valves should be installed on the pipeline to be operated in the event of a spillage; ▪ All boreholes and potential decant points should be identified and secured before the ash backfilling occurs;	The National Water Act (NWA), 1998 (Act No. 36 of 1998)	Operational Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Operational Phase	Ash Backfilling Project	Aquatic Ecology	Project area	▪ Aquatic bi-annual biomonitoring (wet and dry season) should be conducted for the duration of the project as well as after the project is completed; ▪ If ash spills occur the following mitigation is recommended: ▪ Contain the ash using berms and cut off trenches and create emergency shutoff points that should be activated; ▪ Ash within the river reaches should be removed by mechanical means; and ▪ Investigate potential emergency temporary storage areas should the ash need to be redirected.		
Operational Phase	Ash Backfilling Project	Surface Water	Project area	▪ Surface pipelines should be inspected for leaks on regular basis (weekly); ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures or other material to make sleeves which can contain material from spillages and prevent surface water contamination; ▪ Cut off valves should be installed on the pipeline with pressure sensors, which stop the flow in the event of a spill; ▪ If monitoring of surface or ground water indicate exceedances in accordance with the approved IWUL criteria, an investigation into exceedances must be undertaken to understand the cause and determine if related to ash backfilling. If so then relevant authorities need to be notified within 24 hours and an action plan compiled and implemented. ▪ Monitoring of potential surface water contamination is vital. Local river systems, as well as boreholes should be monitored on a regular basis (Monthly during ash backfilling, Quarterly on completion of Ash Backfilling and Bi-annually when no impacts are detected for a period of three years after the project has ceased); ▪ If ash spills/ leakage occurs the following mitigation is recommended: ▪ Contain the ash as much as possible using berms and cut off trenches; ▪ Ash which is present within the river reaches should be removed by mechanical means; and ▪ Accidental spillages or leaks or pipe bursts should be reported and downstream users cautioned until any potential impacts are remediated; ▪ The IGS report for backfilling methodology (Lukas et al. 2013) indicates that the risk of decant is minimal when using the proposed methodology. However if any emerging decant points are observed during operation, monitoring and mitigation should be implemented weekly until impacts are negated. Backfilling should be carried out under the guidelines of this report. ▪ In the event that decant occurs, it could be collected to prevent it from freely flowing into the catchment and collected and treated before disposal. ▪ Flow meters must be installed at either end of the pipelines to ensure that the same amount of slurry leaving the pump station, enters the underground workings; ▪ These reading should be taken on a daily basis and reported on monthly to Sasol headquarters. Additionally these readings should be incorporated into the quarterly surface and groundwater monitoring report currently being undertaken for Sigma Defunct Colliery which must be submitted to DWS; ▪ Comparisons between the volumes dispensed and received should be made to ensure no leaks in the pipeline have occurred; ▪ Should a variation be identified, further investigation must be undertaken to identify the location of the leak. Any leaks in the pipeline must be repaired immediately. ▪ Dirty water may not be permitted to be discharged to the environment	GN 704 requirements regarding stormwater management	Operational Phase
Operational Phase	Ash Backfilling Project	Surface Water	Project area		GN 704 requirements regarding stormwater management	Operational Phase
Operational Phase	Ash Backfilling Project	Surface Water	Project area		GN 704 requirements regarding stormwater management	Operational Phase
Operational Phase	Ash Backfilling Project	Surface Water	Project area		GN 704 requirements regarding stormwater management	Operational Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Operational Phase	Ash Backfilling Project	Wetlands	Project area	▪ It is recommended that the methodology proposed for backfilling by IGS (Lukas et al. 2013) is adhered to in order to prevent spillage into wetland areas as far as possible. All voids located in proximity to wetlands that contain boreholes or subsided areas should not be filled unless the risk of indicates that this risk of spilling into the wetland has been investigated. ▪ All pipeline crossings over wetland areas should be monitored for spillage weekly and any damage or spillage should be reported and addressed with urgency.	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Operational Phase
Operational Phase	Potential spills or leaks from pipeline infrastructure and resulting disturbance to soils	Flora and wetlands	Project area	▪ All erosion noted within the operational footprint as a result of surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan; ▪ A suitable AIP control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all wetland features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines; ▪ All spills from maintenance vehicles or leaks from the pipeline should be immediately cleaned up and treated accordingly; and ▪ Monitor all systems for erosion and incision	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Operational Phase
Operational Phase	Ash Backfilling Project	Soil, Land Use and Land Capability	Project area	▪ Continuous inspections of the pipeline route should be undertaken to ensure that soil erosion has not occurred along the pipeline route; and ▪ Areas where erosion has occurred should be rehabilitated.	▪ Chamber of Mines Guidelines ▪ CARA	Operational Phase
Operational Phase	Dewatering	Groundwater	Project area	▪ It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows. ▪ The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash. ▪ During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Operational Phase
Operational Phase	Ash Backfilling Project	Groundwater	Project area	▪ After the ash backfilling commences, the pipeline should be inspected for any potential leak. A monitoring system to continuously monitor the flow between the pump station and the ash backfilling borehole should be installed. ▪ Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Operational Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
				▪ For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1. Thus the ash material is non-acid forming. Consequently, backfilling of ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation.		
Operational Phase	Ash Backfilling Project	Social	Project area and surrounding communities	▪ Notification to stakeholders on the ash backfilling project schedule should be communicated timeously to landowners in person before and during implementation; ▪ Provide periodic feedback on monitoring results to landowners. This will enable Sasol to pro-actively identify and address key concerns; ▪ It is proposed that Sasol provide feedback to landowners in person on the following matters: ▪ Timelines required for the stabilisation of sub-surface ash used during the backfilling; ▪ Progress of stabilisation of the surface in order to enable landowners to plan accordingly; and ▪ How the ash backfilling will impact the supply of water, now and for the future.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	Operational Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Surface Water / Aquatic Ecology	3 ha	▪ Care should be taken not to impact areas that have remained un-affected throughout the life of the project. ▪ On-going rehabilitation should be conducted throughout the decommissioning and closure phase. Only the removal of remaining infrastructure and re-shaping the final topography should occur during the closure phase. ▪ Repairs on vehicles and machinery utilised during decommissioning and rehabilitation must only take place in designated workshop areas. ▪ Vehicles must be maintained according to their maintenance plans. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Continuous post-closure monitoring is required so that drastic deterioration in surface and groundwater quality is detected as soon as it occurs, allowing for mitigation measures to implemented early. Monitoring is recommended to be conducted until satisfactory groundwater quality is reached and thereafter signed off by the relevant authorities. Should an impact be detected through monitoring, affected receptors should be compensated and monitoring programme should be adapted to assess potential changes within the study area. ▪ As an additional consideration, is recommended that geotechnical surveys are undertaken on a regular (every two years) basis to ensure the stability of the potential subsidence areas following the ash-backfilling project.	▪ GN 704 requirements regarding stormwater management ▪ The National Water Act (NWA), 1998 (Act No. 36 of 1998)	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Soil, Land Use and Land Capability	3 ha	▪ Immediately clean up any hydrocarbon spills in accordance with the hydrocarbon Standard Operating Procedure (SOP). ▪ Vehicles and machinery must be serviced in bunded areas. ▪ Suitable stormwater measures must be implemented to prevent the loss of soil to soil erosion. ▪ The pipeline should only be removed in sections. Once a certain area has been decommissioned and rehabilitated the next section can be removed to prevent extended impact to soil. ▪ Soil should be stockpiled and utilised to rehabilitate the area once the pipeline has	▪ Chamber of Mines Guidelines ▪ CARA	Decommissioning Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
				been removed. ▪ Areas should be rehabilitated and vegetation allowed (where vegetation was previously cleared during decommissioning) to grow immediately after the pipeline has been removed;		
Decommissioning Phase	Site access roads and pipeline crossing wetlands, Removal of infrastructure and rehabilitation	Flora & Wetlands	3 ha	▪ Limit the footprint area of the decommissioning and rehabilitation activities to what is essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan. ▪ All soils compacted as a result of decommissioning activities should be ripped/scarified (<300 mm) and profiled. ▪ Permit only essential personnel within the zones of regulation for all freshwater features identified. ▪ Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream. ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage. ▪ Wetlands and their associated zones of regulation are to be clearly demarcated and avoided wherever possible. ▪ An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases. ▪ As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils, vegetation clearance should be kept to a minimum. ▪ Monitor all systems for erosion and incision. ▪ All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint. ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All existing litter, debris should be removed from the wetland areas and littering should be prohibited on an ongoing basis; ▪ All spills from machinery should be immediately cleaned up and treated accordingly; ▪ Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility.	▪ National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) ▪ National Environmental Biodiversity Act (NEMBA), 2004 (Act 10 of 2004) ▪ Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983)	Decommissioning Phase

Phase	Activity	Aspect	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Air Quality	3 ha	▪ Vegetation establishment (where vegetation was previously cleared away) must take place on the bare soil to prevent soil erosion and dust creation. ▪ Exposed soil must be kept moist using sprays or water tanks to prevent dust creation before vegetation is established (where vegetation was previously cleared away). ▪ Vegetation (where previously cleared) should be planted during the wet season to ensure vegetation establishment and prevent unnecessary costs.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004 standards 2009; ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013). ▪ Act, 2004 (Act No. 39 of 2004) – National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Microns Meters (PM 2.5) 2012	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Project area	▪ If decant occurs it should be collected and treated as to avoid having it introducing contamination into surface water bodies.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Project area	▪ Quarterly groundwater monitoring of the proposed boreholes is recommended until satisfactory groundwater quality is reached and groundwater trends reflect stability for a period of three years.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Social	Project area	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, workers and other service providers will be recruited surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	Decommissioning Phase

6 Impact Management Outcomes

A description of impact management outcomes, identifying the standard of impact management required for the aspects contemplated in Table 6-1.

Table 6-1: Impact Management Outcomes

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
Construction Phase	Construction of the Pipeline and associated clearance activities	Surface Water	Alteration of the natural hydrology or disturbance of natural stream and flows	▪ Prioritize backfill at the potential subsidence areas to reduce or minimize the potential hydrological modifications ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures that allows the pipeline to cross at an elevation above the natural water level	GN 704 requirements regarding stormwater management	Construction phase
Construction Phase	Construction of the pipeline and associated clearance activities	Surface Water / Aquatic Ecology	Potential sedimentation and contamination of water from hydrocarbons, as a result of the construction vehicles utilised. This can result in Sedimentation of the associated watercourses and Water quality impairment	▪ Develop soil management measures for the construction area/s that will prevent an increased runoff into the associated watercourse, such as the construction of trenches and/or the use of silt curtains; ▪ Erosion control structures and mechanisms, such as surface stormwater drainage systems, should be implemented so as to reduce the potential occurrence of erosion and sedimentation within and adjacent to the associated watercourses; ▪ The disturbance of instream channels and riparian zones must be minimized, where possible; ▪ Vehicles must be maintained according to their maintenance plans; ▪ Stationary vehicles should have a drip tray placed below the machine; ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Surface water draining off contaminated areas containing oil and petrol would need to be channeled towards a sump which will separate these chemicals and oils; ▪ Portable septic toilets are to be provided and maintained (including their removal without sewage spillage) for construction crews outside of the 1-100 year floodline; and ▪ Store all litter carefully so it cannot be washed or blown into any of the watercourses within the study area; ▪ Extra precautions should be taken in areas within 500 meters of the Leeuspruit or Rietspruit to prevent any potential impact to the water courses this includes effective stormwater control measures around the areas where the pipeline is being constructed to prevent sedimentation of the rivers.	GN 704 requirements regarding stormwater management	Construction phase
Construction Phase	Construction of the pump booster station	Surface Water	The booster pump station will entail the use of hydrocarbon lubricants for the machine moving parts, which, if not well maintained, could be a source of hydrocarbon contamination. Accidental spillage of hydrocarbon containing materials such as oils or lubricants may occur.	▪ As the booster pump station already exists (with bunding and foundations), clean-up kits for accidental spillage must be available on-site to prevent the spread of accidental spillages and associated impacts. ▪ The mine personnel must be trained for clean-up of and report hydrocarbon containing material spillages.	GN 704 requirements regarding stormwater management	Construction phase
Construction Phase	Construction of the	Wetlands	Loss of wetland area is	▪ The pipeline may not be constructed within 100 metres of a wetland buffer	▪ The NWA Section 21 (c), (g) and (i) of	Construction phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
	Pipeline and associated clearance activities		anticipated to occur due to excavation during construction of the proposed ash backfilling pipeline, as the wetlands will be intersected at 31 points.	with the exception of the various wetland crossing. ▪ Pipeline crossings over wetlands should be above ground on supports so that any damage to the pipes can be detected and minimal wetland area is removed for the pipeline construction. ▪ Erosion control measures should be implemented by re-seeding bare areas of wetland and grassland buffer strips with mixed seed spray of indigenous sedges and grasses.	the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands	Loss of Wetland vegetation	▪ The pipeline route should be designed in such a way that the route of existing infrastructure such as roads and bridges is utilised so that further infringement of infrastructure into the wetland is avoided. ▪ Ensure minimal wetland area is removed for the pipeline construction.		Construction phase
Construction Phase	Construction of the ash backfill pipeline will lead to the direct loss of the vegetation on site.	Fauna and Flora	Loss of Plant Communities	▪ The pipeline route should follow existing roads, servitudes and pipeline routes as far as possible. ▪ The areas of Moderately High Sensitivity (wetlands and riparian edges) and Medium (Secondary Grassland and Degraded Woodland/Savanna) must be avoided ▪ All Highly Sensitive Areas should be avoided and these include all Wetland and Riparian habitat on site. ▪ Restrict access to areas that are not to be disturbed from the pipeline construction ▪ Ensure an alien invasive species management plan is compiled and implemented to prevent the spread of invasive species along the pipeline route. ▪ Keeping clearing of vegetation to a minimum. Excessive vegetation clearance must not be permitted.		Construction phase
Construction Phase	The construction of the backfill pipeline will result in the loss of certain biodiversity aspects.	Fauna and Flora	Loss of biodiversity	▪ If encountered all SSC, as well as the immediate habitat surrounding them, should be preserved and construction of the pipeline should be restricted to areas outside of their immediate habitat. ▪ In the case where this is not possible, and all efforts to avoid these areas have been exhausted, permits may be applied for from the provincial authorities to translocate these species. ▪ It is imperative that the habitat in which these species are translocated to is as similar to the donor habitat as possible and is also within close proximity to the site.		Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Wetlands and Fauna and Flora	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	▪ Ensure soil management programme is implemented and maintained to minimise erosion and sedimentation; ▪ Active rehabilitation, re-sloping, and re-vegetation of disturbed areas immediately after construction; ▪ Limit the footprint area of the construction activities to what is absolutely essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas); ▪ If it is absolutely unavoidable that any of the wetland areas present will be affected, disturbance must be minimised and suitably rehabilitated; ▪ Ensure that no incision and canalisation of the wetland features present takes place; ▪ All erosion noted within the construction footprint should be remedied immediately and included as part of an ongoing rehabilitation plan; ▪ Soils which were compacted as a result of construction activities should be	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Construction phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
				ripped/scarified (<300 mm) and profiled; ▪ A suitable Alien Invasive Plant (AIP) control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all freshwater features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the project area; ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas or river courses and their associated zones of regulation. All vehicles must remain on demarcated roads and within the construction footprint; ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All spills should be immediately cleaned up and treated accordingly; ▪ Wetlands should be monitored weekly during construction; and ▪ Appropriate sanitary facilities must be provided for the duration of the construction activities and all waste must be removed to an appropriate waste facility.		

Construction Phase	Construction of the Pipeline and associated clearance activities	Soil, Land Use and Land Capability	During the pipeline construction, soil erosion and contamination are possible. The soil impacts may be a result of vegetation (where applicable) and topsoil removal for the pipeline and laydown areas, as well as compaction caused by vehicle and machinery onsite.	▪ The pipeline must be constructed in sections not exceeding 100m per section. A maximum of 3 sections may be active at the same time, by the undertaking of one of the following activities per section:
				  ▪ Vegetation Clearance;
				  ▪ Installation of the pipeline; or
				  ▪ Rehabilitation of the footprint.
				▪ Where the pipeline has been constructed within the road reserve and no vegetation is present, the area should be rehabilitated and soil compacted. No vegetation is required to be established within these areas;
				▪ Suitable stormwater management measures must be implemented to prevent the loss of soil during rainfall events;
				▪ All surfaces that are susceptible to erosion shall be covered with a suitable vegetative cover as soon as construction is completed.
				▪ Rehabilitation to be monitored on an annual basis for three years on completion of the construction phase;
				▪ Areas where vegetation is cleared (either for the pipeline where vegetation is present or for the laydown area), should be rehabilitated with a suitable vegetation cover once constriction has been completed;
				▪ Stockpiling of the pipes to be installed must be limited to only what is required and only be stored in designated areas to avoid any unnecessary soil compaction.
					▪ Chamber of Mines Guidelines
					▪ CARA
						Construction phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
Construction Phase	Construction of the Pipeline and associated clearance activities	Air Quality	Dust generated from site clearing, vehicle movement and the construction of the pipeline.	▪ The disturbed areas must be kept to a minimum and it is advised to not clear vegetation unnecessarily; and ▪ Water or a chemical dust suppressant should be used to dampen dust generating areas such as areas where soil has been exposed.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004 standards 2009; ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013). ▪ Act, 2004 (Act No. 39 of 2004) – National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Microns Meters (PM 2.5) 2012	Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Groundwater	Contamination of groundwater due to hydrocarbon spillages.	▪ Machinery should be maintained properly; diesel or other chemicals should be handled appropriately and not spilled. ▪ Re-fueling protocols must also be followed to ensure no diesel is spilled during re-fueling. ▪ Storage tanks must be in a bunded area. ▪ If a considerable amount of fluid is accidentally spilled, the contaminated soil should be scraped off and disposed at an acceptable dumping facility. ▪ Construction vehicles and machinery repairs must only take place in designated workshop areas. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Groundwater monitoring, to assess the time series water quality impacts and trends.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Construction phase
Construction Phase	Drilling of boreholes	Groundwater	Groundwater quality deterioration, due to ash spillage on the surface and leakage through poorly constructed boreholes	▪ Backfilling boreholes should be constructed with solid casing from the top to end, to avoid cross contamination and transportation of the ash slurry from the backfilling borehole via preferred pathways; and ▪ Boreholes should be equipped with lockable security caps. ▪ It is recommended that backfilling boreholes should be drilled in approximately 300 m intervals along the pipeline route. ▪ Once boreholes have been drilled the area around the borehole must be rehabilitated back to its existing state. All evidence of drilling activities must be removed.		Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Social	Creation of jobs during the construction phase of the pipeline	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, construction workers and other service providers will be recruited from surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	Construction phase
Construction Phase	Construction of the Pipeline and associated clearance activities	Heritage	Effects of impaired water quality on aquatic biota should a sudden burst in the pipeline occur. Coal Ash contains many toxic	▪ In the event that heritage resources are identified during project-related activities, potential risks to those heritage resources will need to be assessed. This will be achieved through the development and implementation of a Chace Finds Protocol (CFP) prior to the commencement of construction (refer to Section 9 of the heritage	▪ The National Heritage Resources Act, 1999 (Act No. 25 of 1999) ▪ Regulations to the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (GN R 548) (SAHRA Regulations)'	

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
			elements (salts high pH and metals) which are leachable and have the potential to impact directly on aquatic ecology	specialist study).	▪ SAHRA Minimum Standards: Archaeological and Paleontological Components of Impact Assessment Reports	

Operational Phase	Ash Backfilling Project	Aquatic Ecology	The project has the potential to alter aquatic habitat through the influx of fine particulate matter in the form of ash. Ash, if present near to the river systems, will settle in local river systems and cover available habitat thus reducing diversity and restricting the presence of habitat sensitive species.	▪ Strictly adhering to the engineering and geotechnical procedure for the pumping of the ash slurry (IGS Report for Ash Backfilling Methodology);
				▪ Surface pipelines should be inspected for leaks on a weekly basis;
				▪ Cut off valves should be installed on the pipeline to be operated in the event of a spillage;
				▪ All boreholes and potential decant points should be identified and secured before the ash backfilling occurs;
				▪ Aquatic bi-annual biomonitoring (wet and dry season) should be conducted for the duration of the project as well as after the project is completed;
				▪ If ash spills occur the following mitigation is recommended:
				  ▪ Contain the ash using berms and cut off trenches and create emergency shutoff points that should be activated;
				  ▪ Ash within the river reaches should be removed by mechanical means; and
				  ▪ Investigate potential emergency temporary storage areas should the ash need to be redirected.
					The National Water Act (NWA), 1998 (Act No. 36 of 1998)	Operational Phase

Operational Phase	Ash Backfilling Project	Aquatic Ecology	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Introduction of pollutants in the form of dissolved metals, suspended solids/ particulate matter and salts form ash slurry			
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Changes in the natural pH to alkaline resulting in mobilisation of certain elements	▪ Surface pipelines should be inspected for leaks on regular basis (weekly); ▪ Ensure that the pipes at stream crossings are mounted on stilts with concrete structures or other material to make sleeves which can contain material from spillages and prevent surface water contamination; ▪ Cut off valves should be installed on the pipeline with pressure sensors, which stop the flow in the event of a spill; ▪ If monitoring of surface or ground water indicate exceedances in accordance with the approved IWUL criteria, an investigation into exceedances must be undertaken to understand the cause and determine if related to ash backfilling. If so then relevant authorities need to be notified within 24 hours and an action plan compiled and implemented. ▪ Monitoring of potential surface water contamination is vital. Local river systems, as well as boreholes should be monitored on a regular basis (Monthly during ash backfilling, Quarterly on completion of Ash Backfilling	GN 704 requirements regarding stormwater management	Operational Phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
Operational Phase	Ash Backfilling Project	Surface Water	In the event of pipe bursts or leaks over stream crossings, ash will be deposited directly in the streams resulting in contamination of the surface water. Given the stream crossings identified, the impact on the surface water could be seen at the farm dams and surrounding tributaries. ▪ Water contamination from the underground mine water pumped out, in the case of a burst pipe	and Bi-annually when no impacts are detected for a period of three years after the project has ceased); ▪ If ash spills/ leakage occurs the following mitigation is recommended: ▪ Contain the ash as much as possible using berms and cut off trenches; ▪ Ash which is present within the river reaches should be removed by mechanical means; and ▪ Accidental spillages or leaks or pipe bursts should be reported and downstream users cautioned until any potential impacts are remediated; ▪ The IGS report for backfilling methodology (Lukas et al. 2013) indicates that the risk of decant is minimal when using the proposed methodology. However if any emerging decant points are observed during operation, monitoring and mitigation should be implemented weekly until impacts are negated. Backfilling should be carried out under the guidelines of this report. ▪ In the event that decant occurs, it could be collected to prevent it from freely flowing into the catchment and collected and treated before disposal. ▪ Flow meters must be installed at either end of the pipelines to ensure that the same amount of slurry leaving the pump station, enters the underground workings; ▪ These reading should be taken on a daily basis and reported on monthly to Sasol headquarters. Additionally these readings should be incorporated into the quarterly surface and groundwater monitoring report currently being undertaken for Sigma Defunct Colliery which must be submitted to DWS; ▪ Comparisons between the volumes dispensed and received should be made to ensure no leaks in the pipeline have occurred; ▪ Should a variation be identified, further investigation must be undertaken to identify the location of the leak. Any leaks in the pipeline must be repaired immediately. ▪ Dirty water may not be permitted to be discharged to the environment	GN 704 requirements regarding stormwater management	Operational Phase
Operational Phase	Ash Backfilling Project	Surface Water	The pipeline could impede flows in the catchments where they traverse streams and drainage lines. Impacts could arise if pipes containing slurry burst and large amounts spill on or close to stream crossings. These could result in particulate matter sedimentation in stream channels which could alter the hydrology.		GN 704 requirements regarding stormwater management	Operational Phase
Operational Phase	Ash Backfilling Project	Wetlands	Leakages in the pipeline at one of the 31 wetland crossing points may result in surface water contamination due to heavy metals that may be contained in the fly-ash. This can result in chemical contamination of wetlands and reduces its functionality	▪ It is recommended that the methodology proposed for backfilling by IGS (Lukas et al. 2013) is adhered to in order to prevent spillage into wetland areas as far as possible. All voids located in proximity to wetlands that contain boreholes or subsided areas should not be filled unless the risk of indicates that this risk of spilling into the wetland has been investigated. ▪ All pipeline crossings over wetland areas should be monitored for spillage weekly and any damage or spillage should be reported and addressed with urgency.	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Operational Phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
Operational Phase	Potential spills or leaks from pipeline infrastructure and resulting disturbance to soils	Flora and wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Compaction of soils; ▪ Loss of sensitive species ▪ Loss of natural vegetation; ▪ Increased sedimentation; and ▪ Increased potential for erosion.	▪ All erosion noted within the operational footprint as a result of surface activities should be remedied immediately and included as part of the ongoing rehabilitation plan; ▪ A suitable AIP control programme must be put in place so as to prevent further encroachment as a result of disturbance to the surrounding terrestrial zones; ▪ Permit only essential personnel within the 32 or 100 m zones of regulation for all wetland features identified; ▪ No unnecessary crossing of the wetland features and their associated buffers should take place and the substrate conditions of the wetlands and downstream stream connectivity must be maintained; ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines in the vicinity of the ash backfilling project; ▪ All spills from maintenance vehicles or leaks from the pipeline should be immediately cleaned up and treated accordingly; and ▪ Monitor all systems for erosion and incision	▪ The NWA Section 21 (c), (g) and (i) of the NWA ▪ Section 24 of the Constitution ▪ NEM:BA ▪ NEMA ▪ Department of Water and Forestry (DWAF) guidelines for the delineation of wetlands (2005); ▪ Mining and Biodiversity Guideline (DEA et al., 2013); ▪ MTPB, 2014	Operational Phase
Operational Phase	Ash Backfilling Project	Soil, Land Use and Land Capability	Loss of vegetation along the pipeline route resulting in soil erosion	▪ Continuous inspections of the pipeline route should be undertaken to ensure that soil erosion has not occurred along the pipeline route; and ▪ Areas where erosion has occurred should be rehabilitated.	▪ Chamber of Mines Guidelines ▪ CARA	Operational Phase
Operational Phase	Dewatering	Groundwater	Groundwater quantity impact	▪ It is recommended that mine void dewatering be concurrent with the ash backfilling process to prevent inflow into the void. Ash backfilling should occur at one third more than the abstraction rate after having dewatered the head dependent in flows. ▪ The ash slurry consist of 20% ash and 80% water, it follows that after the initial backfill, the ash will settle and the top 80% of the mine void will still be filled with water. The process of water abstraction should therefore be repeated to ensure that the mine void space is sufficiently backfilled with ash. ▪ During ash backfilling the water level in the mine compartments should be monitored on weekly basis. Loggers could be installed to take automatic readings of the water level.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Operational Phase
Operational Phase	Ash Backfilling Project	Groundwater	Groundwater quality impact	▪ After the ash backfilling commences, the pipeline should be inspected for any potential leak. A monitoring system to continuously monitor the flow between the pump station and the ash backfilling borehole should be installed. ▪ Dewatering should not be conducted prior to ash backfilling but rather conducted simultaneously with ash backfilling. Currently the underground mine is completely flooded, sulphate oxidation has stopped and equilibrium processes are more dominant. Dewatering of the underground void prior to ash backfilling may result in the reestablishment of kinetic sulphide oxidation processes. ▪ For sustainable long term acid generation, at least 0.3 % sulphide-s is needed. The paste pH of the ash material is highly alkaline with total sulphur below 0.1 %. The low sulphur content and the alkaline nature of the ash allows for the high neutralisation potential ratio (NPR), way above 4:1. Thus the ash material is non-acid forming. Consequently, backfilling of	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Operational Phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
				ash serves as mitigation regarding potential groundwater quality deterioration because the ash will be a source of alkalinity in the mine void, neutralising any potential acid that may be formed due to kinetic sulphide oxidation.		
Operational Phase	Ash Backfilling Project	Social	Impact to people ustilising the land for their livelihood	▪ Notification to stakeholders on the ash backfilling project schedule should be communicated timeously to landowners in person before and during implementation; ▪ Provide periodic feedback on monitoring results to landowners. This will enable Sasol to pro-actively identify and address key concerns; ▪ It is proposed that Sasol provide feedback to landowners in person on the following matters: ▪ Timelines required for the stabilisation of sub-surface ash used during the backfilling; ▪ Progress of stabilisation of the surface in order to enable landowners to plan accordingly; and ▪ How the ash backfilling will impact the supply of water, now and for the future.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Surface Water / Aquatic Ecology	Potential contamination of water from hydrocarbons, as a result of the vehicles utilised during decommissioning.	▪ Care should be taken not to impact areas that have remained un-affected throughout the life of the project. ▪ On-going rehabilitation should be conducted throughout the decommissioning and closure phase. Only the removal of remaining infrastructure and re-shaping the final topography should occur during the closure phase. ▪ Repairs on vehicles and machinery utilised during decommissioning and rehabilitation must only take place in designated workshop areas. ▪ Vehicles must be maintained according to their maintenance plans. ▪ Stationary vehicles should have a drip tray placed below the machine. ▪ Machinery and vehicles should be stored in a designated area and not stored where there is a potential for contamination of the environment. ▪ Continuous post-closure monitoring is required so that drastic deterioration in surface and groundwater quality is detected as soon as it occurs, allowing for mitigation measures to implemented early. Monitoring is recommended to be conducted until satisfactory groundwater quality is reached and thereafter signed off by the relevant authorities. Should an impact be detected through monitoring, affected receptors should be compensated and monitoring programme should be adapted to assess potential changes within the study area. ▪ As an additional consideration, is recommended that geotechnical surveys are undertaken on a regular (every two years) basis to ensure the stability of the potential subsidence areas following the ash-backfilling project.	▪ GN 704 requirements regarding stormwater management ▪ The National Water Act (NWA), 1998 (Act No. 36 of 1998)	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Soil, Land Use and Land Capability	The underlying soil will be compacted and susceptible to erosion. Topsoil will need replacement on the pipeline route. Hydrocarbon spillages from vehicles and machinery	▪ Immediately clean up any hydrocarbon spills in accordance with the hydrocarbon Standard Operating Procedure (SOP). ▪ Vehicles and machinery must be serviced in bunded areas. ▪ Suitable stormwater measures must be implemented to prevent the loss of soil to soil erosion. ▪ The pipeline should only be removed in sections. Once a certain area has	▪ Chamber of Mines Guidelines ▪ CARA	Decommissioning Phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
			used during decommissioning could contaminate soil resources.	been decommissioned and rehabilitated the next section can be removed to prevent extended impact to soil. ▪ Soil should be stockpiled and utilised to rehabilitate the area once the pipeline has been removed. ▪ Areas should be rehabilitated and vegetation allowed (where vegetation was previously cleared during decommissioning) to grow immediately after the pipeline has been removed;		
Decommissioning Phase	Site access roads and pipeline crossing wetlands, Removal of infrastructure and rehabilitation	Flora & Wetlands	Increased vehicular movement along river crossings and within wetland/riparian zones, resulting in: ▪ Potential contamination of soils as a result of the ingress of hydrocarbons; ▪ Loss of natural vegetation; ▪ Increased sedimentation; ▪ Increased potential for onset of erosion; ▪ Potential dumping of decommissioned infrastructure in wetland/riparian areas; and ▪ Potential incomplete removal of infrastructure.	▪ Limit the footprint area of the decommissioning and rehabilitation activities to what is essential in order to minimise impacts as a result of vegetation clearing and compaction of soils (all areas but critically so in wetland areas). ▪ All erosion noted within the decommissioning area footprint should be remedied immediately and included as part of the ongoing rehabilitation plan. ▪ All soils compacted as a result of decommissioning activities should be ripped/scarified (<300 mm) and profiled. ▪ Permit only essential personnel within the zones of regulation for all freshwater features identified. ▪ Wherever possible, restrict decommissioning activities to the drier winter months to avoid sedimentation of the freshwater resources further downstream. ▪ No material may be dumped or stockpiled within or within 500 metres of any rivers, tributaries or drainage lines. ▪ Wetlands and their associated zones of regulation are to be clearly demarcated and avoided wherever possible. ▪ An AIP management plan to be implemented and managed for the life of the proposed decommissioning, rehabilitation, closure and post-closure phases. ▪ As much vegetation growth as possible should be promoted within the proposed development area during all phases. In order to protect soils, vegetation clearance should be kept to a minimum. ▪ Monitor all systems for erosion and incision. ▪ All areas where active erosion is observed should be ripped, re-profiled and seeded with indigenous grasses. ▪ No vehicles or heavy machinery may be allowed to drive indiscriminately within any wetland areas and their associated zones of regulation. All vehicles must remain on demarcated roads and within the project area footprint. ▪ All vehicles must be regularly inspected for leaks; ▪ Re-fueling must take place at the 3 Shaft diesel facility, on a sealed surface area away from water courses to prevent ingress of hydrocarbons into topsoil; ▪ All existing litter, debris should be removed from the wetland areas and littering should be prohibited on an ongoing basis; ▪ All spills from machinery should be immediately cleaned up and treated accordingly; ▪ Appropriate sanitary facilities must be provided for the duration of the rehabilitation activities and all waste must be removed to an appropriate waste facility.	▪ National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) ▪ National Environmental Biodiversity Act (NEMBA), 2004 (Act 10 of 2004) ▪ Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983)	Decommissioning Phase

Phase	Activity	Aspect	Impact	Mitigation Measures	Compliance with standards	Time period for implementation
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Air Quality	The extent of impacts depends on the extent of demolition and rehabilitation efforts during decommissioning. Impacts of this activity on the atmospheric environment will be similar to the impacts during the decommissioning and rehabilitation phase. The impacts will be short-term and localised.	▪ Vegetation establishment (where vegetation was previously cleared away) must take place on the bare soil to prevent soil erosion and dust creation. ▪ Exposed soil must be kept moist using sprays or water tanks to prevent dust creation before vegetation is established (where vegetation was previously cleared away). ▪ Vegetation (where previously cleared) should be planted during the wet season to ensure vegetation establishment and prevent unnecessary costs.	▪ National Environmental Management: Air Quality Act, Act.39 of 2004 standards 2009; ▪ National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) - National Dust Control Regulations (2013). ▪ Act, 2004 (Act No. 39 of 2004) – National Ambient Air Quality Standard for Particulate Matter with Aerodynamic Diameter less than 2.5 Microns Meters (PM 2.5) 2012	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quantity impact	▪ If decant occurs it should be collected and treated as to avoid having it introducing contamination into surface water bodies.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Groundwater	Groundwater quality impact	▪ Quarterly groundwater monitoring of the proposed boreholes is recommended until satisfactory groundwater quality is reached and groundwater trends reflect stability for a period of three years.	▪ SANS ▪ River quality objectives. ▪ South African water quality guidelines for drinking, irrigation and livestock watering.	Decommissioning Phase
Decommissioning Phase	Decommissioning and rehabilitation of the pipeline	Social	Creation of jobs during decommissioning and rehabilitation phase while the pipeline is being removed	▪ Where feasible, promote the creation of employment opportunities for women and youth; ▪ Where possible, workers and other service providers will be recruited surrounding areas to increase employment opportunities for directly affected and local communities; ▪ Establish a monitoring system to ensure that the subcontractors honour the specified local employment policy; and ▪ If required, the local resident status of applicants should be verified in consultation with community representatives and local government.	▪ Mineral and Petroleum Resource Development Act (Act of 2002); ▪ Mine Health and Safety Act (Act of 1996); ▪ Occupational Health and Safety, 1993 (Act no. 85 of 1993) (OHS); ▪ International Human Rights Guiding Principles; ▪ IFC PS 4: Community Health, Safety and Security; and ▪ National Environmental Management Act (Act of 1998).	Decommissioning Phase

7 Financial Provision

Sasol proposes to obtain environmental authorisation for the proposed construction, operation and decommissioning of the pipeline to transfer ash slurry from the Ash supplier to the Sigma underground workings to ensure stability of the underground mine workings to prevent subsidence from occurring. Therefore the basic assessment process has assessed and provided mitigation measures for the decommissioning and rehabilitation of the pipeline. It should be noted that R 517 Million has been secured through financial guarantee for mitigation measures that are proposed to address the significant risk of subsidence and reduce the risk to insignificant. Of this R 517 Million, R 279 Million has been allocated to the ash backfilling project for construction, operational and decommissioning phases.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

7.1 Determination of the amount of Financial Provision

7.1.1 Describe the closure objectives and the extent to which they have been aligned to the baseline environment described under the Regulation

Closure and rehabilitation is a continuous series of activities that begin with planning prior to the project's design and construction, and end with achievement of long-term site stability and the establishment of a self-sustaining ecosystem. Not only will the implementation of this concept result in a more satisfactory environmental conclusion, but it will also reduce the financial burden of closure and rehabilitation. The following points outline the main objectives for rehabilitation and closure:

- Make all areas safe for both humans and animals;
- Make all areas stable and sustainable;
- Maintain and monitor all rehabilitated areas following re-vegetation;
- Comply with local, district and national regulatory requirements; and
- Follow a comprehensive consultation and communication process with all stakeholders.

Rehabilitation and closure objectives have been tailored to the project at hand. The mitigation measures proposed in the decommissioning phase aims to assist Sigma Defunct Colliery in carrying out successful rehabilitation for the ash backfilling project.

7.1.2 Confirm specifically that the environmental objectives in relation to closure have been consulted with landowner and interested and affected parties

A separate closure plan does not form part of this BAR process. The activities relevant to the pipeline have been included in the Sigma financial provisioning for rehabilitation activities to be undertaken at the colliery. This BAR will be made available for public review for a period of 30 days.

7.1.3 Provide a rehabilitation plan that describes and shows the scale and aerial extent of the main mining activities, including the anticipated mining area at the time of closure

This section is considered to be not applicable. The ash backfilling project is considered to be a mitigation measure to implement remediation of the Sigma Defunct Colliery mining lease area. A closure plan has been compiled by Golder Associates Inc. in 2009 and submitted to the DMR for consideration. It is noted that although mining has been undertaken throughout the mining lease area only specific areas will be ash backfilling where a significant impact to the environment or health and safety risk to the community has been identified due to the risk of subsidence.

7.1.4 Explain why it can be confirmed that the rehabilitation plan is compatible with the closure objectives

This section is considered to be not applicable. The ash backfilling project is considered to be a mitigation measure to implement remediation of the Sigma Defunct Colliery mining lease area. A closure plan has been compiled by Golder Associates Inc. in 2009 and submitted to the DMR for consideration. It can be confirmed that the proposed ash backfilling project is in alignment with the closure objects for the Sigma Defunct Colliery.

7.1.5 Calculate and state the quantum of the financial provision required to manage and rehabilitate the environment in accordance with the applicable guideline

Sasol proposes to obtain environmental authorisation for the proposed construction, operation and decommissioning of the pipeline to transfer ash slurry from the Ash supplier to the Sigma underground workings to ensure stability of the underground mine workings to prevent subsidence from occurring. Therefore the basic assessment process has assessed and provided mitigation measures for the decommissioning and rehabilitation of the pipeline. It should be noted that R 517 Million has been secured through financial guarantee for mitigation measures that are proposed to address the significant risk of subsidence and reduce the risk to insignificant. Of this R 517 Million, R 279 Million has been allocated to the ash backfilling project for construction, operational and decommissioning phases.

Sigma Defunct Colliery will continue to provide annual financial provision updates which will be submitted to the DMR.

The financial provision breakdown is provided in Table 7-1.

Table 7-1: Financial Provision for Ash Backfilling Project

Item Description	Estimated Cost
Capital cost	
Access roads and terraces	R 6 000 000
Boreholes and underground seals	R 73 000 000
Slurry delivery system	R 35 000 000
Return water system	R 27 000 000
Electrical supply and reticulation, and C&I	R 12 000 000
Site rehabilitation costs	R 10 000 000
Sub-total (CAPEX)	**R 163 000 000**
Operational cost	
Electricity costs (extra over disposal to FAD5)	R 4 000 000
Plant and personnel	R 45 000 000
Maintenance costs	R 14 000 000
Sub-total (OPEX) (PV)	**R 63 000 000**
Sub-total (CAPEX + OPEX)	**R 226 000 000**
Contingency (10%)	**R 23 000 000**
Sub-total	**R 249 000 000**
P and G / Overheads (12%)	**R 30 000 000**
Total (Excl. VAT)	**R 279 000 000**

7.1.6 Confirm that the financial provision will be provided as determined

The financial guarantee of R 279 Million has already been approved and provided for in Sigma Defunct Colliery financial provision for rehabilitation.

8 Monitoring compliance with and performance assessment

Mechanisms for monitoring compliance with and performance assessment against the environmental management programme and reporting thereon is described below.

8.1 Monitoring of Impact Management Actions

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented. The monitoring programmes have been discussed below.

8.1.1 Aquatic Ecology (Biomonitoring)

The monitoring programme should include sites/locations where biological monitoring has occurred previously. The sites included in this study will be sufficient for future monitoring in the high flow season. The objectives of the programme would be to monitor the state of the aquatic ecosystem through the measurement of physical and biological properties. As of this study the baseline data is established and can be used to compare with in future studies as a means to determine if ecological degradation has occurred.

Biomonitoring activities should occur bi-annually with the high flow assessment should be conducted in middle to late February with the low flow assessment in May, during the ash backfilling project. A biomonitoring report should be provided annually on completion of the two surveys.

8.1.1.1 Parameters

The following parameters should be monitored by qualified specialists:

- In situ and Ex situ water quality constituents;
- Sediment metal analysis;
- Habitat integrity;
- Aquatic macroinvertebrates;
- Fish assemblages; and
- Riparian vegetation.

8.1.1.2 Key Performance Indicators

Key performance indicators would include the improvement of fish communities associated with the project area. It is recommended that *Atyidae* (shrimp) population is to be monitored for changes in water quality and habitat sensitivity as they are relatively sensitive taxa and

are still present in deeper regions that are less suited to SASS 5. A decline in their population may be an indication of increased pollution and/or habitat modification.

If modifications to the system occur, a reduced biological diversity will be observed. Proliferation of pollution tolerant species may also be an indication of a deterioration of ecological integrity. If there is further reduction in species diversity further studies should be undertaken which should include water quality analysis as well as the accumulation of pollutants in the sediments.

8.1.2 Groundwater

The recommended boreholes are based on the outcomes of the hydrogeological studies conducted by Digby Wells (2013) the boreholes are in accordance to those stipulated in the WUL. Based on the current groundwater updates no amendments to the recommended monitoring boreholes are required. The recommended boreholes are listed in Table 8-1 and shown in Table 8-1.

In addition, it is proposed that the boreholes given in Table 8-2 and Figure 8-2 should be drilled to ensure that the pollution plume from ash backfill is extensively monitored during operational and post-closure phases.

Table 8-1: Ashfill Monitoring Boreholes

Site Name	X	Y	Z	Depth (m)
B12/179	78982.19	-2965042	1430.39	41
B12/180	79103.01	-2965271	1425.86	41
B12/182	79785.18	-2965341	1443.23	56.4
C316/41	78900.27	-2966078	1442.5	56.6
UG032	78863.06	-2965218	1424.12	50
UG033	78563.71	-2964360	1438.78	50
UG034	78490.45	-2964377	1437.66	53
UG041	78540.53	-2966379	1452.88	50
UG048	77307.98	-2967220	1471.74	77
UG049	77072.47	-2967386	1473.14	79
UG069	77965.73	-2964789	1428.64	34
B12/178	78962.07	-2965232	1425.05	42
B12/181	79752.43	-2965338	1442.19	56
B12/183	79616.47	-2965435	1436.02	59.3
B12/185	78399.25	-2964877	1424.95	38
B12/186	78666.57	-2964795	1427.64	46.3

Site Name	X	Y	Z	Depth (m)
C316/21	77818.95	-2966852	1463.2	68
C316/22	78477.56	-2966382	1453.2	60.9
C316/24	78715.47	-2966355	1448.96	55.3
C316/25	78700.69	-2966327	1448.65	55
C316/30	78708.32	-2966240	1447.9	56.5
C316/31	78164.05	-2966593	1458.23	65.7
C316/42	79017.34	-2965996	1438.85	53.6
C316/44	78289.49	-2966504	1456.8	48.8
C316/46	78974.63	-2966024	1440.46	55.2
C316/47	78974.63	-2966024	1440.5	54.4
UG047	77555.39	-2967042	1467.81	77
UG054	78329.74	-2966486	1455.9	62
UG055	78024.46	-2966706	1459.61	63
UG056	77673.23	-2966957	1468.12	73
UG063	77868.3	-2967057	1467.6	77
UG064	77933.53	-2967119	1466.5	71
UG065	77862.68	-2966991	1466.59	72.4
UG066	77215.79	-2967307	1472.74	78.9
UG067	76878.49	-2967642	1476.39	83.2
C316/51	79680.92	-2966876.16	1430.09	68.00
C316/52	79684.47	-2966761.13	1429.31	67.00
C316/53	79709.81	-2966519.97	1428.35	64.00
C316/54	79729.29	-2966304.91	1428.33	56.00
NW025	73945.9	-2967309.79	1444.63	
UG003	74869.29	-2970131.45	1462.75	60
UG004	75944.23	-2969659.58	1466.93	60
UG005	75865.56	-2970578.44	1465.93	60
UG008	74408.31	-2968527.33	1453.6	95.52
UG009	74864.11	-2968952.3	1450.71	50
UG014	77711.04	-2971730.49	1484.75	145
UG017	77255.85	-2970610.62	1484.52	90

Site Name	X	Y	Z	Depth (m)
UG037	76731.34	-2968449.82	1467.71	93.4
UG038	75192.95	-2968864.22	1451.01	75
UG040	76368.27	-2966012.76	1448.87	80
UG053	74578.87	-2967631.7	1440.64	50.5
UG061	74807.69	-2968620.51	1447.98	58
UG051	79465.1	-2965915.61	1428.93	54
WW005	77692.89	-2961324.07	1436.97	72
WW012	79111.1	-2963821.32	1449.65	66
WW018	77981.78	-2960547.38	1426.06	70
WW039	78168.22	-2961194.4	1435.41	60
WW048	79075.78	-2964108.06	1447.34	54.4
WW049	78430.31	-2964191.82	1439.41	58

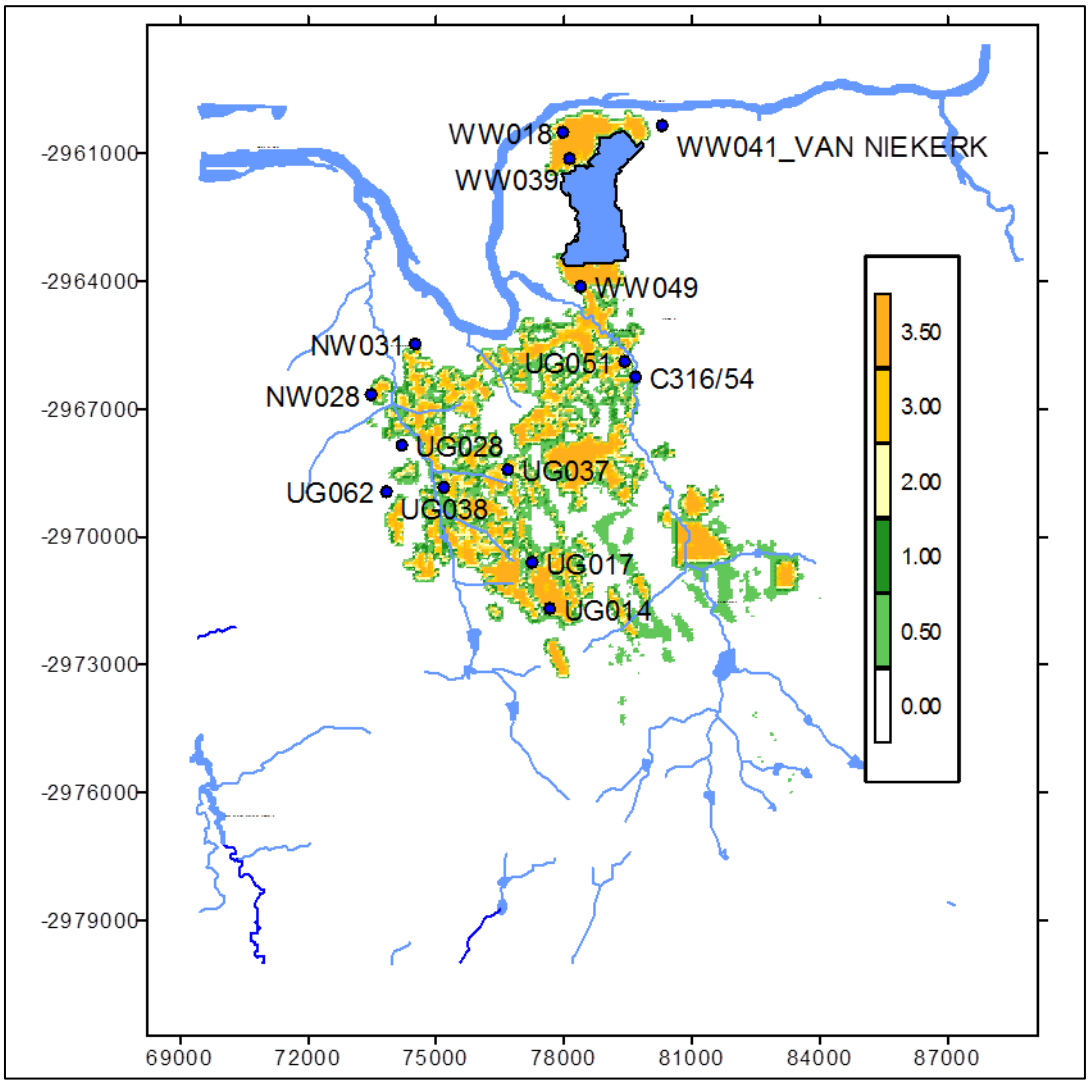

Figure 8-1: Ashfill Monitoring Boreholes

Table 8-2: Proposed Drilling Targets

Borehole ID	Xcoord	Ycoord	Depth (m)	Purpose
UG070	77225	-2964758	50	Intermediate aquifer, north-north-east, between Sigma underground backfill and the Vaal barrage
UG071	76819	-2965439	60	Intermediate aquifer, north, between Sigma underground backfill and the Vaal barrage
UG072	75323	-2965989	60	Intermediate aquifer, north-north-west, between Sigma underground backfill and the Vaal barrage
UG073	77654	-2967903	80	Intermediate aquifer, central, of Sigma underground backfill

Borehole ID	Xcoord	Ycoord	Depth (m)	Purpose
UG074	79722	-2968057	80	Mine groundwater system between backfilled void and east of the Leeuspruit
UG075	80041	-2968134	80	Mine groundwater system between Sigma underground backfilled and west of the Leeuspruit
UG076	74879	-2968893	70	Mine groundwater system between Sigma underground backfill and borehole SPB4
UG077	75250	-2971017	100	Intermediate aquifer, west, between backfilled void and west of the Rietspruit
UG078	75629	-2970851	100	Intermediate aquifer, west, between backfilled void and east of the Rietspruit
UG079	76232	-2971870	100	Intermediate aquifer, south west, between backfilled void and east of the Rietspruit
UG080	77340	-2971484	100	Mine groundwater system between backfilled voids in the south
UG081	77553	-2972930	100	Plume from southernmost backfilled void
UG082	79557	-2971708	100	Plume from southern central backfilled void
UG083	80096	-2971279	100	Plume from south eastern backfilled void
UG084	80382	-2969310	80	Plume from the backfilled void north of the No 5 dam backfill
WW053	77797	-2964109	50	Intermediate aquifer between Moholo south backfilled void and the Vaal barrage

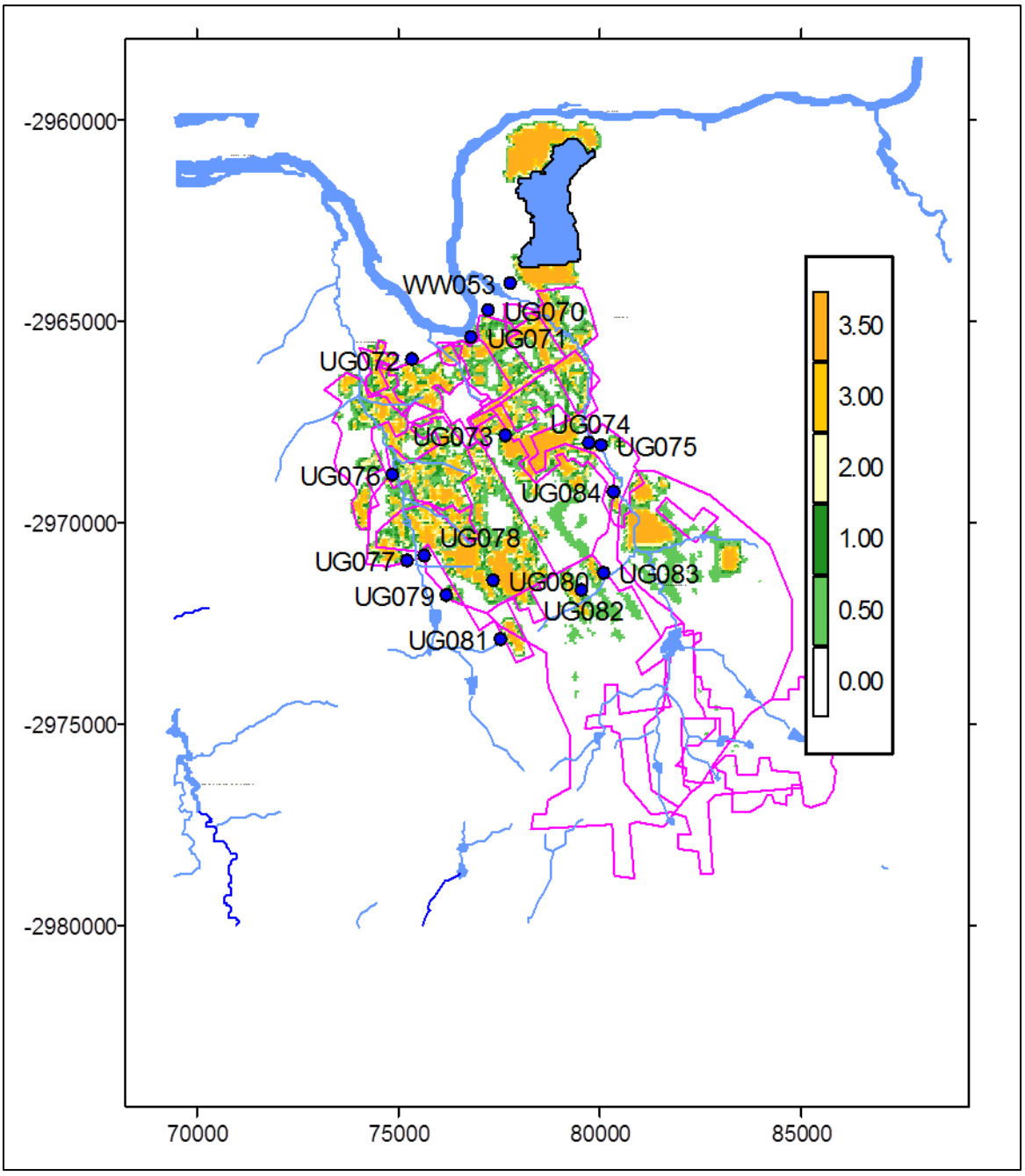

Figure 8-2: Proposed Drilling Targets for Monitoring Plume from Future Ash Backfill Areas

8.1.2.1 Sampling Frequency

A quarterly groundwater monitoring of the proposed boreholes is recommended. When sampling, the following procedures should apply:

- One litre plastic bottles with a plastic cap are required. Glass bottles are required if organic constituents are to be tested for. Sample bottles should be marked clearly with the borehole name, date of sampling, water level depth and the sampler's name.

- Water levels (mbgl) should be measured prior to taking the sample, using a dip meter;
- Samples for metal analysis must be filtered in the field to remove suspended material;
- Samples should be kept cool in a cooler box prior to being submitted to the laboratory; and
- The pH and EC meter used for field measurements should be calibrated daily using standard solutions obtained from the instrument supplier.

All water samples must be analysed by an accredited analytical laboratory that uses approved analytical procedures. The capturing of monitoring results in the Sigma Water Database should continue.

The results should be interpreted and reported to the DWS on a quarterly basis. The contents of the report should include the quarterly groundwater monitoring results, as well as comments on the effectiveness of the mitigation measures and monitoring program. The chemical analysis should be conducted in accordance with the constituents stipulated in the WUL (WUL no. 10/C22K/CGIJ/4608). The chemical analysis should be conducted in accordance with the constituents stipulated in the WUL (WUL no. 10/C22K/CGIJ/4608).

8.1.3 Surface Water

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented.

A monitoring program is used as an early detection tool for surface water quality and is used to determine when additional mitigation measures must be implemented. Monitoring should be implemented throughout the project. The impacts on water quality will be determined by benchmarking the monitoring data against the Leeuspruit/ Taaiboschspruit WQG.

The existing surface water monitoring programme (as provided in IGS report, 2017) is deemed sufficient for Sigma Defunct Colliery and this report recommends a continuation of the that monitoring programme to ensure compliance with the newly (2017) authorised Water Use Licence.

Table 8-3: Monitoring programme

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
At all surface water monitoring sites in Table 11-20	-To monitor impacts on water quality in the stream -To detect any spillages and -To confirm that no decant is taking place into the surface water	- Monthly when backfilling is being undertaken at points upstream and downstream of the backfilled area - Reduce to quarterly on backfilled areas; - This can further be reduced to biannually (wet and dry season) when no impacts are detected for a period of Three years after the project has ceased as is standard practice.	All parameters as indicated in Table 8-4

Table 8-4: Summary of the parameters/ variables analysed

pH	EC	TDS	Ca	Mg	Na	K
P-Alk	M-Alk	Cl	SO_4	NO_2/NO_3 as N		Cd
Al	Fe	Mn	NH_4/NH_3	as	N	B
Cr	Co	Cu	Pb	PO_4	COD	DOC
phenols	TOC	Turbidity	Suspended Solids	Faecal Coliform	Si	F

8.2 Monitoring and Reporting Frequency

Table 8-5 discusses the monitoring and reporting frequency.

8.3 Responsible Persons

The roles and responsibilities associated with the monitoring programme are set out in Table 8-5.

8.4 Time Period for Implementing Impact Management Actions

Table 8-5 captures the time period for implementing impact management actions.

8.5 Mechanism for Monitoring Compliance

Table 8-5 sets out the method of monitoring, the implementation of the impact management actions, the frequency of monitoring the implementation of the impact management actions, an indication of the persons who will be responsible for the implementation of the impact management actions, the time periods within which the impact management actions must be implemented and the mechanism for monitoring compliance with the identified impact management actions.

Table 8-5: Monitoring and Management of Environmental Impacts

Source Activity	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions
All activities	Aquatic Ecology (Biomonitoring)	The objectives of the programme would be to monitor the state of the aquatic ecosystem through the measurement of physical and biological properties. As of this study the baseline data is established and can be used to compare with in future studies as a means to determine if ecological degradation has occurred. Key performance indicators would include the improvement of fish communities associated with the project area. It is recommended that Atyidae (shrimp) population is to be monitored for changes in water quality and habitat sensitivity as they are relatively sensitive taxa and are still present in deeper regions that are less suited to SASS 5. A decline in their population may be an indication of increased pollution and/or habitat modification. If modifications to the system occur, a reduced biological diversity will be observed. Proliferation of pollution tolerant species may also be an indication of a deterioration of ecological integrity. If there is further reduction in species diversity further studies should be undertaken which should include water quality analysis as well as the accumulation of pollutants in the sediments.	Biomonitoring must be undertaken by an independent aquatic ecologist	Biomonitoring activities should occur bi-annually with the high flow assessment should be conducted in middle to late February with the low flow assessment in May, during the ash backfilling project. A biomonitoring report should be provided annually on completion of the two surveys.
All activities	Monitoring of Flora	Compile and Implement alien plant monitoring to prevent the establishment of alien invasive plant species.	An AIP should be compiled by a qualified botanist to be implemented. Alien invasive species monitoring utilising the AIP should be undertaken by an independent Environmental Officer/Independent Third Party.	Annual monitoring for three years after construction and decommissioning and rehabilitation phase
All activities	Surface Water monitoring	At all surface water monitoring sites in Table 11-20 ▪ The objective of the surface water monitoring is to: ▪ To monitor impacts on water quality in the stream ▪ To detect any spillages and ▪ To confirm that no decant is taking place into the surface water	Surface water monitoring must be undertaken by an independent hydrologist	▪ Monthly when backfilling is being undertaken at points upstream and downstream of the backfilled area ▪ Reduce to quarterly on backfilled areas ▪ This can further be reduced to biannually (wet and dry season) when no impacts are detected for a period of Three years after the project has ceased as is standard practice.

Source Activity	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions
All activities	Groundwater monitoring	Quarterly groundwater monitoring of the proposed boreholes is recommended. When sampling, the following procedures should apply: ▪ One (1) litre plastic bottles with a plastic cap are required. Glass bottles are required if organic constituents are to be tested for. Sample bottles should be marked clearly with the borehole name, date of sampling, water level depth and the sampler's name. ▪ Water levels (mbgl) should be measured prior to taking the sample, using a dip meter; ▪ Samples for metal analysis must be filtered in the field to remove suspended material; ▪ Samples should be kept cool in a cooler box prior to being submitted to the laboratory; and ▪ The pH and EC meter used for field measurements should be calibrated daily using standard solutions obtained from the instrument supplier. All water samples must be analysed by an accredited analytical laboratory that uses approved analytical procedures. The capturing of monitoring results in the Sigma Water Database should continue. The results should be interpreted and reported to the Department of Water Affairs on a quarterly basis. The contents of the report should include the quarterly groundwater monitoring results, as well as comments on the effectiveness of the mitigation measures and monitoring program. The chemical analysis should be conducted in accordance with the constituents stipulated in the WUL (WUL no. 10/C22K/CGIJ/4608). The chemical analysis should be conducted in accordance with the constituents stipulated in the WUL (WUL no. 10/C22K/CGIJ/4608)	Groundwater monitoring must be undertaken by an independent geohydrologist	Quarterly groundwater monitoring of the proposed boreholes is recommended.
Audit Reports	Auditing against the construction / decommissioning conditions outlined within the approved EMP and Environmental Authorisation (EMP Performance Assessment)	To determine compliance to EMP conditions.	Internal Environmental Officer Independent Third Party (external ECO)	Daily monitoring by Internal Environmental Officer during construction / decommissioning phase Monthly monitoring by external ECO during construction phase

Source Activity	Impacts requiring monitoring programmes	Functional requirements for monitoring	Roles and responsibilities (For the execution of the monitoring programmes)	Monitoring and reporting frequency and time periods for implementing impact management actions
Audit Reports	Auditing against the operational conditions outlined within the approved EMP and Environmental Authorisation (EMP Performance Assessment)	To determine compliance to EMP conditions	Environmental Officer/Independent Third Party	Annual Performance Assessment (until ash backfilling is no longer being undertaken)
All activities	Rehabilitation activities during construction and decommissioning phase	The purpose of monitoring is to ensure that the objectives of rehabilitation are met and that the rehabilitation process is followed.	Environmental Officer/Independent Third Party	Annual monitoring for three years after construction and decommissioning and rehabilitation phase

9 Indicate the Frequency of the Submission of the Performance Assessment / Environmental Audit Report

Monitoring to be undertaken during the construction /decommissioning phase of the pipeline must be completed daily by the internal ECO appointed at Sigma Defunct Colliery and monthly by an external independent ECO. The reports must be submitted to the DMR on a monthly basis. A performance assessment report for the pipeline during operation phase will be submitted on an annual basis to the DMR.

10 Environmental Awareness Plan

10.1 Manner in which the applicant intends to inform his or her employees of any environmental risk which may result from their work

Sasol has developed internal Environmental, Health and Safety Policies. The Environmental Policy will be communicated to all personnel, whether they are contractors or permanent staff, and the policy will be displayed at Sigma Defunct Colliery and at the contractor's yard.

Employees will receive general environmental awareness training on specific items contained in this EMP, as well as on Best Possible Environmental Practices (BPEP).

10.1.1 Specific Environmental Training

Environmental Awareness Training will be undertaken to make employees and contractors aware of the following:

- The importance of conforming with the environmental policy and procedures and with the requirements of the EMP;
- The significant social and environmental impacts of their work activities and the environmental benefits of improved personal performance;
- Their roles and responsibilities in achieving conformance with the environmental policy and procedures and with the requirements of the environmental management system;
- The potential consequences of departure from specified operating procedures; and
- Possible archaeological finds action steps for mitigation measures, surface collections, excavations and communication routes to follow in the case of a discovery.

The guidelines for training are summarised below, which are in line with the ISO 14001:2004 guidelines with regards to training and awareness creation.

Table 10-1: Training Guidelines

Types of Training	Audience	Purpose
Raising awareness of the strategic importance of environmental management	Senior management	To gain commitment and alignment to the organisation's environmental policy.
Raising general environmental awareness	All employees	To gain commitment to the environmental policy and objectives and to instil a sense of individual responsibility.
Skill enhancement	Employees with environmental responsibilities	To improve performance in specific tasks.
Compliance	Employees whose actions can affect compliance	To ensure that regulatory and internal requirements for training are met.

The training programme will consist of the following elements:

- Identification of employee training needs;
- Development of a training plan to address defined needs;
- Verification of conformance of the training programme to regulatory or organisation requirements and standards;
- Training of target employee groups;
- Documentation of training received; and
- Evaluation of training received.

This training is undertaken on an annual basis for all personnel, together with the annual required induction programmes. The training material provided will be subject to annual review, based on issues such as incidents, accidents, new legislative requirements, modified processes and environmental and social aspects identified from time to time. This training is to be carried out and coordinated internally by Sasol.

Sasol will, therefore, develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets.

In addition, the Sigma Defunct Colliery Emergency Preparedness and Response Plan will be updated to include measures relevant to the ash backfilling project and communicated and trained to all site personnel during the induction process

10.2 Manner in which risks will be dealt with in order to avoid pollution or the degradation of the environment

An Emergency Response Plan has been developed for the Sigma Defunct Colliery and will be updated and implemented for the proposed ash backfilling project. The approach used by Sasol to respond to risks that may pollute or degrade the environment during the construction, operational and decommissioning phase is detailed in this internal procedure.

The unplanned events that may happen at the project site and the proposed mitigation plan are listed in Table 10-2.

Table 10-2: Unplanned Events, Risks and their Management Measures

Unplanned event	Mitigation / Management / Monitoring
Hydrocarbon spills from vehicles, heavy machinery and workshop areas.	▪ Hydrocarbons and hazardous substances must be stored in bunded areas and any refuelling should take place in contained areas; ▪ Vehicles and heavy machinery should be serviced and checked on a regular basis according to the maintenance plan of each to prevent leakages and spills; and ▪ All stationary vehicles must have drip trays placed beneath them to prevent any hydrocarbon contamination.
Spills form hazardous materials or waste storage facilities.	▪ Implementation of storm water management system around hazardous materials or waste storage facilities to contain spills; ▪ Provide sufficient capacities for the storage of waste (temporary waste bins for use by construction workers on the construction site; ▪ Ensure that an agreement is in place with a suitable qualified service provider to remove the waste on a regular basis; and ▪ All hazardous waste should be removed by a suitably qualified service provider and disposed of to an approved permitted landfill site.

11 Specific information required by the Competent Authority

No request for specific information has been requested for this project by the DMR to date.

12 Undertaking

The EAP herewith confirms:-

- the correctness of the information provided in the reports
- the inclusion of comments and inputs from stakeholders and I&APs;
- the inclusion of inputs and recommendations from the specialist reports where relevant; and
- the acceptability of the project in relation to the finding of the assessment and level of mitigation proposed.

Signature of the Environmental Assessment Practitioner:	
Name of Company:	Digby Wells Environmental
Date:	July 2018

13 References

ACOCKS, J.H.P, 1988. Veld types of South Africa. 3rd edn. Memoirs of the Botanical Survey of South Africa 57: 1-147.

Allan, D. G., Seaman, M. T. and Kaletja, B. 1995. The endorheic pans of South Africa. In Cowan, G. I.(Ed.), Wetlands of South Africa, South African Wetlands Conservation Programme Series, Pretoria: Department of Environmental Affairs and Tourism: 75-101 p.

ASHTON PJ, PATRICK MJ, MACKAY HM, WEAVER, AVB. (2005). Integrating biodiversity concepts with good governance to support water resources management in South Africa. ISSN 0378-4738 = Water SA **31** 4 October 2005.

ARQ (2003). Evaluation of the effect of fly ash backfill on the stabilisation of surface infrastructure in areas undermined by bord and pillar mining methods along the Sasolburg / Parys road. Prepared by ARQ Consulting Engineers (Pty) Ltd.

Belem, T. and Benzaazoua, M., An overview on the use of paste backfill technology as a ground support method in cut-and-fill mines.

Blodget S. and Kuipers J. R. 2002. Underground hard rock mining: Subsidence and hydrologic environmental impacts. Centre for science and public participation: 50p.

BRANCH, B. 2001. Snakes and Other Reptiles of Southern Africa. Struik Publishers, South Africa.

BREDENKAMP, J.G. 1982. 'n Plantekologiese studie van die ManyeletinWildtuin. D.Sc. thesis, University of Pretoria, Pretoria.

Brinson, M.M. 1993. A hydrogeomorphic classification for wetlands. Wetlands Research Program Technical Report WRP-DE-4. U.S. Army Corps of Engineers, Waterway Experimental Station. Vicksburg, MS: Bridgham and Richardson.

BROMILOW, C. 1995. Problem Plants of South Africa. Briza Publications, Pretoria.

Chang, Q., Chen, J., Zhou, H. and Bai, J., 2014. Implementation of paste backfill mining technology in Chinese coal mines. The Scientific World Journal, 2014.

Coleman T. and van Niekerk A. Water quality in the Orange River. Orange River integrated water resources management plan: 26pp.

Department of Water Affairs and Forestry Directorate National Water Resource Planning (2004) Internal Strategic Perspective: Inkomati Water Management Area: P WMA 05/000/00/0303, WRC, Pretoria.

DICKENS CWS, GRAHAM PM.(2002). The South African Scoring System (SASS), Version 5, Rapid bioassessment method for rivers. African Journal of Aquatic Science. **27** 1–10.

DRIVER A, MAZE K, ROUGET M, LOMBARD AT, NEL, JL, TURPIE JK, COWLING R, DESMET P, GOODMAN P, HARRIS J, JOMAS Z, REYERS B, SINK K, STRAUSS T

(2005). National spatial biodiversity assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia **17**: 1–45.

DEPARTMENT OF AGRICULTURE AND FORESTRY AND FISHERIES. 1998. National Forests Act (Act No 84 of 1998).

DEPARTMENT OF AGRICULTURE, 1983. Conservation of Agricultural Resources Act (CARA) (Act No 43 of 1983).

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM, 2004. National Environmental Management: Biodiversity Act (NEMBA), (Act 10 of 2004): Publication of Lists of Critically Endangered, Endangered, Vulnerable and Protected Species, Government Gazette 23 February 2007.

DU PREEZ, L. and CARUTHERS, V. 2009. A Complete guide to the frogs of South Africa. Struik Nature, South Africa.

DWAF (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) (1996). South African water quality guidelines (Second Edition). Aquatic Ecosystems. Department of Water Affairs and Forestry, Pretoria.

DWAF (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) (1996A). South African water quality guidelines (Second Edition). Vol 1: Domestic Use. Department of Water Affairs and Forestry, Pretoria.

DWAF (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) (1996B). South African Water Quality Guidelines (Second Edition). Vol 5: Agricultural Use: Livestock. Department of Water Affairs and Forestry, Pretoria.

DWAF (DEPARTMENT OF WATER AFFAIRS AND FORESTRY) (1999). Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0. DWAF Report No. N/28/99. Department of Water Affairs and Forestry, Pretoria.

Ecosystem services. Centre for Environmental Management. University of Nottingham, Nottingham, NG7 2RD.

Ercikdi, B., Cihangir, F., Kesimal, A. and Deveci, H., 2017. Practical importance of tailings for cemented paste backfill. In Paste Tailings Management (pp. 7-32). Springer, Cham.

Garrett, G. P.; Inman, C. R. Selenium-induced changes in fish populations of a heated reservoir. *Proc. Annul. Conf. Southeast. Assoc. Fish and Wildl. Agen.* **1984,** *38*, 291-301.

GERBER, A., AND GABRIEL, M.J.M. (2002). Aquatic Invertebrates of South African Rivers: Field Guide. Institute for Water Quality Services, Department of Water Affairs and Forestry, Pretoria.

Government Gazette (16 April 2013) Publication of lists of species that are threatened or protected, activities that are prohibited and exemption from restriction. *Government Gazette*, No 36375 **Notice 389 of 2013**, 104–218.

Goudie A.S. and Thomas D.S.G., 1985. Pans in Southern Africa with particular reference to South Africa and Zimbabwe. Zietschritt fur Geomorphologie NF. 29: 1-19 p.

Haines-Young, R. and Potschin, M.2009: Methodologies for defining and assessing.

HOLLAND, S. 2008. Detrended Correspondence Analysis (DCA): 10 pp.

IGS (2013). Sigma Underground Mine: Proposed Backfilling Methodology. Prepared by the Institute for Groundwater Studies (IGS), University of the Free State.

INSTITUTE OF NATURAL RESOURCES, 2003. Indigenous medicinal plant trade: Sector analysis. Investigation report: no. 248.

INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE (IUCN) 2001. IUCN Red Data List categories and criteria: Version 3.1. IUCN Species Survival Commission: Gland, Switzerland.

INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE (IUCN), 2012. Red Data List Species available online at www.iucn.org.

Kempster, P.L., Hattingh, W.A.J. & Van Vliet, H.R. (1980). Summarized water quality criteria. Department of Water Affairs, forestry and environmental Conservation, Pretoria. Technical Report No TR **108**: 45.

KLEYNHANS C.J. (1996). A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo system, South Africa). Journal of Aquatic Ecosystem Health **5**: 1–14.

KLEYNHANS CJ, LOUW MD, MOOLMAN J. (2007). Reference frequency of occurrence of fish species in South Africa. Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Water Research Commission.

KLEYNHANS CJ, MACKENZIE MD, LOUW MD (2007) Module F: Riparian Vegetation Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT **333/08**.

KLEYNHANS, C.J. & LOUW, M.D. (2007). Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Resource Commission and Department of Water Affairs and Forestry report. WRC Report No. TT **329/08.**

KLEYNHANS, C.J. (1999). The development of a fish index to assess the biological integrity of South African rivers. Water SA **25**: 265–278.

KLEYNHANS, C.J. (2000) Desktop estimates of the ecological importance and sensitivity categories (EISC), default ecological management classes (DEMC), present ecological status categories (PESC), present attainable ecological management classes (present AEMC), and best attainable ecological management class (best AEMC) for quaternary catchments in South Africa. DWAF Report, DWAF, Pretoria, South Africa.

KLEYNHANS, C.J. (2003). National Aquatic Ecosystem Biomonitoring Programme: Report on a National Workshop on the use of Fish in Aquatic System Health Assessment. NAEBP Report Series No 16. Institute for Water Quality Studies, Department of Water Affairs and Forestry, Pretoria, South Africa.

KLEYNHANS, C.J. (2007). Module D: Fish Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT **330/08**.

KLEYNHANS, C.J., LOUW, M.D. & GRAHAM, M. (2008). Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT **377/08**.

Kotze, D.C. and Marneweck, G.C. 1999. Guidelines for delineating the boundaries of a wetland and the zones within a wetland in terms of South African Water Act. As part of the development of a protocol for determining the ecological reserve for wetlands in terms of the Water Act resource protection and assessment policy implementation process. Department of Water Affairs and Forestry, South Africa.

Limpitlaw D., Aken M., Lodewijks H. and Viljoen J. Post-mining rehabilitation, lland-use and pollution. The South African institute of mining and metallurgy. Sustainable development in the life of coal mining in South Africa: 10pp.

LÖTTER, M. 2007. Biodiversity status of the Mpumalanga Lakes District. Scientific Services. Mpumalanga Tourism and Parks Agency. Proceedings of the Mpumalanga Lakes District, Chrissiesmeer, 31 August 2007.

LOW, A.B. and REBELO, A.G. 1996. Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs and Tourism, Pretoria.

Lukas E., van Tonder G., Vermeulen D. and Allwright A. 2013. Sigma underground mine: Proposed Backfilling Methodology (Draft Report). Institute for Groundwater Studies (IGS): 45 pp.

LYNCH, K., (1992). Good City Form. MIT Press, London. (131).

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. and Goge, C. 2007. A technique for rapidly assessing wetland health: WET-Health. WRC Report TT 340/08.

Mantel S.K., Muller N.W.J., Hughes D.A. 2010. Ecological impacts pf small dams on South African rivers Part 2: Biotic response – abundance and composition of macroinvertebrate communities. *Water SA* : **36**: 361 – 370.

Marneweck, G.C. and Batchelor, A.L. 2002. Wetland inventory and classification. In Palmer, R.W., Turpie, J., Marneweck, G.C. and Batchelor, A.L. (Eds). Ecological and Economic

Evaluation of Wetlands in the Upper Olifants River Catchment. Water Research Commission Report No K5/1162.

Marshall, T.R. and Harmse, J.T. 1992. A review of the origin and propagation of pans. SA Geographer 19: 9-21 p.

MAFANYA T, 2011. Sigma Defunct Colliery Water Monitoring Report No. 32 covering the period July to December 2012. Sasol Mining (Pty) Ltd.

MANTEL SK, MULLER NWJ, HUGHES DA (2010) Ecological impacts pf small dams on South African rivers Part 2: Biotic response – abundance and composition of macroinvertebrate communities. *Water SA* : **36**: 361 – 370.

Masniyom, M., 2009. Systematic Selection and Application of Backfill in Underground Mines.

MCMILLAN PH, (1999). An integrated habitat assessment system (IHAS v2) for the rapid biological assessment of rivers and streams. Division of the Environment and Forestry Technology, Report No. ENV-P-I 98132. CSIR, Pretoria.

Metsimaholo Local Municipality (2012), Final Integrated Development Plan 2012/13-2016/17.

Metsimaholo Local Municipality. (2012). Spatial Development Framework: 2012 / 2013.

NEL JL, MURRAY KM, MAHERRY AM, PETERSEN CP, ROUX DJ, DRIVER A, HILL L, VAN DEVENENTER H, FUNKE N, SWARTZ ER, SMITH-ADAO LB, MBONA N, DOWNSBOROUGH L, NIENABER S (2011) Technical report for the National Freshwater Ecosystem Priority Areas project. *Water research commission*. WRC report No. 1801/2/11, ISBN 978-1-4312-0149-5. Set no. 978-1-4312-0148-7.

Oberholzer P.J., Myburgh J.G., Ashton P.J., Coetzee J.J., Botha A.M. 2011. Bioaccumulation of aluminium and iron in the food chain of Lake Loskop, South Africa. Ecotoxicology and Environmental Safety 75:134-141 p.

OBERHOLZER, B. 2005. Guideline for involving visual and aesthetic specialists in EIA processes: Edition 1. CSIR Report No ENV-S-C 2005 053 F. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs and Development Planning, Cape Town.

Ochieng G. M., Seanego E.S. and Nkwonta O.I. 2010. Impacts of mining on water resources in South Africa: A review. Scientific research and essays. Vol 5: pp 3351-3357.

PALMER CG, ROSSOUW JN, (2000) Water Quality: Olifants River Ecological Water Requirement Assessment. Dept. Water Affairs and Forestry, Report No. PB **000-00-5999**. DWAF, Pretoria.

Republica de mocambique ministerio das obras publicas e habitacao direccao nacional de aguas (2010) The Joint Limpopo River Basin Study Scoping Phase, Final Report, Main Report.

River Health Programme (RHP) (2001) State of the rivers report: Crocodile, Sabie-Sand and Olifants River systems. Water Research Commission Report: TT**147/01**, WRC, Pretoria.

ROUX DJ, BADENHORST JE, DU PREEZ DU, STEYN GJ (1994) Note on the occurrence of selected trace metals and organic compounds in water, sediment and biota of the Crocodile River, Eastern Transvaal, South Africa. Water SA 20: 333–340.

ROUX, D.J. (2001). Strategies used to guide the design and implementation of a national river monitoring programme in South Africa. Water Research Commission.

SKELTON, P.H. (2001). A complete guide to freshwater fishes of southern Africa. Struik Publishers, South Africa.

Sheshpari, M., 2015. A review of underground mine backfilling methods with emphasis on cemented paste backfill. Electronic Journal of Geotechnical Engineering, 20(13), pp.5183-5208.

Sivakugan, N., Veenstra, R. and Naguleswaran, N., 2015. Underground mine backfilling in Australia using paste fills and hydraulic fills. International Journal of Geosynthetics and Ground Engineering, 1(2), p.18.

Sivakugan, N., Veenstra, R. & Naguleswaran, N. Int. J. of Geosynth. and Ground Eng. (2015) 1: 18. https://doi.org/10.1007/s40891-015-0020-8

Statistics South Africa (2012). Retrieved from http://beta2.statssa.gov.za/?page_id=993&id=metsimaholo-municipality.

SORENSEN, E. M. B.; CUMBIE, P. M.; BAUER, T. L.; BELL, J. S.; HARLAN, C. W. Histopathological, hematological, condition-factor, and organ weight changes associated with selenium accumulation in fish from Belews Lake, North-Carolina. *Arch. Environ. Con. Tox.* **1984,** *13* (2), 153-162.

THIRION, C. (2007). Module E: Macroinvertebrate Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT **332/08**.

THIRION, C.A., MOCKE, A. & WOEST, R. (1995). Biological monitoring of streams and rivers using SASS4. A Users Manual. Internal Report No. N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry. **46**.

VAN VUREN JHJ, DU PREEZ HH, DEACON AR (1994) Effect of Pollutants on the Physiology of Fish in the Olifants River (Eastern Transvaal). WRC Report No. 350/1/94. Water Research Commission, Pretoria, South Africa.

Vermeulen P.D. and Usher B.H. (2006). An Investigation into Recharge in South African Underground Collieries.

WEPENER V, VAN VUREN JHJ, CHATIZA FP, MBIZI Z, SLABBERT L, MASOLA B (2005) Active biomonitoring in freshwater environments: early warning signals from biomarkers

in assessing biological effects of diffuse sources of pollutants. *Physics and Chemistry of the Earth* **30**: 751–761.

Water Research Commission, 2008. Wetlands Research Programme: Wetland rehabilitation (WRC Project No. K5/1408). WRC Report TT 341/08.

Wepener V., van Dyk C., Bervoets L., O'Brien G., Covaci A. and Cloete Y. 2011. An assessment of the influence of multiple stressors on the Vaal River, South Africa. Physical and Chemistry of the Earth 36: 949-962 pp.

WWF. 2011. Coal and water futures in South Africa: 92 pp.

www.dwaf.gov.za. Accessed on 2013-09-05 at 8:23 am.

ZHOU Q, ZHANG J, FU J, SHI J, JIANG G (2008) Biomonitoring: An appealing tool for assessment of metal pollution in the aquatic ecosystem. *Analytica Chimica Acta* **606:** 135–150.

Appendix A: CV

Appendix B: Plans

Plan 1: Regional Map

Plan 2: Local Map

Plan 3: Land Tenure Map

Plan 4: Proposed pipelines locations

Plan 5: Areas subsidence within the Sigma Defunct Colliery

Plan 6: Ecosystems in need of protection in relation to the Sigma study area

Plan 7: NFEPA wetland areas in relation to the proposed pipelines and ash backfilling project area

Plan 8: Free State Biodiversity Sector Plan

Plan 9: Wetland delineation represented Hydro-geomorphic Units

Plan 10: Wetlands and areas of subsidence

Plan 11: PES for wetlands coinciding with the route for the proposed pipelines

Plan 12: Wetland delineation showing the 32 m and 100 m buffers

Plan 13: Heritage resources identified within the vicinity of the Project

Plan 14: Location of where the pipeline will cross the river systems

Plan 15: Position of selected mine monitoring boreholes

Plan 16: Selected boreholes for Wonderwater and Mohlolo workings

Plan 17: Environmental and current land use map

Plan 18: Pipeline crossing points over wetlands

Plan 19: Composite plan

Appendix C: Public Participation Process

Appendix C 1: Database

Appendix C 2: Background Information Document

Appendix C 3: Advert

Appendix C 4: Site Notice

Appendix C 5: Correspondence

Appendix C 6: Stakeholder Consultation

Appendix C 7: Comment and Response Report

Appendix D: Authorisations

Appendix E: Aquatic Ecology Specialist Study

Appendix F: Fauna and Flora Specialist Study

Appendix G: Wetland Specialist Study

Appendix H: Heritage Specialist Study

Appendix I: Groundwater Specialist Study

Appendix J: Surface Water Specialist Study

Appendix K: Geochemistry Specialist Study

Appendix L: Noise Specialist Study

Appendix M: Social Specialist Study

Appendix N: Visual Specialist Study