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Tutuka Power Station Ash Disposal Facility (ADF): External Environmental Performance Assessment

as part of the Part 2 Exemption amendment application process to the Exemption issued.

Audit Report

FINAL

06 September 2019

Eskom (Pty) Ltd

GCS Project Number: - 19-0217

Client Reference: Part 2 Amendment Applications

DEA Reference: 14/12/16/3/3/3/52

Tutuka Power Station Ash Disposal Facility (ADF): External Environmental Performance Assessment – Audit Report

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Eskom Holdings SOC Ltd

19-0217

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Report Issue	**FINAL**		
GCS Reference Number	19-0217		
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Title	Tutuka Power Station Ash Disposal Facility (ADF): External Environmental Performance Assessment		
	Name	**Signature**	**Date**
Author	Elizabeth Mosepele		September 2019
Document Reviewer	Fatima Matlou		September 2019

EXECUTIVE SUMMARY

Eskom's core business is in the generation, transmission and distribution of electricity. The coal-fired, six boiler/turbine unit giant contributes 3 600 MW supplied to consumers and industries throughout the country. Tutuka power station is situated 6.7 km from a small settlement called Thuthukani Township and 25 km from Standerton in Mpumalanga. The power station requires adequate dry ash disposal facilities in order to continue generating electricity until the end of the life of the station.

The facility is currently in possession of an Integrated Environmental Authorisation (IEA), 14/12/16/3/3/3/52 & DEA/EIA/0001416/2012, issued by the Department of Environmental Affairs (DEA) on 19 October 2015. From an environmental perspective, the motivation for the Exemption application was based on surface water and groundwater reports as well as the ash classification results that formed part of the ADF's EIA process. The intention of the studies and models was to illustrate a worst case scenario (i.e. ashing without lining) and therefore did not include any mitigation measures in the formulation of predictions. The result of that exercise was that the identified impacts and their significance ratings sketch the unmitigated state. The impacts as identified in the surface and groundwater reports were determined to be the potential impacts that would be experienced during the transitional period (prior to lining). Although Eskom is committed to be compliant with all environmental legislation in connection with its ashing activities for Tutuka Power station, the lining of the future ashing area could only be provided after four (4) years from receipt of the IEA. This duration was due to consideration of project planning lead times within the internal and external governance processes (e.g. Public Finance Management Act (PFMA) application to the Department of Public Enterprises). The estimated footprint required for this 4-year exemption period was only 54ha.

The DEA granted the 4-year Exemption on 5 May 2016, and it contained conditions that Tutuka would have to comply with.

GCS Water and Environment (Pty) Ltd. (GCS) was contracted by Eskom to conduct an independent Environmental Performance Assessment (EPA) Audit for the Tutuka Power Station Ash Disposal Facility's Exemption approval. The audit was undertaken for conditions included in the Exemption approval

This assessment monitored compliance in terms of document control, systems and procedures. Following the checklist audit and documentation review.
Accordingly, the following activities were undertaken as part of the EPA Audit, which include the following:

- Assessment and comparison of the current site activities with those described in the Exemption approval;
- Comparison of environmental mitigation measures implemented on site to those required and committed to in terms of the Exemption Approval in order to assess whether these comply with the management objectives committed to in the Exemption approval;
- Assessment of monitoring requirements to current monitoring practices;
- Assessment of relevant documentation pertaining to various compliance aspects; and
- Identification of current activities and facilities at the Tutuka Power Station Ash Disposal Facility (ADF), which are not specifically included in the Exemption approval.

The audit findings, detailed in the report, include practical recommendations whereby the various non-compliance issues can be corrected. All findings were ranked according to the following criteria:

- Compliant;
- Minor non-compliance;
- Moderate non-compliance; and
- Major non-compliance.

Audit Methodology

In line with conditions of Tutuka's Exemption approval, the EPA audit focused on all the conditions included as part of the Exemption approval to ensure that the specified conditions are executed and adhere to.

The external audit process followed, included the following steps:

- **Step 1:** Conducting the opening meeting in order to:
    - Ensure mutual understanding of the objectives, as well as scope of the audit; and
    - Discuss the relevant documentation such as the audit checklist and the station layout before conducting the on-site audit activities.
- **Step 2:** Conducting the on-site audit observation, using the prepared checklists; and
- **Step 3:** Conducting the closing meeting at the end of the audit.

The findings of the EPA Audit are included in **Error! Reference source not found.** The audit findings also include practical recommendations whereby the various non-compliance issues can be corrected.

All findings were ranked according to the following criteria:

- Compliance;
- Minor non-compliance;

- Moderate non-compliance; and
- Major non-compliance.

The following colour coding was used to indicate areas of compliance, minor non-compliance, moderate non-compliance, and major non-compliance:

- Compliant
- Minor non-compliance
- Moderate non-compliance
- Major non-compliance
- Noted/Not applicable

Each colour coding has a value (score) attached to it. Kindly refer to the scoring indicated below:

Compliant	2
Minor non-compliance	1
Noted/Not Applicable	0
Moderate non-compliance	-1
Major non-compliance	-2

The findings are entered into the audit spreadsheet which tabulates the percentage of compliance to the regulatory requirements.

Key Findings

Based on the auditing findings, it can be concluded that Tutuka **is 86% compliant** with their conditions included in the 2016 Exemption approval. Through the on-site meetings and observations, it is clear that Tutuka is aware of all the areas of concern. The environmental Department representatives conducts monthly inspections and ensures that non-conformances are taken up with heads of departments as soon as possible.

A summary of the critical and moderate findings made during the EPA are presented in the sections that follow.

A detailed description of all the audit findings, the ranking and scoring together with observations and recommendations are provided for in **Table 5.1.**

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1 INTRODUCTION

Eskom's core business is in the generation, transmission and distribution of electricity. The coal-fired, six boiler/turbine unit giant contributes 3 600 MW supplied to consumers and industries throughout the country. Tutuka power station is situated 6.7 km from Thuthukani Township and 25 km from Standerton in Mpumalanga. The power station requires adequate dry ash disposal facilities in order to continue generating electricity until the end of the life of the station.

The facility is currently in possession of an Integrated Environmental Authorisation (IEA), 14/12/16/3/3/3/52 & DEA/EIA/0001416/2012, issued by the Department of Environmental Affairs on 19 October 2015.
Subsequent to this authorisation, the station applied for a 4-year Exemption from installing the required liner (a Class C liner), as a means to allow station ashing operations to continue while the required designs of the Class C liner were being developed, and to allow its installation. As part of the Exemption application process, the equivalent footprint (area) for the 4-year Exemption was estimated to be 54ha and was assessed and motivated by an independent Environmental Consultant. The DEA granted the 4-year Exemption on 5 May 2016, and it had some conditions that Tutuka is expected to comply with.

GCS Water and Environment (Pty) Ltd. (GCS) was contracted by Eskom to conduct an independent Environmental Performance Assessment (EPA) Audit for the Tutuka Power Station Ash Disposal Facility as part of the Part 2 Exemption amendment application process to the Exemption issued, in terms of Regulation 31 and 32 of GN 326. The EPA audit was carried out against all conditions included in the Exemption approval.

A one (1) day site visit was undertaken at the Tutuka Power Station on 21 May 2019. The site visit was initiated with a project kick-off meeting during which GCS met with, Tutuka's' Environmental Officer (EO) for this project. Following the kick-off meeting, a comprehensive review of the documentation and associated checklists was undertaken. This assessment monitored compliance in terms of document control, systems and procedures. Following the checklist audit and documentation review.

Accordingly, the following activities were undertaken as part of the EPA Audit:

- Assessment and comparison of the current site activities with those described in the Exemption approval;
- Comparison of environmental mitigation measures implemented on site to those required and committed to in terms of the exemption in order to assess whether

these comply with the management objectives committed to in the Exemption approval;
- Assessment of monitoring requirements to current monitoring practices;
- Assessment of relevant documentation pertaining to various compliance aspects; and
- Identification of current activities and facilities at the Tutuka Power Station ADF, which are not specifically included in the Exemption approval.

2 AUDIT PROCESS

The following steps formed the basis of the EPA Audit.

2.1 Step 1: What is the objective of the audit?

The objectives of any audit should be clearly defined and settled before either an internal or external audit begins. The setting of objectives is important, as it is against these objectives that Tutuka will be reviewed and expected to improve.

The following objectives formed the basis for the EPA Audit:

- Ensuring legal compliance in terms of the Exemption approval;
- Checking that the environmental management tools to achieve compliance are used correctly and efficiently;
- To check whether the environmental management tools are effectively fulfilling their intended purpose of environmental compliance;
- Ensuring environmental performance on a continuous basis, i.e. throughout the life cycle of the Tutuka ADF;
- Reducing environmental liability;
- To facilitate the transference of information or best practice between operating units;
- To increase environmental awareness among the employees; and
- To track the environmental accountability of managers.

2.2 Step 2: Scope of the audit

The conditions of the Exemption approval stipulate that regular performance assessments need to be undertaken to ensure compliance with the prescribed conditions as contained in the said documents.

This EPA Audit is taken to mean a regular, systematic, documented verification of whether Tutuka Power Station Ash Disposal Facility is in compliance with the conditions of the

exemption approval and whether environmental performance objectives and targets are being met.

2.3 Steps 3: Information required to conduct the audit

Table 2.1 sets out the procedures that were used to obtain the audit information.

Table 2.1: Process to obtain audit information

ACTION	DESCRIPTION
Inspection	Inspection consists of examining records and documents. Inspection of records and documents provides audit evidence of varying degrees of reliability depending on their nature and source and the effectiveness of internal controls over their processing.
Observation	Observation consists of on-site observation of the activities being conducted on site.
Enquiry	Enquiry consists of seeking information of knowledgeable persons inside the organisation.
Confirmation	Confirmation consists of making enquiries to corroborate information contained in the Exemption approval.
Computation	Computation consists of checking the accuracy of source documents and the site's records or performing independent checks of information relating to environmental aspects and impacts.

2.4 Steps 4: Conducting the audit

The audit consisted of comparing the information gathered during on-site interviews, from reports as well as assessing on-site activities with the conditions of the Exemption approval. A checklist was developed based on the conditions of the approval and used as an auditing tool to establish the audit results.

2.5 Steps 5: Evaluating the audit results

The results of the audit are presented, and the auditor assesses the final compliance in relation to the realistic representation of on-site activities; taking into account South African Environmental Legislation. Through such an assessment, the auditor should determine whether the final compliance is a true representation of on-site activities and a final recommendation should be made regarding actual compliance.

2.6 Step 6: Presenting the audit results

The findings of the Audit are included in **Table 5.1** of this Report. The audit findings also include practical recommendations whereby the various non-compliance issues can be corrected.

All findings were ranked according to the criteria indicated in **Table 2.2**. The colour coding assigned to the rankings is used to visually indicate areas of compliance, minor non-compliance, moderate non-compliance, and major non-compliance. Furthermore, to indicate which conditions are not applicable to the on-site activities and which are repeat conditions that have already been scored. Each colour coding has a value (score) attached to it.

Table 2.2: Ranking criteria and colour coding scores.

RANKING	SCORE
Compliant	2
Minor non-compliance	1
Noted/Not Applicable	0
Repeat Condition	-
Moderate non-compliance	-1
Major non-compliance	-2

All findings were ranked according to the following criteria:

Noted/Not Applicable:

- The specific condition is not relevant to the current on-site activities.

Repeat Condition:

- The specific condition is a repeat of a previous condition.

Compliant:

- Tutuka complies with the conditions as stated in the Exemption approval.

Non-compliance:

- **Minor Non-compliance:**
  - Isolated observations demonstrating that full compliance to the environmental requirements on site have not been, or will not be, fully achieved.
- **Moderate Non-compliance:**
  - There is a substantial failure to meet the environmental requirements for the project, there is a possibility of substantial environmental degradation and/or pollution, and/or objective evidence was observed raising doubt as to the integrity of data or records inspected.
- **Major Non-compliance:**

- There is a critical failure against legal requirements or management response that presents an immediate or significant risk that could result in prosecution and/or adverse legal findings due to failure to meet regulatory requirements; result in immediate injury or serious injury; result in prolonged business outage; and/or could result in serious damage to the project's reputation.

It must be noted that duplicate conditions are not scored due to the fact that this will negatively influence the scoring results. Duplicate conditions are marked as a Repeat Condition.

2.7 Step 7: Decision-making based on audit results

Decision-making, based on the audit results, must have the following objectives; to improve the present situation and to institute fair and reasonable corrective action. Tutuka should make decisions based on the significance of the problem or non-compliance and the resources required to improve the situation.

2.8 Step 8: Instituting corrective action

It is recommended that an environmental action plan be generated and implemented to address the Audit recommendations. The plan may include:

- Goals;
- Strategies;
- Performance indicators;
- Responsibilities; and
- A timetable for achievement and
- Process/system to track progress

An EPA audit is an effective management tool on condition that the recommendations, as identified in this Audit, are considered and implemented. The audit provides a basis for recommending actions to correct any deficiencies and to address any areas of environmental non-compliance recorded as part of the audit findings.

3 DETAILS OF THE AUDITOR

GCS, appointed by Eskom to conduct an external EPA audit, has more than 30 years of experience and expertise in undertaking and compiling compliance audits.

3.1 Project Team

The EPA Audit was undertaken by the GCS team presented in **Table 3.1**.

Table 3.1: GCS Team

NAME	DESIGNATION	RESPONSIBILITY
Elizabeth Mosepele	Junior Environmental Consultant	• Site visits • Compilation of Audit Report
Fatima Matlou	Senior Environmental Consultant	• Overall Legal Compliance • Site visits • Liaison with Client and Project Management • Environmental Legal Assessment • Compilation of Audit Report

3.2 Assumptions and Limitations

The findings, results, observations, conclusions and recommendations given in this audit are based on the Auditor's best legal and professional knowledge as well as available information.

Even though GCS exercises due care and diligence in rendering services and preparing documents, GCS accepts no liability, and the client by receiving this document, indemnifies GCS and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by GCS and by the use of the information contained in this document.

This audit report must not be altered or added to without the prior written consent of the auditor. This also refers to electronic copies of this Audit which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this audit must make reference to this EPA Audit. If these form part of a main audit relating to this investigation or report, this audit must be included in its entirety as an annexure or separate section to the main audit.

Refer to **Appendix A** for the Declaration of Independence of the Auditor.

4 AUDIT SCORING RESULTS: 2019 EXEMPTION APPROVAL - EPA AUDIT

Figure 4-1 presents the percentage compliance of Tutuka Power Station for the 2019 external EPA audit for the ADF in tabular and graphic format.

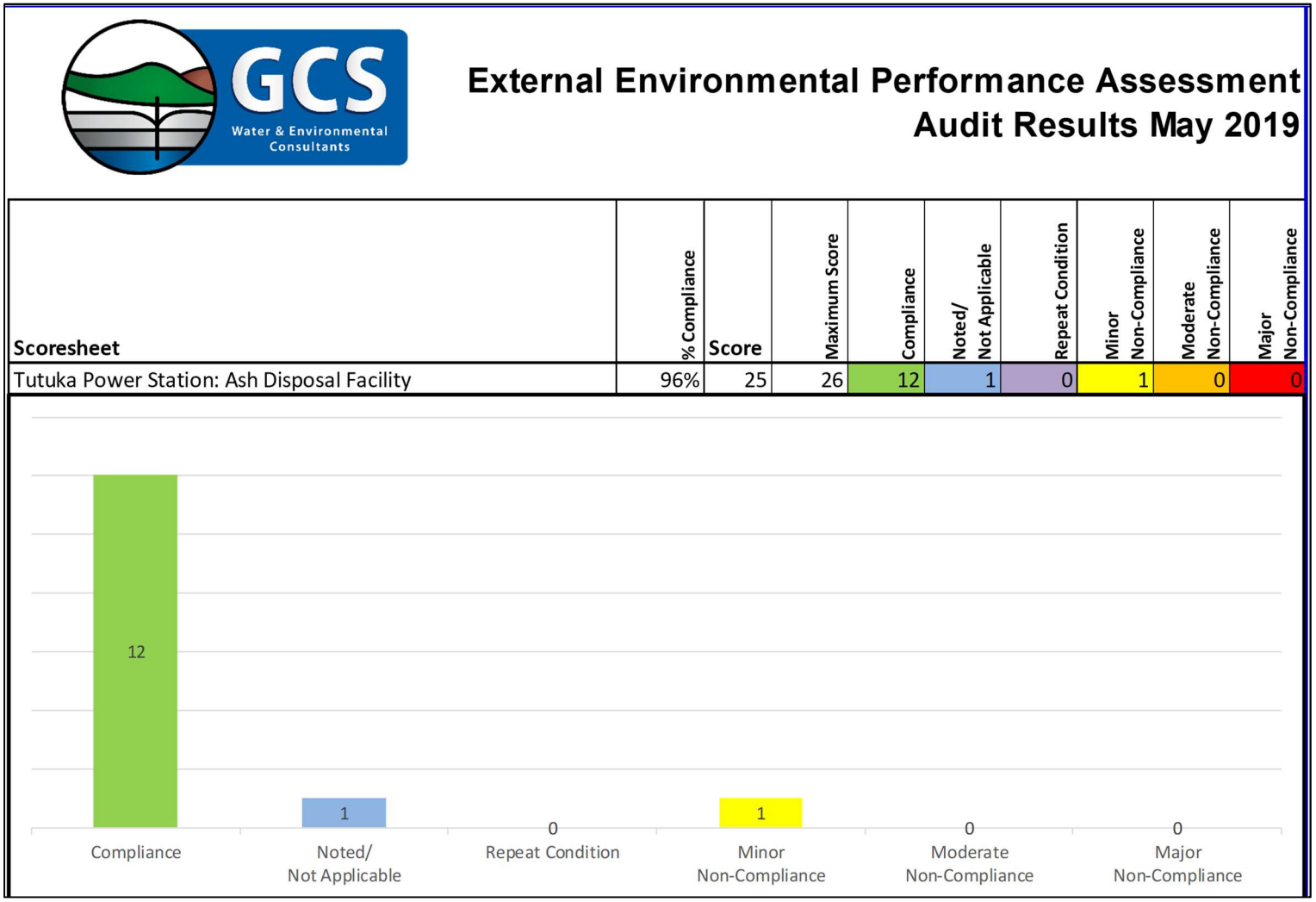

Figure 4-1: 2019 External EPA Audit Results for the ADF Project.

The graph within the table shows the number of non-compliances observed as well as the number of conditions repeated, noted or not applicable. It can be seen from the graph that Tutuka is compliant with the majority of the Exemption approval conditions.

5 AUDIT FINDINGS – MAY 2019 EPA AUDIT

Table 5.1 represents the conditions, observations and recommendations, related to the Exemption approval, as observed at the Tutuka Power Station Ash Disposal Facility, May 2019 audit.

Table 5.1: Scoring Results of the EPA Audit in respect of conditions of the Exemption approval (audit undertaken in May 2019).

DATE:	26/04/2019		SITE: Eskom	Operations: Tutuka Power Station	
No	**Conditions**	**Status**	**Score**	**Observations**	**Recommendations**
1	The permanent ash disposal facility will be lined as per Environmental Authorisation dated 19 October 2015, after four (4) years of the issuance of this exemption, with a view to minimise seepage of poor quality leachate into the groundwater resources;	Noted/Not Applicable	0	**This condition is noted:** The Ash Disposal Facility at Tutuka Power Station is not yet lined. Eskom Tutuka Power station applied for a 4-year Exemption from installing the required liner (a Class C liner), as a means to allow station ashing operations to continue while the required designs of the Class C liner were being developed, and to allow its installation. As part of the Exemption application process, the equivalent footprint (area) for the 4-year Exemption was estimated to be 54ha and was assessed and motivated by an independent Environmental Consultant. The DEA granted the 4-year Exemption on 5 May 2016, and it had some conditions. The Exemption period lapses on 4 May 2020. Parallel to ashing on the area under the Exemption, developmental work was executed for the Class C liner for the Ash Disposal Facility. In 2018, Tutuka realised that the 54ha approved under the Exemption would not be fully utilised at the end of the 4-year Exemption period, and a process to determine the most feasible option to manage this usage fap was undertaken, whereby a few alternative strategies were assessed. Through the assessment process a decision was made that the most feasible option was to apply for an extension of the Exemption period, without extending the area under the Exemption. To execute this strategy, Eskom undertook a Part 1 amendment process in November 2018, but the DEA rejected that application (dated 09 January 2019) and required that a Part 2 amendment process be undertaken instead (which is the subject of this application).	Eskom (Pty) Ltd appointed an Environmental Consultant to undertake the Part 2 Exemption amendment application process to the Exemption issued, in terms of Regulation 31 and 32 of GN 326.
2	The Holder of EA must compile and submit annual progress reports annually on the status of the engineering drawings;	Compliance	2	**This condition is adhered to:** The Department of Water and Sanitation was provided with a copy of the final designs before being submitted for decision by the DEA. Currently Eskom is trying to set up a meeting with the DWS so that they can present the designs for influence before submission for final decision.	It is recommended that Eskom pursue finalisation of the date with the DWS in order to present the designs. Thereafter Eskom will submit the final designs for decision making.
3	The ash disposal facility, pollution control dams, drainage trenches or any effluent storage facility must not be constructed on geological features such as lineaments, dykes, fault zones or shallow water table;	Compliance	2	**This condition is adhered to**. The PCDs, drainage trenches and other effluent storage facility are not constructed on geological features.	No applicable recommendations.
4	A groundwater monitoring programme in terms of quality and quantity must be developed and implemented which will include monitoring of boreholes up gradient and down gradient of the proposed ash disposal facility and be submitted for approval before disposal of ash;	Compliance	2	**This condition is adhered to:** A groundwater Monitoring programme has been developed and implemented on site. Eskom appointed GHT Consulting Scientists to undertake monitoring. Monitoring reports have been provided and have been included as Appendix C of this Report. The reports have also been submitted to the DWS.	No applicable recommendations.
5	A monitoring programme which defines the frequency of measurements, parameters to be monitored as well as database and reporting must be developed.	Compliance	2	**This condition is adhered to:** Monitoring programme has been developed and implemented on site. Eskom appointed GHT Consulting Scientists to undertake monitoring. Monitoring reports have been provided and have been included as Appendix C of this Report.	No applicable recommendations.

6	Groundwater levels and quality must be monitored on a two-month basis in order to quantify ongoing impact and provide early warnings of any problems;	Minor non-compliance	1	**Minor Non-Compliant:** Groundwater levels and quality is monitored on a quarterly basis at Tutuka Power station. The existing Tutuka monitoring protocol as well as the conditions of the WUL stipulates that the monitoring should be done on a quarterly basis. It is difficult to conduct the monitoring on a two-monthly frequency as the acceptable period from DWS for groundwater monitoring is quarterly.	It is recommended that Eskom consult with the DEA in order to motivate for monitoring at the station to be undertaken on a quarterly basis as with the conditions of the WUL.
7	Additional groundwater monitoring boreholes must be incorporated into the existing monitoring programme and must be sited and drilled to a depth that penetrates the whole system for both shallow and deep groundwater;	Compliance	2	**This condition is adhered to:** GHT was appointed by Eskom to extend the Tutuka Power Station Groundwater Monitoring System by installing ten (five deep and shallow pairs) additional monitoring boreholes on the perimeter of the final ash stack.	No applicable recommendations.
8	The shallow aquifer zone must be ceased and sealed off in the deeper boreholes to minimise the risk of cross contamination. A few of the monitoring boreholes must be installed in the shallow aquifer as an early detection system;	Compliance	2	**This condition is adhered to:** The shallow boreholes were constructed with a short solid casing followed by perforation to allow for seepages to be detected above the deep geology whereas the deep boreholes were constructed with solid casings within the upper shallow geology forming a seal to prevent downward flow to the deep geology. In this manner, impacts upon the deep and shallow geology or aquifers can be monitored separately.	No applicable recommendations.
9	If all parameters after being monitored for a period of two years or less show an increasing trend, the groundwater quality monitoring frequency must be changed from bimonthly to monthly.	Compliance	2	**This condition is noted:** Mostly stable long-term trends are observed in these boreholes, although some seasonal fluctuations are observed. There has not been an increase in the trends.	It is recommended that Eskom comply with this condition and change the frequency should it become necessary to do so.
10	Emergency actions plans in case of groundwater pollution from the ash disposal facility and pipe leakages must be adhered to in order to protect groundwater quality from degradation.	Compliance	2	**This condition is adhered:** Tutuka has Emergency actions plans in place in case of any incidents that have the potential to impact on the groundwater quality.	No applicable recommendations.
11	Abstraction from boreholes close to the ash disposal site must be avoided due to the fact that the water quality is unsuitable for human consumption.	Compliance	2	**This condition is adhered:** No abstraction takes place close to the as disposal site.	No applicable recommendations.
12	The licence holder must maintain the structural integrity of the ash disposal facility to prevent lipping and erosion.	Compliance	2	**This condition is adhered:** Erosion control measures are in place at the Ash disposal facility.	No applicable recommendations.
13	Any subsided surface adjacent to the ash disposal facility must be rehabilitated to minimise ingress of surface water into the ash disposal facility. Massive subsides must be reported to the council of Geoscience immediately.	Compliance	2	**This condition is adhered:** Surface water is not allowed into the Ash disposal Facility.	No applicable recommendations.
14	The site should be capped effectively to minimise ponding and runoff should be directed away from the ash disposal facility.	Compliance	2	**This condition is adhered:** All runoff from the area is intercepted by the southern portion of the ash disposal facility which results in localised ponding. Runoff is temporarily retained and drained underneath the ash disposal facility in the direction of three pollution control dams (the pollution control dams are located on the Wolwespruit.	It is recommended that Eskom comply with this condition, and ensure ponding is minimised as far as possible. SWMP should always be implemented and SWM infrastructure maintained to minimise any possible contamination.
		Total Findings	**14**		

6 CONCLUSION AND RECOMMENDATIONS

By conducting an EPA, Eskom recognises the importance of authorisation in regulating processes related to the project.

Currently the overall compliance with the Exemption approval is noteworthy. Overall there was one (1) incident of minor non-compliance, and zero (0) incidents of major non-compliance observed for the audit period. Tutuka is compliant with most of the conditions of the Exemption approval that apply to the current status of the project. There were no incidents of Major Non-compliances observed. This is a verification that Tutuka takes their compliance to the Exemption approval seriously and the Auditor is satisfied that the conditions of the Exemption approval are being complied with in full.

From the auditing findings, it can be concluded that Tutuka is 96% compliant with their conditions. Through the on-site meetings and observations, it is clear that Tutuka is aware of all the areas of concern.

A summary of the critical and moderate findings made during the EPA are presented in the sections that follow.

A detailed description of all the audit findings, the ranking and scoring together with observations and recommendations are provided for in Table 5.1.

6.1 Monitoring Frequency

Condition 6 of the Exemption approval

Groundwater levels and quality is monitored on a quarterly basis at Tutuka Power station. The existing Tutuka monitoring protocol and also the conditions of the WUL stipulates that the monitoring should be done on a quarterly basis. It is difficult to conduct the monitoring on a two-monthly frequency as the acceptable period from DWS for groundwater monitoring is quarterly.

It is recommended that Eskom consult with the DEA in order to motivate for monitoring at the station to be undertaken on a quarterly basis as with the conditions of the WUL.

APPENDIX A: DECLARATION OF AUDITOR INDEPENDENCE

I, **Fatima Matlou**, declare that:

- I act as the independent environmental auditor in this assessment;
- I will perform the work relating to the assessment in an objective manner, even if this results in views and findings that are not favourable to the authorisation holder;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental auditing, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activities;
- I will comply with the Act, Regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 34 of the Regulations when preparing this assessment and any report relating it;
- I have no, and will not engage in, conflicting interests in the undertaking of this assessment;
- I undertake to disclose to the holder and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the assessment is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the assessment;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will provide the competent authority with access to all information at my disposal regarding the assessment, whether such information is favourable to the holder or not;
- All the particulars furnished by me in this form are true and correct;
- I will perform all other obligations as expected from an environmental auditor in terms of the Regulations; and

- I realise that a false declaration is an offence in terms of Regulation 48 of the Regulations and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014.

Signature of the Environmental Auditor
06 September 2019

APPENDIX B: WATER QUALITY MONITORING REPORT [LATEST QUARTELY REPORT]

GHT CONSULTING SCIENTISTS

Tutuka Power Station

MONITORING REPORT
PHASE 52
OCTOBER 2016
FINAL REPORT

PROJECT TEAM
L.J. van Niekerk
S. Staats
C. Makhanya

for

Eskom

TUTKA POWER STATION

Project no.:	002-24-mon.724	Start Date:	January 2015
Current Phase:	Phase 52 Final Report	Start Date:	October 2016
Report no.:	RVN 724.18/1689	Report Date:	December 2016

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30 October 2016 Our ref.: RVN 724.18/1689

The Manager
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Private Bag 2016
Standerton
2430
Tel: 017 749 9410
Cell: 060 414 9308

FOR ATTENTION: Mrs. Ilse Coop

Dear Ilse,

Monitoring Report Phase 52 – Final Report

It is our pleasure in enclosing three compact disc copies and one hard copy of the report RVN 724.18/1689 "TUTUKA POWER STATION, Monitoring Report Phase 52". This is a final report and includes the field work and audits conducted as well as a detailed description of the chemistry on all the sites at the Power Station. All the issues that need immediate attention are also discussed in detail in this report.

We trust that the report will fulfil the expectations of the Power Station and we will supply any additional information if needed.

Yours sincerely,

Louis J van Niekerk (Pr.Sci.Nat.)
Managing Director

Copies: One compact disc copy and one printed copy to Mrs Ilse Coop – Environmental Manager (coopi@eskom.co.za)

Executive Summary

This report summarizes findings made during routine water quality monitoring Phase 52 undertaken at Tutuka Power Station by GHT Consulting Scientists in October 2016. The activities at Tutuka Power Station may impact upon the following drainage areas:

- *Area 1: Wolwe Spruit Drainage System – Southern Drainage system*
- *Area 2: Pretorius Spruit Drainage System*
- *Area 3: Racesbult Spruit Drainage System*
- *Area 4: Uitkyk Spruit Drainage System*
- *Area 5: Leeu Spruit Drainage System*

The defects pertaining to the monitoring system are omitted from this summary as the maintenance ***whereby all boreholes will be fitted with a marker post and bee-proof cap is being planned early January 2017. Additional boreholes (deep and shallow pairs) will also be drilled at Thuthukani, dam PMD11 and downstream from PMS34****.*

The following conclusions and recommendations have been made on the basis of site observations, monitoring measurements and analyses of laboratory test results:

Current State

- *The southern dirty water trench has been cleaned. Improvement are expected in groundwater sites that are in close proximity to previously impacted streams.*
- ***The borehole on the eastern side of the ash stack (FBB320) must be incorporated into the monitoring system as valuable monitoring information can be recorded prior to ashing close to the borehole. The windmill must be removed so that a cap can be fitted during the planned maintenance.***
- *Although the dirty water trench south of the ash stack has been cleaned, there is however a part on the south-eastern side of the ash stack where there is no dirty water inception. Surface run-off can flow into the stream at AMS69 and AMS68 impacting upon this site (as reflected by the exceedance of EC, Cl and NO3 at this site****). A proper diversion strategy must be investigated and the dirty water trench must be extended from the east to the west at the sump near site AMS35 which divert the ash water to dam AMD09.***
- ***The water levels of the dirty water dams PMD10, PMD11, PMD12 and PMD24 must be lowered and controlled to prevent overflows.***
- *Although the problems at CMS22 have been taken up with New Denmark Colliery,* ***this facility must be properly operated and the illegal emergency dam below the sump must either be registered and lined or removed****.*

Groundwater levels and chemical analyses results

General

- ***The WUL must be amended revising groundwater quality objectives. Boreholes from the same locality and geology with the same historical concentrations ought to be grouped together as all groundwater sites cannot be measured across the board against the same objectives.***
- ***The WUL must be amended revising surface water quality objectives. Upstream water qualities higher than existing surface water qualities must be taken into account.***

Affected Drainage Area 1 – Wolwe Spruit Drainage System

- ***The WUL must be amended revising groundwater quality objectives. Boreholes from the same locality and geology with the same historical concentrations ought to be grouped together as all groundwater sites cannot be measured across the board against the same objectives.*** *For instance, boreholes AMB31 and AMB51 are used for background purposes and are not within the natural drainage of the ash stack. The origin of exceeding ammonium may be attributed by agricultural purposes and* ***cannot be regarded as a contravention of the WUL due to ashing activities.*** *Furthermore, there was a sudden unaccounted increase in Mn at AMB51 (background) since beginning of 2016****.***
- *The slight rise in water table depth of the ash stack may either be due to historic influences of brine water irrigation or seepage from the clean north dam AMD14. Although the rise in water levels are extremely slow,* ***it must be investigated as this means the ash is slowly becoming more saturated****.*
- *Although the EC values and Mg, Ca, Cl and TDS concentrations are exceeded at AMB25D, AMB26D, AMB54 (only Mg and Cl), the trend graphs are stable, increasing slightly. As the purpose of these boreholes are to monitor the Hazardous Waste site, they had to be drilled directly into ash stack. The deep piezometers extend into the dolerite*

sill below the ash stack. Even in the presence of the ash stack, groundwater and groundwater drainage will tend to follow the historic stream system or paleochannel coming from the dam north of the ash stack. The groundwater in the sill occurs between the dolerite sill and thinly covered geology on top of it (so-called bedding plane fractures) where the borehole acts as a sump collecting this seepage. ***It must be requested that the boreholes drilled into the ash stack (AMB24, AMB25, AMB26 and AMB54) be removed from the WUL as it can be expected that the ash stack would impact on the geology directly below it.***

- *Boreholes (AMB90, AMB91, AMB92, AMB93, AMB65, AMB67 and AMB02) within close proximity of streams south of the ash stack that have been impacted upon by the silted southern AWR trench that has now been cleaned must be monitored for improvement.* ***Boreholes AMB90, AMB91, AMB92, AMB93, AMB65 and AMB67 must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.***
- *Borehole AMB64 is 800m further south, and not close to streams indicating unaffected geology when not in close proximity to surface impacted sites.*
- *The slightly deeper water level depth at AMB21 may be due to previous abstraction. The trends are however stable. It was confirmed that the electricity has been removed and that no further abstraction will be taking place.*
- *Similar chemical concentration measured at borehole AMB02 and AMB21 may indicate recharge occurring from the same impacted region or stream. Groundwater gradients created towards borehole AMB21 due to previous abstraction may have enhance the movement of contaminants from AMB02 (impacted upon the stream as explained due to overflows from the silted southern AWR trench) to AMB21. As already stated, no abstraction is taking place anymore.* ***Monitoring must continue in order to establish improvement and possible cause due to earlier abstraction.***
- *Impacts at borehole AMB63 directly below the first dirty water dam AMD09 may reflect impacts from the dam or historical overflows.* ***Overflow must be prevented.***
- *Even though it might seem impacts from the second dirty water dam (either through overflows or seepage) are visible in the shallow piezometer of borehole AMB56, the absence of SO4 (with a concentration of 11083 mg/L in the dam), this seems unlikely. The presence of Cl and NH4 may be due to cattle utilizing the water directly below the dam wall. The farm is being evacuated.* ***Monitoring must continue in order to establish improvement and possible cause after evacuation of the land.***
- *The exceedances in Fluoride detected in boreholes AMB77 and AMB01 may be attributed to the fact that Fluoride is easily released (via ion exchange) from rocks through natural processes due to slight changes in chemistry or water table depth (artificial recharge which may arise from the clean water dam AMD07 or receding water table due to diminishing rainfall) dislodging fluoride from the geology as detected in boreholes AMB77 and AMB01. This may be a natural process.* ***This emphasizes the need for different groundwater quality objectives for different areas.***

Affected Drainage Area 2 – Pretorius Spruit Drainage System

- *The steady decrease in the water level depths may indicate external influences. There is however no comparison between the groundwater and that of the dam PMD24. The presence of leaking pipes or water from the coal transfer house must be investigated.*
- *The exceedance of Na and F at AMB61 has been historically recorded. The occurrence may be from local geology. It is recommended that the WUL parameters be amended grouping boreholes into similar classification groups according to locality and geology. Inspect conveyor for ash spillage to minimize impact on PMS03.*
- *Limited surface water impacts may be visible at PMB76 (upstream from now removed temporary coal stockpile) and PMB75 (downstream from coal transfer house) without resemblance between surface- and groundwater. However, due to decreasing water level depth, the situation must be closely monitored to establish possible influences. Re-evaluation of WUL objectives must include these sites.*
- *Although the exceedance of the elements at PSD04 may be exaggerated by concentration, dam PMD10 is the only contaminated upstream source. This once again emphasizes the control of the water level of this dam.*
- *The source of the water flowing into dam PMD16 must be determined.*
- *PMS01, PMD18 and PMS10 are all directly downstream from the dirty water dam PMD11. This once again emphasizes the control of the water level of this dam.*

Affected Drainage Area 3 – Racesbult Spruit Drainage System

- *The water levels of PMB06 and PMB07 exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. However, variability at PMB07 may be a reflection of surface water activities (run-off from the conveyor). The same variability was also visible at PMB09 downstream from dam PMD03. Na is the only exceedance at PMB07.* ***This once again indicate that the WUL objectives must be amended to grouping boreholes of similar locality and geology together. Keep monitoring and prevent surface run-off from the coal conveyor.***

- *The variability at CMB10 may indicate possible surface water activities and* ***must be closely monitored.***
- *The upstream qualities at RSS04 cannot be attributes to power station activities. These poor upstream qualities will have a detrimental effect on downstream sites to which Tutuka must adhere.* ***This also indicate that the WUL objectives may have to be adjusted for surface water sites that the power station is held accounted for and are not influenced by the power station.***
- *The issue at CMS22 has been taken up with New Denmark Colliery. The only exceeding parameter of Na is at CMB71.* ***This once again indicate that the WUL objectives must be amended to grouping boreholes of similar locality and geology together.***

Domestic Waste Site

- *The water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. Borehole DMB35 upstream from the waste site exhibit a steeper increase since 2015.*
- *The occurrence of NH4 upstream from DMB35 is uncertain.* ***It is recommended that a numerical model be constructed for the domestic waste site to quantify impacts detected at DMB33 or DMB34 (downstream form the site as natural drainage are not in the direction of this borehole).***

Affected Drainage Area 4 – Uitkyk Spruit Drainage System

- *Although variability in groundwater levels indicate possible surface water activities, the water levels exhibit the same variability over vast distances between them. Furthermore, the water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter.*
- *Borehole CMB32 may show signs of impacts.* ***Improve the clean/dirty separation of the Coal Stockyard and continue monitoring.***
- *The problem at CMS46 was discussed with New Denmark Colliery personnel. These are french drains or septic tanks where chlorination is taking place to prevent bacteriological impacts. This overflow enters the coal stockyard pollution control dam CMD15.* ***It must be requested that this site be considered as a dirty water site. Once again with Na being the only exceeding parameter at CMB72, it is recommended that the WUL be amended by grouping of boreholes according to geology and locality.***

Affected Drainage Area 5 – Leeu Spruit Drainage System

- *Upstream qualities are already above the WUL quality objectives for EC. Although EC and Cl are the only elements exceeded at the downstream site LSS07, the concentration of SO4 (which is not part of WUL objectives for surface water sites) has increased by 70 mg/L.* ***These impacts are clearly from CMS60, PMD11 and PMD10 which emphasize the control of water levels of these dams.***
- *The microbiological exceedance at Thuthukani Sewage Plant (TE01) may be due to inadequate chlorination or cattle utilising the water.* ***Future samples are to be taken from the discharge point and not in-stream.***

Hydrocarbon Analyses

- *Table 61 indicates that no hydrocarbon compounds were detected for the analysed samples by using the employed analyses methods.*

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APPENDICES

1 INTRODUCTION

1.1 General

GHT was commissioned to upgrade the Tutuka Power Station Water Quality Database, perform routine monitoring and compile monitoring reports. Maps showing the location of all known monitoring sites and amended site identifiers have been prepared and are presented in **Appendix A**.

1.2 Date and number of the monitoring event

This investigation reports on the 52nd routine monitoring investigation of the surface water and groundwater quality at Eskom Tutuka Power Station by GHT Consulting (GHT) and can be considered a continuation of the monitoring programme. Surface- and groundwater samples were collected on the 10th and 11th of October 2016 and subsequently submitted to Aquatico Scientific (Pty) Ltd for analyses of the inorganic parameter concentrations. Ten selected samples were sent to the Organic Analysis Laboratory for total petroleum hydrocarbon analyses. Three selected samples were sent for bacteriological analyses to the Institute for Groundwater Studies.

In accordance with the numbering system employed during previous monitoring phases, both the date and the number of the monitoring event is indicated and this report is therefore numbered as follows: October 2016, Phase 52. The previous monitoring phase (Phase 51) was completed in June 2016.

1.3 Identification, consolidation and numbering of monitoring areas and sites

The monitoring sites at Tutuka Power Station have been classified according to their location relative to the infrastructure and natural streams in the environment. Five different Affected major drainage systems and two additional areas have been identified at Tutuka Power Station, namely:

Area 1: Wolwe Spruit Drainage System – Southern Drainage system

- Wolwe Spruit Drainage System - Background Borehole and Clean Water Dams & Canals Surrounding the Ashing Area
- Sites On Ash Stack
- Sites South West of the Ash Stack
- Clean and Dirty Water Sites East of Ash Stack
- Clean and Dirty Water Sites South of Ash Stack

Area 2: Pretorius Spruit Drainage System

- Power Station - Southern Drainage system
- Power Station – South-western Drainage system

Area 3: Racesbult Spruit Drainage System

- Power Station - Northern Drainage system
- Domestic Waste Site Area – Northern Drainage system
- Coal Stockyard Area- Southern Drainage system

Area 4: Uitkyk Spruit Drainage System

- Coal Stockyard Area- Northern Drainage system

Area 5: Leeu Spruit Drainage System

- Southern Drainage system including Thuthukani Sewage Plant

These five monitoring areas as well as the surface- and groundwater monitoring sites identified during the site assessment are shown in the site maps of Tutuka Power Station attached in **Appendix A**.

From the data gathered during the field visits and site inspections, eight different types of monitoring sites were identified. These different types of monitoring sites are:

- Groundwater sites (labelled B),
- River or natural stream sites (labelled R),
- Canal or trench sites (labelled C),
- Sewage effluent or discharge sites (labelled K),
- Pan or dam sites (labelled P),
- Seepage sites (labelled S),
- Sump sites (labelled T), and,
- Other sites (labelled Z).

All the sampling sites identified at Tutuka Power Station are listed in Appendix B.

1.4 Pollution Sources

The main pollution sources at Tutuka Power Station are the following facilities listed with monitoring sites with their respective up-gradient monitoring boreholes (with higher piezometric heads than the associated down-gradient monitoring boreholes):

- Ash Stack
  - AMB31, AMB36.
- Pollution Control dams AMB08 & AMB09
  - AMB31, AMB36.
- Sewage Plant and Maturation Pond PMD03
  - PMB76 and PMB07.
- Thuthukani Sewage Plant.
  - Planning of drilling in process.
- New Denmark Coal Stockyard, Pollution Control Dam and Coal Settling Ponds
  - CMB69.
- Domestic Waste Site
  - DMB35.
- Station dams PMD10, PMD11, PMD12 and PMD13 complex with oil Skimmers
  - PMB76.

Throughout the report, impacts will be discussed within the direction of the natural drainage from the pollution source further downstream.

1.5 Approach to study

This report investigates the current state of the monitoring system and various monitoring sites and the observed water level trends. These methods include:

- A description of the current state of the water monitoring system and infrastructure at Tutuka Power Station to identify any problems that may require attention;
- A description of the actions taken in response to problems identified during the previous monitoring phase;

2 CURRENT STATE OF THE MONITORING SITES AND RESPONSE FROM PREVIOUS PHASE

2.1 Field inspection

A very important part of a routine monitoring investigation is the field visit to the individual monitoring sites. This enables the investigators to make first hand observations regarding the condition of each monitoring site. By noting the conditions of the different monitoring sites during a specific monitoring phase in table format, problematic sampling sites in the monitoring system may be readily identified and reported on. During the subsequent monitoring phases, these problematic sites may then be revisited to determine whether the problematic situation has been addressed. This process allows one to verify whether the reported environmental performance is a true and fair representation of the actual environmental performance.

2.2 Current state of possible pollution sources and associated monitoring sites

The current states as observed and noted during Phase 52, of the possible pollution sources and associated monitoring sites at Tutuka Power Station are summarised in a site-specific fashion in Table 1 to Table 23. These tables contain columns in which the problems identified during the current phase, mitigation to problems identified during the previous and current monitoring phase, as well as actions taken since the previous phase is listed. Also included are photographs taken during the latest monitoring phase of aspects relevant to the monitoring system. In the tables, these photographs are referred to by number at the monitoring site location where the photographs were taken. This should assist the Tutuka Power Station Environmental Department in managing the identified pollution sources and other problems related to the environment.

Response tables attached in Appendix D must be completed by the relevant personnel of Tutuka Power Station and send to GHT Consulting before the next Site Assessment and monitoring which will take place in January 2017. These tables serve as a control to evaluate the actions taken in addressing the identified problems and upon completion included in future monitoring reports.

2.2.1 Affected Drainage Area 1 – Wolwe Spruit Drainage System

Table 1. Current state of monitoring system and pollution sources – Upstream north and Upstream west to south-west of the Ashing Area.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Wolwe Spruit Drainage System - Upstream north.	*AMS16	Clean water diversion trench from area north of ash stack upstream of AMD14.	1st Sampling point in clean water system from north of the ash stack.	AMD14	11-Oct-16	15:05	Dry	No Sample		Dry. Satisfactory condition.	-
	*AMD14	Clean water dam north of the ashing area - "North Dam".	2nd Sampling point of clean water drainage form the north of ash stack.	~	11-Oct-16	15:10	Mod	No Sample		No access.	Arrange keys.
	*AMB36	Monitoring borehole north of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	11-Oct-16	12:42	~	No Sample		No access. Bees previously reported.	Upgrade to be completed in 2017.
Wolwe Spruit Drainage System - Upstream west to south-east.	*AMB31	Production borehole at ashing office.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	11-Oct-16	17:00	13.64	Y		Satisfactory condition.	Upgrade to be completed in 2017. Determine if still utilized for watering game.
	*AMB51	Monitoring borehole about 700 m south of ash stack west of blue pipeline.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	11-Oct-16	11:01	24.98	Y		No marker post and borehole is blocked at 28m.	Upgrade to be completed in 2017.
	*AMB52	Monitoring borehole about 1 km south of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	11-Oct-16	10:55	13.79	Y		No marker post previously reported. No locknut.	Upgrade to be completed in 2017.
	*AMB53	Monitoring borehole south of ash stack about 1 km east of AMB52.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	11-Oct-16	10:47	9.89	Y		No locking pin and bees are active at the borehole.	Upgrade to be completed in 2017.

Table 2. Current state of monitoring system and pollution sources – South-west of the Ash Stack.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System -South West of the As Stack	*AMB55V	Conveyor belt south west of AMB55.	Ash spillages and general operations.	~	11-Oct-16	13:35	~	No Sample		Satisfactory condition.	~
	AMS50V	Sump at washing bay.	General operations.	AMS50	0-Jan-00	0:00	0	No Sample		Dry. Satisfactory condition.	-
	*AMB55	Monitoring borehole east of rehabilitated remedial plant.	Seepage from remediation area.	~	11-Oct-16	16:49	Dry	No Sample		Dry. Satisfactory condition.	Upgrade to be completed in 2017.
	AMS50	Dirty water southern toe drainage canal start at tanker refill point upstream from S48.	1st sampling point in dirty water trench west and south of ash stack	~	11-Oct-16	12:38	Dry	No Sample		Dry. Satisfactory condition. Cleaned.	-
	*AMS30	Small clean water trench downstream of offices and transfer area discharge into field.	1st Sampling point in clean water stream from west of the ash stack.	~	11-Oct-16	15:49	Stagnant	No Sample		Stagnant, satisfactory condition.	-

Table 3. Current state of monitoring system and pollution sources – Sites on Ash Stack and directly south of the ash stack - south-western drainage system.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System Sites On Ash Stack and directly south of the ash stack.	AMS17	Brine water irrigation on front stack.	Brine water irrigation quality.	Southern dirty water trench	11-Oct-16	12:15	~	Y		Sample taken from leak at refill point.	-
	*AMB26D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	~	11-Oct-16	16:38	17.91	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMB26S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	~	11-Oct-16	16:40	17.29	No Sample		Damp. Satisfactory condition.	Upgrade to be completed in 2017.
	*AMB54	Monitoring borehole south of hazardous disposal site.	Class H site plus seepage from ash stack to geology below ash stack.	~	11-Oct-16	16:31	19.76	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMS52	Clean water stream south of the ash stack.	2nd sampling point in clean water system from west and south of the ash stack.	AMS54	11-Oct-16	12:43	Dry	No Sample		Dry. Satisfactory condition.	-
	*AMB25D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	~	11-Oct-16	16:05	12.79	Y		Casing rusted and damaged.	Upgrade to be completed in 2017.
	*AMB25S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	~	11-Oct-16	16:07	11.68	Y		Too low to sample. Casing rusted and damaged.	Upgrade to be completed in 2017.
	AMS48	Dirty water southern toe drainage trench downstream from AMS50.	2nd sampling point in dirty water trench west and south of ash stack	AMS54	11-Oct-16	15:45	Low	Y		Satisfactory condition. Cleaned.	-
	*AMS54	Clean water trench south of the ash stack downstream from AMS52.	3rd sampling point in clean water system from west and south of the ash stack.	AMS15, AMS29	11-Oct-16	12:45	Dry	No Sample		Satisfactory condition.	-

Table 4. Current state of monitoring system and pollution sources – Sites on Ash Stack and directly south of the ash stack - south-western drainage system.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System - Sites On Ash Stack and directly south of the ash stack.	AMS35	Dirty water southern toe drainage trench downstream from AMS48.	3rd sampling point in dirty water trench west and south of ash stack	AMB90A&B, AMB92A&B	11-Oct-16	15:44	Low	Y		Satisfactory condition. Cleaned	-
	*AMB24D	Monitoring borehole in ash stack on standby stack.	Seepage from ash stack to below ash.	~	11-Oct-16	15:53	28.08	Y		Casing rusted and damaged.	Upgrade to be completed in 2017.
	*AMB24S	Monitoring borehole in ash stack on standby stack.	Ash stack water level and ash reference qualities.	~	11-Oct-16	15:57	26.08	No Sample		Casing rusted and damaged.	Upgrade to be completed in 2017.
	*AMS15	Clean water stream south of the ash stack downstream from AMS54.	4th Sampling point in the clean water stream from west and south of ash stack.	AMB90A&B, AMB92A&B	11-Oct-16	15:32	Dry	No Sample		Dry. Satisfactory condition.	-
	*AMB92A	Monitoring borehole on south-eastern corner of ash stack - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	~	11-Oct-16	15:34	1.79	Y		Satisfactory.	Upgrade to be completed in 2017.
	*AMB92B	Monitoring borehole on south-eastern corner of ash stack - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	~	11-Oct-16	15:34		Y			
	*AMB90A	Monitoring borehole south of ashing area east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	~	11-Oct-16	12:59	~	No Sample		No marker post. Unable to open.	Upgrade to be completed in 2017.
	*AMB90B	Monitoring borehole south of ashing area east of stream - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	~	11-Oct-16	12:59		No Sample		No marker post. Unable to open.	Upgrade to be completed in 2017.

Table 5. Current state of monitoring system and pollution sources – Sites 200 meters and further south of the ash stack - south-western drainage system.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System - South-western Drainage System Clean and Dirty Water Sites south of Ash Stack	*AMS29	Clean water stream south of the ash stack downstream from AMS15.	5th Sampling point in clean water stream from west and south of ash stack..	AMB93A&B AMB67A&B	11-Oct-16	10:26	Dry	No Sample		Dry. Satisfactory condition.	-
	*AMB93A	Monitoring borehole south of ashing area and AMB90 and east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	~	11-Oct-16	10:28	2.37	Y		No marker post.	Upgrade to be completed in 2017.
	*AMB93B	Monitoring borehole south of ashing area and AMB90 and east of stream - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	~	11-Oct-16	10:28		Y			
	*AMB67A	Monitoring borehole south of ashing area.	Seepage from ash stack to deep aquifer.	~	11-Oct-16	10:14	2.35	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMB67B	Monitoring borehole south of ashing area.	Seepage from ash stack to upper aquifer.	~	11-Oct-16	10:16		Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMB64	Monitoring borehole south of ashing area.	Seepage from ash stack.	~	11-Oct-16	9:41	2.83	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMS36	Clean water trench south of the ash stack downstream from AMS29.	6th sampling point in clean water stream from west and south of ash stack..	AMB02	11-Oct-16	10:35	Dry	No Sample		Satisfactory condition.	-
	*AMB02	Monitoring borehole upstream ashing area settling dam.	Impacts from ash stack and southern dirty water trenches upon western clean water diversion and drainage system.	~	11-Oct-16	9:29	0.25	Y		No Plinth. Casing bent and difficult to remove cap.	Upgrade to be completed in 2017.

Table 6. Current state of monitoring system and pollution sources Ashing Area – Sites south-east of ash stack - South eastern drainage system.

Site Information					Current State Description					
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System - South-eastern Drainage System Clean and Dirty Water Sites south of Ash Stack	*FBB320	Background borehole east of ash stack, just south of two old cement dams.	Upgradient borehole with higher peizometric head used for background sample as reference.	~	20-Jun-16	~	No Sample		Not inspected during this monitoring event.	Old windmill to be removed and fitted with marker post and cap.
	*AMS69	Clean water diversion under ash stack flowing to AMS68.	1st sampling point of eastern diversion of Wolwe Spruit.	AMB91A&B, AMB65	11-Oct-16	Low Stagnant	No Sample		Low stagnant. The clean water pipes which diverts water underneath the ash stack has been covered with ash however no longer blocking the flow to AMS68A.	The ash must be cleared from the diversion and the dirty water canal must also be upgraded.
	*AMS68	Clean water stream east of ash stack flowing past AMB91 south of ash stack.	2nd sampling point of eastern diversion of Wolwe Spruit.	AMB91A&B, AMB65	11-Oct-16	Low Stagnant	Y		Satisfactory condition. Precipitated salts visible.	Keep monitoring.
	*AMB91A	Monitoring borehole south of ashing area west of stream - Deep.	Seepage from ash stack, eastern dirty water trench and clean water stream drainage to deep aquifer.	~	11-Oct-16	2.24	Y		No marker post.	Upgrade to be completed in 2017.
	*AMB91B	Monitoring borehole south of ashing area west of stream - Shallow.	Seepage from ash stack, eastern dirty water trench and clean water stream drainage to shallow aquifer.	~	11-Oct-16		Y		No marker post.	Upgrade to be completed in 2017.
	*AMB65	Monitoring borehole south of ashing area.	Seepage from ash stack.	~	11-Oct-16	1.98	Y		No locknut or pin.	Upgrade to be completed in 2017.

Table 7. Current state of monitoring system and pollution sources Ashing Area - Southern Drainage System. Dirty Water dams.

Site Information					Current State Description					
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Wolwe Spruit Drainage System - Southern Drainage System Dirty Water Dams South of Ash Stack	AMD09	First dam (dirty settling dam) in dirty water system.	Dirty water settling dam qualities and operations.	AMB63, AMB21	11-Oct-16	Mod	Y		Satisfactory condition.	Always prevent overflows.
	*AMB63	Monitoring borehole below settling water dam.	Seepage from settling dam AMD09.	~	11-Oct-16	0.90	Y		Cap damaged.	Upgrade to be completed in 2017.
	*AMB21	Production borehole south of ash stack next to the clean water dam.	Seepage from dirty water dam AMD08	~	11-Oct-16	7.00	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	AMD08	Second dam (dirty water dam) in the dirty water system.	Dirty water dam qualities and operations.	AMB56D&S, AMB21	11-Oct-16	Low	Y		Lots of salt visible around dam yet in a satisfactory condition.	-
	*AMB56D	Monitoring borehole between clean and dirty water dam. Deep.	Seepage from dirty water dam AMD08 to deep aquifer.	~	11-Oct-16	3.03	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*AMB56S	Monitoring borehole between clean and dirty water dam. Shallow.	Seepage from dirty water dam AMD08 to shallow aquifer.	~	11-Oct-16	2.86	Y		Satisfactory condition.	Upgrade to be completed in 2017.

Table 8. Current state of monitoring system and pollution sources Ashing Area - Southern Drainage System. Clean Water dam.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Wolwe Spruit Drainage System - Southern Drainage System - Clean Water Sites South of Ash Sta	*AMD07	Clean water dam at the end of the dirty water system.	Effectiveness of clean water bypass system to clean water dam.	AMB77D&S, AMB01	11-Oct-16	8:00	Low	Y		Low. Satisfactory condition.	-
	*AMB77D	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to deep part of aquifer.	~	11-Oct-16	8:05	3.76	Y		No cap and marker post.	Upgrade to be completed in 2017.
	*AMB77S	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to shallow part of aquifer.	~	11-Oct-16	8:05	1.00	Y		No cap and marker post.	Upgrade to be completed in 2017.
	*WSS61	Upstream from the confluence from WSS32.	Upstream from confluence.	~	11-Oct-16	11:32	Dry	No Sample		Satisfactory condition.	-
	*WSS32	Tributary joining Wolwe Spruit from east just north of road.	Tributary background sample.	~	11-Oct-16	11:30	Dry	No Sample		Satisfactory condition.	-
	*AMB01	Monitoring borehole south clean water dam.	Seepage from clean water dam.	~	11-Oct-16	11:26	3.08	Y		No marker post or plinth. Old beehive in borehole.	Upgrade to be completed in 2017.
	*WSS06	Stream leaving the ashing area at the southern side.	Stream leaving ashing area.	~	11-Oct-16	11:28	Low Stagnant	Y		Satisfactory condition.	-

2.2.2 Affected Drainage Area 2 – Pretorius Spruit Drainage System

Table 9. Current state of monitoring system and pollution sources - Power Station Impacts from north and north-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Pretorius Spruit Power Station impacts from north-east and east.	AMD27	Raw Water dam. South of the shooting range.	Leakage detection of clean water losses.	~	11-Oct-16	15:25	Mod	No Sample		Satisfactory condition.	-
	*AMB61	Monitoring borehole west of ashing east of tar road.	Drainage to the southwest.	~	11-Oct-16	12:05	2.88	Y		No casing , cap and marker post.	Upgrade to be completed in 2017.
	*AMS64	Clean Surface catchemnt upstream from AMB61.	Runoff from ash conveyor.	AMB61	11-Oct-16	12:04	Dry	No Sample		Dry. Satisfactory condition.	-
	*PMS03	Small dam and wetland east of power station next to road.	Clean water run-off.	~	11-Oct-16	14:58	Low	Y		Satisfactory condition.	-
	*PSS59	Upstream sample point form the east flowing into PSD04.	Upstream from PSD04.	~	11-Oct-16	11:50	Dry	No Sample		Dry. Satisfactory condition.	-

Table 10. Current state of monitoring system and pollution sources - Power Station Impacts from north-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Pretorius Spruit Impacts from north-eastern part of Power Station	*PMB76	Monitoring borehole east of power station and north-east of old coal stockpile.	Seepage from temporary coal stockpile in PS area.	~	11-Oct-16	14:05	5.79	Y		Satisfactory condition. Sudden increase in water level depth.	Upgrade to be completed in 2017.
	PMD24	Small dam south of temporary coal stockpile.	Dams south of temporary CSP.	PMB75, PMS65	11-Oct-16	14:26	Very low	No Sample		Dam is silted up.	Dam must be closely monitored and cleaned when necessary.
	PMD24V	Temporary Coal Stockpile - Removed and rehabilitated.	General operations.	~				No Sample	P1	Removed and rehabilitated	-
	*PMB75	Monitoring borehole south east of power station and south of conveyor.	Seepage from temporary coal stockpile in PS area.	~	11-Oct-16	13:34	1.49	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*PMS65	Seepage water in vicinity of PMB75.	Seepage water in vicinity of PMB75.	~	11-Oct-16	15:22	Dry	No Sample		Dry. Satisfactory condition.	-
	PMS41	Clean water run-off canal from power station to PMD10.	Run-off from PS & overflow from eastern cooling towers.	~	11-Oct-16	13:40	Low	No Sample		Dry. Satisfactory condition.	-
	PMS41V	Emergency Stack	General operations.	~						Satisfactory condition.	-

Photo 1. Temporary Coal Stockpile removed

Table 11. Current state of monitoring system and pollution sources - Power Station impacts from north-east (dirty water dam).

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Pretorius Spruit Power Station impacts from north-east (dirty dam)	59C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.	~	11-Oct-16	15:06	~	N		Dry. Satisfactory condition.	-
	PMD10	Stein Muller Dam south-east of the power station.	Stein Muller Dam downstream from S41.	PMB04, PMS02	11-Oct-16	14:48	Full	Y		Overgrown and full.	Remove excess vegetation when and where necessary and lower water level.
	*PMB04	Monitoring borehole south-east of power station and Stein Muller Dam.	Seepage from Stein Muller Dam - PMD10.	~	11-Oct-16	14:46	~	No Sample		Infested with bees and no locknut or pin.	Upgrade to be completed in 2017.
	*PMS02	Stream south of the power station with drainage water from dam PMD10.	Overflow from PMD10.	~	11-Oct-16	12:35	Low	No Sample		Low, flowing slowly.	Lower water level of dam PMD10.
	*PSD04	Farm dam south of the power station. Water drains from dam PMD10 and PMS02.	Farm dam downstream from PMS02 & PMS03.	~	11-Oct-16	11:55	Mod	Y		Satisfactory condition.	-
	*PSS11	Tributary of Leeu Spruit south of the power station.	Downstream from PSD04.	~	11-Oct-16	16:46	Dry	No Sample		Flowing slowly. Satisfactory condition.	-

Table 12. Current state of monitoring system and pollution sources - Power Station Impact from the north-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Pretorius Spruit Power Station Impact from the north-east.	*PMS58	Stream south of the power station with drainage water from dam in bird sanctuary.	Overflow from dam in bird sanctuary.	~	11-Oct-16	12:47	Dry	No Sample		Dry. Satisfactory condition.	-
	*PMD16	Small dam next to the western security gate of the power station area.	Clean water dam.	PMS21	11-Oct-16	13:12	Low	Y		Low, stagnant .Satisfactory condition.	-
	*PMS21	Stream south of the power station with drainage water from dam PMD16.	Overflow from PMD16.	~	11-Oct-16	12:44	Dry	No Sample		Flowing slowly. Satisfactory condition.	-
	*PMS66	Possible fountain west of PMD11 and north of fence.	Possible fountain west of PMD11 and north of fence.	~	11-Oct-16	15:30	Dry	No Sample		Dry. Satisfactory condition.	-
	PMS70V	Contractors area south of western cooling towers south of Power Station	Remove oil containers and placed in oil sump.	~	11-Oct-16	11:19	~	N		Satisfactory condition.	-
	PMS70	Canal flowing into PMD29.	General operations.	~	11-Oct-16	15:30	Low	No Sample		Full flowing slowly. Satisfactory condition.	-
	PMS70V	Contractors area south of western cooling towers south of Power Station	Remove oil containers and placed in oil sump.	~	11-Oct-16	11:19	~	N		Satisfactory condition.	-
	PMD29	Ash settling ponds in Power Station.	General operations.	~	11-Oct-16	15:08	Full	No Sample		Satisfactory.	-
	107C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.	~	11-Oct-16	15:01	~	N		Dry. Satisfactory condition.	-

Table 13. Current state of monitoring system and pollution sources - Power Station impacts from the north-east (dirty dam)

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Pretorius Spruit Power Station Impact from the north-east (dirty dam)	PMS56	Clean water run-off canal from power station to PMD11.	Run-off from PS.	~	11-Oct-16	12:24	Dry	No Sample		Dry. Satisfactory condition.	-
	77C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.	~	11-Oct-16	15:04	~	No Sample		Dry. Satisfactory condition.	-
	PMS47	Canal from the cooling towers west to PMD11.	Run-off from PS & overflow from western cooling towers.	~	11-Oct-16	13:47	Low	No Sample		Dry. Satisfactory condition.	-
	PMD11	DB Thermal Dam south of power station.	DB Thermal Dam downstream from PMS47.	PMS01	11-Oct-16	13:17	Mod	Y		Moderately full 85%. Satisfactory condition. Monitoring borehole PMB05 is destroyed.	Remove excess vegetation when and where necessary and lower water level.
	PMS01	Stream south of the power station with drainage water from dam PMD11.	Overflow from PMD11.	~	11-Oct-16	12:39	Low	Y		Low, flowing slowly.	Lower water level of dam PMD11.
	PMD18	Farm dam south of the power station. Water drains from PMD11 & PMD16.	Farm dam downstream from PMS01, PMS21 & PMS58.	PMS58, PMS21, PMS66, PMS01, PMD11	11-Oct-16	12:46	Very low	Y		Satisfactory.	-
	*PMS10	Tributary of Pretorius Vlei Spruit downstream of PMD18.	Down stream from PMD18.	~	11-Oct-16	16:46	Low	Y		Flowing slowly. Satisfactory condition.	-

2.2.3 Affected Drainage Area 3 – Racesbult Spruit Drainage System

Table 14. Current state of monitoring system and pollution sources- Power Station impacts from the south-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Racesbult Spruit Power Station impacts from the south-east.	PMS20	Canal from the cooling towers west to PMD12.	Run-off from PS & overflow from western cooling towers	~	11-Oct-16	13:42	Dry	No Sample		Dry. Satisfactory condition.	-
	PMS27	Clean water run-off canal from power station to PMD12.	Run-off from PS.	~	11-Oct-16	14:28	Dry	No Sample		Dry. Satisfactory condition.	-
	PMS26	Canal from the cooling towers east to PMD12.	Run-off from PS & overflow from eastern cooling towers.	~	11-Oct-16	14:28	Dry	No Sample		Dry. Satisfactory condition.	-
	PMD12	North Potable dam north of the power station.	North Potable dam downstream from PMSS20, PMS26 & PMS27.	PMB06, PMS24	11-Oct-16	13:52	Full	Y		Full.	Lower water level of dam PMD12.
	*PMB06	Monitoring borehole north of the power station and North Potable Dam.	Seepage from North Potable Dam - PMD12	~	11-Oct-16	13:53	0.68	Y		Borehole collar casing completely rusted.	Upgrade to be completed in 2017.
	*PMS24	Stream north of the power station. Drainage from dam PMD12 or a spring.	Overflow from PMD12	~	11-Oct-16	13:30	Dry	No Sample		Dry. Satisfactory condition.	-

Table 15. Current state of monitoring system and pollution sources – Power Station impacts from the south-east (station dams).

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Racesbult Spruit Power Station impacts from the south-east (station dams	PMD20	Dam west of conveyor used during cleaning of station drain dams PMD17.	Settling dam west.	PMB07	11-Oct-16	15:50	High	No Sample		Cleaning in progress.	Clean dam to increase capacity.
	*PMS24	Stream north of the power station. Drainage from dam PMD12 or a spring.	Overflow from PMD12	~	11-Oct-16	13:30	Dry	No Sample		Dry. Satisfactory condition.	-
	PMD13V	Oil skimmers	Operational standards.	~	11-Oct-16	15:43	~	No Sample	P2-P3	Satisfactory.	-
	PMD17	Settling dams above dirty water dam PMD13, overflow into PMD13.	Settling dams.	PMB07	11-Oct-16	15:42	Full	No Sample	P4	Cleaning at western side in progress.	Dam must be cleaned to increase capacity.
	PMD19	Small dam next to settling ponds, PMD17.	Small settling dam.	PMB07	11-Oct-16	14:50	Full	No Sample	P5	Overgrown.	Vegetation must be cleared on a regular basis.
	PMD13	Dirty Water Dam in the north-east of the power station.	Dirty water dam.	PMB07, PMS23	11-Oct-16	14:13	Low	Y	P6	Oil visible on surface.	Remove excess oil where necessary.

Photo 2. Oil skimmers

Photo 3. Oil Skimmers

Photo 4. Cleaning in progress at PMD17

Photo 5. PMD19

Photo 6. PMD13

Table 16. Current state of monitoring system and pollution sources – Power Station impacts from the south-east (downstream station dams).

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Racesbult Spruit Power Station impacts from the south-east (downstream station dams)	PMS34	Containment canal just beneath PMD13.	Overflow from Dirty Water Dam PMD13.	PMB07	11-Oct-16	14:40	Low	Y	P7-P8	Satisfactory condition. A borehole must be installed.	-
	10C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.	~	11-Oct-16	15:39	~	N		Leaking Pipes next to sump. Dry.	-
	*PMB07V	Leaking water between PMD20 & PMD21 and flowing towards PMB07	General Operations.	~				N		Leaking water running from below PMD20 to PMB07.	Upgrade to be completed in 2017.
	PMD21	Small dam north of station drain outlets.	Small settling dam.	PMB07	11-Oct-16	15:52	Dry	No Sample		Fully silted up.	Clean dam to increase capacity.
	*PMB07	Monitoring borehole north-east of the power station and Dirty Water Dam.	Seepage from Dirty Water Dam PMD13.	~	11-Oct-16	14:46	2.68	Y		Satisfactory condition. (Note that there is currently a decomposing rat in the borehole which could effect chemistry)	Upgrade to be completed in 2017.
	*PMS23	Stream overflow from dirty water dam PMD13 and PMS34.	Overflow from PMS34 & Dirty Water Dam PMD13.	~	11-Oct-16	10:16	Dry	No Sample		Stagnant. Seepage from containment canal PMS34. Satisfactory.	-

Photo 7. PMS34

Photo 8. PMS34 - soil

Table 17. Current state of monitoring system and pollution sources – Impacts from old domestic waste and sewage plant from the south east.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Old waste Site East of Power Station	*PMB08	Monitoring borehole north of the rehabilitated old Domestic Waste Site.	Seepage from old waste site	~	11-Oct-16	14:55	Blocked	No Sample		Borehole infested with bees.	Upgrade to be completed in 2017.
Sewage plant East of Power Station	*PMD03	Dam west sewage plant.	Maturation Dam	PMB09	11-Oct-16	10:15	Full	Y		Overgrown, yet satisfactory.	Remove excess vegetation when and where necessary.
	*PMB09	Monitoring borehole next to the stream from dam below Sewage Plant.	Seepage from sewage plant	~	11-Oct-16	14:58	Blocked	No Sample		Borehole is currently blocked by old beehive.	Upgrade to be completed in 2017.

Table 18. Current state of monitoring system and pollution sources – Impacts from domestic waste site.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Racesbult Spruit Domestic Waste Site	*DMB35	South of the solid waste site and next to the entrance.	Upstream from waste site.	~	11-Oct-16	14:41	5.52	Y		No locking pin.	Upgrade to be completed in 2017.
	*DMS44	Surface water east of waste site. Collect runoff from dump in excavation.	Run-off from site.	~	11-Oct-16	15:20	Damp	No Sample		Not enough water to obtain sample.	
Racesbult Spruit - Northern Drainage System - Domestic Waste Site Impact	*DMB35V	Old and New Domestic Waste Site	General operations.	~	11-Oct-16	8:00	~	No Sample		Satisfactory condition.	Upgrade to be completed in 2017.
	DMT01	Sump on north-eastern corner.	Seepage from waste site.	~	0-Jan-00	15:20	Dry	No Sample		Not part of the WUL sites.	-
	*DMB34	North of the solid waste site.	Seepage from waste site.	~	11-Oct-16	14:52	1.88	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	DMD31	New dam situated below the domestic waste site.	Dam next to DMB86.	DMB33	11-Oct-16	14:42	Dry	No Sample		Satisfactory condition.	-
	*DMB33	North of the solid waste site.	Seepage from waste site.	~	11-Oct-16	15:14	2.06	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*DMB86	Old borehole with piezometer north of the solid waste site.	Seepage from waste site.	~	11-Oct-16	15:24	~	No Sample		Not part of the WUL sites.	Upgrade to be completed in 2017.
	*DMB89	West of proposed new extension and north of the borrow pit.	Seepage from waste site.	~	11-Oct-16	15:24	~	No Sample		Not part of the WUL sites.	Upgrade to be completed in 2017.
	*DMB87	North west of new proposed extension.	Seepage from waste site.	~	11-Oct-16	15:02	2.56	Y		Satisfactory condition.	Upgrade to be completed in 2017.
	*DMS37	Streamlet northeast of waste disposal site.	Run-off from site.	DMB88	11-Oct-16	15:03	Dry	No Sample		Dry. Satisfactory condition.	-
	*DMB88	North west of new proposed extension.	Seepage from waste site.	~	11-Oct-16	14:59	3.27	Y		Was able to open borehole using magnet. However the extreme corrosion is still an ongoing issue.	Upgrade to be completed in 2017.

Table 19. Current state of monitoring system and pollution sources Coal Stockyard impacts from the east.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Racesbult Spruit Upstream from the east	*RSD01	Dam next to the Bethal Road upstream site.	Farm dam background sample.	~	11-Oct-16	15:34	Full	No Sample		Satisfactory condition.	-
	*RSS04	Downstream from RSD01 upstream site. Could be a spring.	Downstream from RSD01.	~	11-Oct-16	15:36	Low	Y		Satisfactory condition.	-
Racesbult Spruit - Southern Drainage System - Coal Stockyard Area Impact east of conveyor	*CMB69	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	~	11-Oct-16	14:40	~	No Sample		Casing and marker post damaged. Bees are active.	Upgrade to be completed in 2017.
	CMS62	Tanker refill point at southern fence of coal stockyard.	Tanker refill point and surrounding area.	CMB10	11-Oct-16	14:35	Dry	No Sample		Precipitated salts visible.	Spillages must be prevented.
	*CMB10V	Coal transfer house near CMB10.	General operations.	~	11-Oct-16	11:19	~	N		Satisfactory condition.	-
	*CMB10	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	~	11-Oct-16	14:31	11.19	Y		No locking pin and bees are removed at the borehole.	Upgrade to be completed in 2017.
	*CMB70	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from stock pile.	~	11-Oct-16	14:45	3.63	Y		No locking pin. Number plate damaged.	Upgrade to be completed in 2017.
	*RSS49	Downstream from RSS04 about 100 m east of conveyor.	Downstream from RSS04.	~	11-Oct-16	14:50	Dry	No Sample		Satisfactory condition.	-

Table 20. Current state of monitoring system and pollution sources – Impacts from Coal Stockyard Area east of conveyor up to Leeu Spruit.

Site Information					Current State Description						
Area with Possible Env. Hazard	**No. On Map**	**Site Description**	**Site Objective**	**Monitored by Site**	**Date**	**Time**	**Water Level & Flow**	**Sampled**	**Photo no.**	**Current State**	**Proposed Mitigation**
Racesbult Spruit - Southern Drainage System Coal Stockyard Area Impact east of conveyor	CMS22	Sample at point of outflow from sump west of conveyor.	Surface runoff from transfer house.	CMB71	11-Oct-16	14:06	Full	Y	P9	Alternation is taking place. However, overflowing to the temporary dam below.	Prevent overflows.
	CMD23	Illegal temporary dam receing overflows from CMS22	Legal compliance.	~	11-Oct-16	14:06	Full	No Sample	P10	Temporary dam to intercept overflow from CMS22.	Remove dam.
	*CMB71	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from CMS22 and stock pile.	~	11-Oct-16	14:00	2.70	Y		No locking pin.	Upgrade to be completed in 2017.
	*CMS60	Seepage or possible fountain west of conveyor and south-west of CSY.	Seepage southwest of CSY.	RSS31	11-Oct-16	14:08	Low Stagnant	Y		Satisfactory condition.	-
Racesbult Spruit downstream	*RSS31	In stream west of conveyor.	Downstream from RSS49.	~	11-Oct-16	13:49	Low Stagnant	Y		Satisfactory condition.	-
	*RSS45	Downstream of RSS31, on Pieter Bosman's farm.	Downstream from RSS31.	~	11-Oct-16	13:16	Low Stagnant	Y		Satisfactory condition.	-
	*RSS09	At tar road crossing.	Downstream from RSS45.	~	11-Oct-16	16:41	Low Slow flow	Y		Satisfactory condition.	-

Photo 9. CMD23 – overflows from PMS22

Photo 10. CMS22

2.2.4 Affected Drainage Area 4 – Uitkyk Spruit Drainage System

Table 21. Current state of monitoring system and pollution sources – Coal Stockyard impacts from the south-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Uitkyk Spruit Coal Stockyard Area Impacts from south-east.	CMS71	Canal and small settling pan in Coal Stockyard.	Coal water canal.		11-Oct-16	14:30	Dry	No Sample		Satisfactory condition.	-
	CMD28	Dam inside Coal Stockyard.	Coal settling pans.	~	11-Oct-16	15:10	Mod	No Sample		Satisfactory condition.	-
	CMS28	Overflow of draining system at coal stock pile flowing into CMD15.	Run-off from stock pile.		11-Oct-16	15:53	Mod	Y		Satisfactory condition.	-
	CMD26	Coal settling pans north-west of coal stockyard.	Settling pan and silt trap south of CMS57.		11-Oct-16	15:00	Low	No Sample		Satisfactory condition.	-
	*CMS57	Run-off water from coal stockyard flowing towards Uitkyk Spruit.	Run-off from northern settling ponds at CSY.		11-Oct-16	15:10	Dry	No Sample		Dry. Satisfactory condition.	-
	*CMS63	Storm water pipe and seepage north of Coal Stockyard.	Storm water pipe and seepage from coal stack.		11-Oct-16	14:45	Dry	No Sample		Dry. Satisfactory condition.	-
	*CMB32	Monitoring borehole north of coal stock yard.	Seepage from stock pile and CMS63.		11-Oct-16	15:00	0.63	Y		No Cap. Borehole is blocked at 15m.	Upgrade to be completed in 2017.

Table 22. Current state of monitoring system and pollution sources – Coal Stockyard impacts from the south-east.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Uitkyk Spruit - Northern Drainage System - Coal Stockyard Area Impact	*CMS46	Water from sewage pits next to fence flowing towards dam CMD15.	Overflow from sewage pit.		11-Oct-16	15:07	Low, Stagnant	Y		Not overflowing.	-
	CMD15	Pollution control dam of New Denmark Colliery north of coal stockyard.	Pollution Control Dam.		11-Oct-16	15:15	Mod	Y		Satisfactory condition.	-
	*USS38	CMD15's overflow.	Overflow from CMD15.		11-Oct-16	15:30	Dry	No Sample		Satisfactory condition.	-
	*CMB19	Monitoring borehole north of coal stock yard below dam CMD15.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.		11-Oct-16	15:19	1.84	Y		No Locknut. Casing damaged.	Upgrade to be completed in 2017.
	*CMB12	Monitoring borehole below pollution control dam next to Uitkyk Spruit.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.		11-Oct-16	15:40	1.22	Y		No locking pin.	Upgrade to be completed in 2017.
	*CMB72	Monitoring borehole north of coal stock yard next to Uitkyk Spruit.	Seepage from dam CMD15, CMS63 & stock pile.		11-Oct-16	15:27	1.76	Y		No locknut and Cap.	Upgrade to be completed in 2017.
	*USS12	Stream north of coal stockyard downstream from dam CMD15.	Downstream from CMS38.		11-Oct-16	15:15	Mod Stagnant	No Sample		Satisfactory condition.	-

2.2.5 Affected Drainage Area 5 – Leeu Spruit Drainage System

Table 23. Current state of monitoring system – Leeu Spruit.

Site Information					Current State Description						
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	Monitored by Site	Date	Time	Water Level & Flow	Sampled	Photo no.	Current State	Proposed Mitigation
Leeu Spruit Area - Southern Drainage System	*LSS13	Crossing of road over Leeu Spruit - background value.	Leeu Spruit sampling point 1.	~	11-Oct-16	16:28	Low	Y		Low, flowing slowly. Satisfactory condition.	-
	*LSS33	Crossing of road over Tributary of Leeu Spruit downstream from LSS13.	Tributary to Leeu Spruit.	~	10-Oct-16	16:28	Low	Y		Satisfactory condition.	-
	*LSS14	Crossing of road over Leeu Spruit downstream from LSS13.	Leeu Spruit sampling point 2.	~	10-Oct-16	16:35	Mod	Y		Satisfactory condition.	-
	*NMS67	Storm water trench next to road at corner of road to NDC	Runoff, seepage or overflow from upstream dam.	~	0-Jan-00	14:33	Dry	No Sample		Not part of the WUL sites.	-
	*NMS40	Mine sewage plant - effluent overflow - sample in Spruit next to tar road.	Effluent overflow from mine sewage plant.	~	11-Oct-16	13:07	Dry	No Sample		Dry. Satisfactory condition.	-
	TE01V	Thuthukani Sewage Plant	Monitor general operational standards.	TE01	11-Oct-16	13:35	~	N		Satisfactory condition.	A borehole must be drilled to monitor possible groundwater pollution.
	*TE01	Thuthukani Sewage Plant final purified sewage effluent discharge point.	Monitor sewage effluent discharge quality.	~	11-Oct-16	14:29	Low Stagnant	Y		Satisfactory condition.	-
	*LSS07	Crossing of road over Leeu Spruit downstream from LSS14 at Grootdraai Dam.	Leeu Spruit sampling point 3.	~	11-Oct-16	12:30	Low	Y		Satisfactory condition.	-

3 Groundwater Levels and Chemistry

In this chapter observations regarding the temporal trends in the piezometric and groundwater levels are made. These trends provide an indication of the extent to which factors such as the climate and power station activities influence the groundwater regime. None of the current power generation activities depends on the use of groundwater and no dewatering of the aquifer system underlying Eskom's property is taking place.

Furthermore, the chemical analyses are discussed as measured against the Water Use License Objectives.

The results of all the inorganic chemical, hydrocarbon and bacteriological analyses that have been performed on water samples from Tutuka Power Station during the current and previous phases of the monitoring program are available in an electronic database for review.

3.1 Chemical Analysis Reliability

The most common way to evaluate the reliability of an analysis is to perform an Ion Balance Calculation. For any water analysis, the total cation and anion concentrations should balance. The difference between these concentrations is referred to as the Ion Balance Error. A negative value indicates that anions predominate in the analysis, whereas a positive value shows that cations are more abundant. For the analysis to be considered reliable, the ion balance error should not be greater than 5% of the total ion concentration. A value greater than this figure indicates that some major constituents have not been analysed for or that there is an analytical error. Some trace elements are not included in the ion balance calculation however, these may still be important as pollution indicators and may be used to identify point sources of pollution.

3.2 Chemical Data Presentation Formats

The results of the inorganic chemical analyses are presented in various formats in this report. These formats include:

- Water Quality Tables classified according to the Water Use Licence for Surface and Groundwater Quality Objectives.
- Time Graphs of the chemical concentrations variations over time of the groundwater sites.
- Bar Chart Plots of the surface water sites along the drainage systems.

The formats used are not exhaustive and any special requirements could be incorporated if suggested by the client or if shown necessary as the monitoring program progresses. The formats of data presentation used in this report are discussed below.

3.2.1 Current Water Use Licence requirements

As stipulated in Tutuka Power Stations Water Use Licence the impacts of the activities associated with the Tutuka Power Station must not exceed the groundwater quality limits as specified in Table 24. The data for the groundwater sites at Tutuka Power Station for the current phase was inserted in table format, the results are depicted in Table 24 All the clean surface water sites were classified against the Leeu Spruit Quality objectives (as listed in Table 26) as the surface impacts all drain through various tributaries to this stream.

Table 24. Groundwater quality limits as per Tutuka Power Stations Water Use Licence.

Water Use License Groundwater Quality Objectives	
Variables	**Limits**
EC (mS/m)	150
Sodium (mg/l)	200
Magnesium (mg/l)	70
Calcium (mg/l)	150
Chloride(mg/l)	200
Sulphate (mg/l)	400
Nitrate (mg/l)	10
Fluoride (mg/l)	1
pH (pH units)	5.0 - 9.5
Total Dissolved Solids (mg/l)	1000
Potassium (mg/l)	50
Iron (mg/l)	0.2
Manganese (mg/l)	0.2
Ammonium (mg/l)	1

Table 25. Quality limits for waste water to be discharged as per Tutuka Power Stations Water Use Licence.

Variables	Limits
EC (mS/m)	28
Chloride(mg/l)	18
Nitrate (mg/l)	0.5
Fluoride (mg/l)	0.3
pH (pH units)	6.0 - 9.0
Ortho-phosphate (mg/l)	0.20
Chemical Oxygen Demand (mg/l)	18
Faecal Coliforms (counts/100ml)	<60
Ammonia (mg/l)	0.5

Table 26. Leeu Spruit water quality guideline.

Water Use License Leeuspruit In Stream Water Quality Guidelines	
Variables	**Limits**
EC (mS/m)	30.0
Chloride(mg/l)	20.0
COD (mg/l)	18.0
Nitrate (mg/l)	0.5
Fluoride (mg/l)	1.0
pH (pH units)	6.0-9.0
Faecal coliforms (counts/100ml)	<60
Ortho-phosphate (mg/l)	0.25
Ammonia (mg/l)	0.5

3.2.2 MMAC Plots and Time graphs

Monitoring is undertaken so that changes in water quality over time can be identified. Such changes may be particularly evident in areas affected by surface activities, which could enhance water degradation. For this investigation, the evaluation of previous and the current monitoring period has been condensed and plotted in a format referred to as the Maximum, Minimum, Average and Current plot (MMAC) as well as Time Graphs. The results from a number of sample sites can be plotted in a single diagram for comparison. The MMAC plots and Time Graphs for this monitoring phase can be perused in Appendix C.

A diagram of an MMAC plot is shown in the Figure 1 and serves to explain the meaning of each element in the presentation. Instead of only an average value, twice the standard deviation, given as one value above and one value below the average is supplied. The standard deviation allows an idea of the usual range of values measured for the particular constituent at the particular site. A small standard deviation indicates a stable sample, while a large value represents a high variation in values. The maximum and minimum values ever recorded at the site are indicated in these plots by horizontal lines.

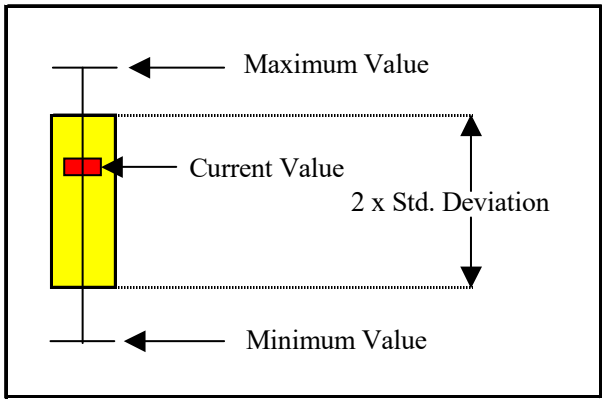

Figure 1. Maximum, Minimum, Average and Current Plot (MMAC).

In this way, a visual comparison may be made between the different sampling points for each monitoring period. At the same time, the history of each sampling point can be assessed. For example, if the red rectangle in the diagram was an actual data point, the current value would be higher than the average. If this is the case for other indicator parameters, and the condition persists through a number of monitoring events, then progressive degradation is indicated.

It must be noted that on the MMAC plots in Appendix C, only the sampling sites that were sampled during the last monitoring phase were included. The geohydrological software package 'WISH' (Institute for Groundwater Studies, UOVS, 2005) was used to evaluate the data.

- The upper horizontal line of the standard indicates the WUL Quality objectives. This is the limit above which remedial action should be implemented. It does not mean that the water is unsuitable for a particular use, but rather that the particular situation must be more thoroughly assessed.

3.3 Affected Drainage Area 1 – Wolwe Spruit Drainage System

The fluctuations in the groundwater and piezometric levels that have been observed since 2005 in the boreholes of the Wolwe Spruit Area are shown in Figure 2 to Figure 7 with associated tables describing the trends below each graph.

3.3.1 Upstream and Background Boreholes

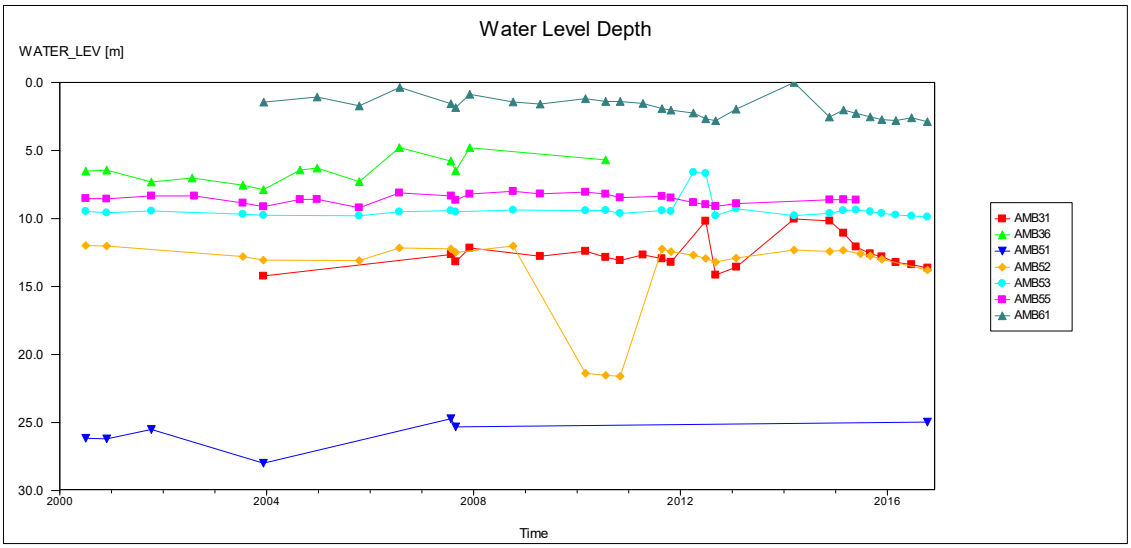

Figure 2. Water level depths (mbgl) of up gradient boreholes drilled upstream north and west to south-west of the ash stack.

Table 27. Water level trends (mbgl) of up gradient boreholes drilled upstream north and west to south-west of the ash stack.

Background Boreholes Upstream from Ash Stack Influences										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase 52**	**Trend**	**Comment**
AMB36	Monitoring borehole north of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	No access. Bees previously reported.	~	~	~	~	~	Not enough data to establish trend.	The water levels (except at AMB55 and AMB53) exabit the same pattern with decreasing levels in 2012 increasing thereafter.
AMB31	Production borehole at ashing office.	Upgradient borehole with higher peizometric head used for background sample as reference.	Satisfactory condition.	12.59	12.82	13.23	13.4	13.64	Stable increasing water table depth since 2014, although more apparent than at the other boreholes (possibly due to abstraction).	
AMB55	Monitoring borehole east of rehabilitated remedial plant.	Seepage from remediation area.	Dry. Satisfactory condition.	Dry	Dry	Dry	Dry	Dry	Borehole was dry during current phase.	
AMB61	Monitoring borehole west of ashing east of tar road.	Drainage to the southwest.	No casing , cap and marker post.	2.53	2.73	2.8	2.6	2.88	Stable slightly increasing water table depth.	
AMB51	Monitoring borehole about 700 m south of ash stack west of blue pipeline.	Upgradient borehole with higher peizometric head used for background sample as reference.	No marker post and borehole is blocked at 28m.	~	~	~	~	24.98	Stable.	
AMB52	Monitoring borehole about 1 km south of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	No marker post previously reported. No locknut.	12.75	13	~	~	13.79	Stable increasing slightly since 2014.	
AMB53	Monitoring borehole south of ash stack about 1 km east of AMB52.	Upgradient borehole with higher peizometric head used for background sample as reference.	No locking pin and bees are active at the borehole.	9.5	9.62	9.74	9.82	9.89	Stable.	

The same pattern with decreasing groundwater level depths in 2012, increasing thereafter are apparent. Except for borehole AMB31 where possible abstraction is causing a slightly steeper increasing trend since 2015, stable, slightly decreasing trends are visible with no visible influence from power station activities.

Table 28. Current phase chemistry – Upstream north and Upstream west to south-west of the Ashing Area.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - Upstream north.	*AMS16	Clean water diversion trench from area north of ash stack upstream of AMD14.	1st Sampling point in clean water system from north of the ash stack.	No Sample																				
	*AMD14	Clean water dam north of the ashing area - "North Dam".	2nd Sampling point of clean water drainage form the north of ash stack.	No Sample																				
	*AMB36	Monitoring borehole north of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	No Sample																				
Wolwe Spruit Drainage System - Upstream west to south-east.	*AMB31	Production borehole at ashing office.	Upgradient borehole with higher peizometric head used for background sample as reference.	Exceed	Mn NH4-N	7.87	59.9	35.4	31.9	51.1	27.6	23.5	3.86	0.363	397	3.57	0.00	0.846	1.36	69		0.052		This borehole is used for background purposes and is not within the natural drainage of the ash stack. The origin of ammonium may be attributed by agricultural purposes and cannot be regarded as a contravention of the WUL due to ashing activities. There was a sudden unaccounted increase in Mn since beginning of 2016. **Continue monitoring to establish possible trends of both these parameters.**
	*AMB51	Monitoring borehole about 700 m south of ash stack west of blue pipeline.	Upgradient borehole with higher peizometric head used for background sample as reference.	Exceed	NH4-N	8.52	74.3	59.5	41	47.9	64.5	6.86	0.277	0.318	445	19.9	0.00	0.01	2.44			0.03		This borehole is used for background purposes and is not within the natural drainage of the ash stack. The origin of ammonium may be attributed by agricultural purposes and cannot be regarded as a contravention of the WUL due to ashing activities. **Continue monitoring to establish possible trends.**
	*AMB52	Monitoring borehole about 1 km south of ash stack.	Upgradient borehole with higher peizometric head used for background sample as reference.	Below		8.85	85	194	12.9	23.5	35.4	2.71	0.469	0.339	560	3.09	0.00	0.001	0.051			0.025		
	*AMB53	Monitoring borehole south of ash stack about 1 km east of AMB52.	Upgradient borehole with higher peizometric head used for background sample as reference.	Below		8.76	57.1	129	6.89	12.4	20.4	0.675	0.393	0.344	348	1.71	0.00	0.001	0.605			0.025		

The boreholes AMB31 and AMB51 are used for background purposes and are not within the natural drainage of the ash stack. The origin of ammonium may be attributed by agricultural purposes and cannot be regarded as a contravention of the WUL due to ashing activities. There was a sudden unaccounted increase in Mn at AMB51 since beginning of 2016. Continue monitoring to establish possible trends of both these parameters.

3.3.2 Drainage from the south-west and boreholes drilled on the ash stack

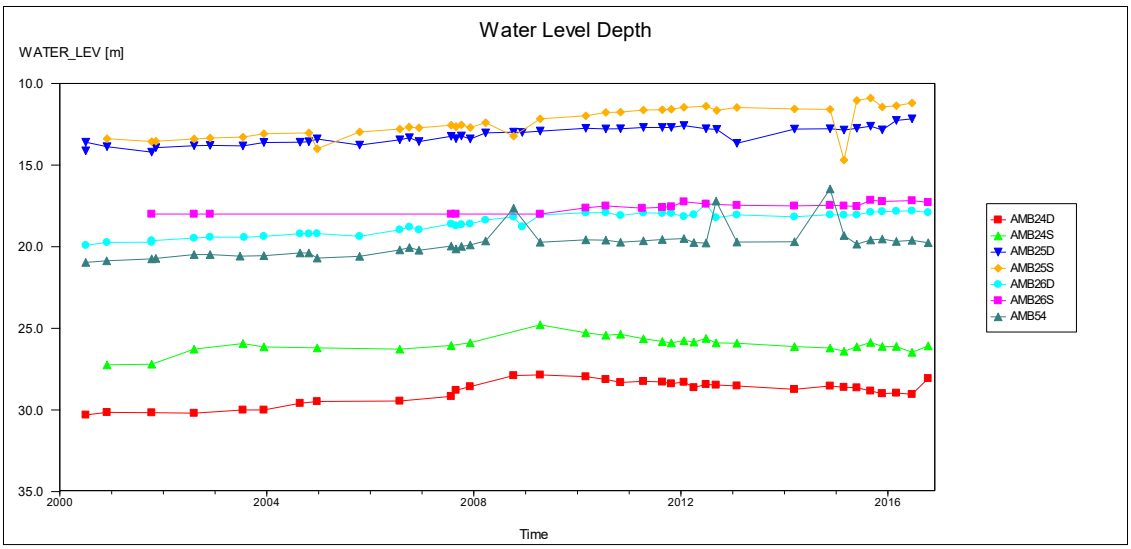

Figure 3. Water level depths (mbgl) of boreholes drilled on the ash stack.

Table 29. Water level trends (mbgl) of boreholes drilled on the ash stack.

Boreholes Drilled on the Ash Stack										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase 52**	**Trend**	**Comment**
AMB26D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	Satisfactory condition.	17.89	17.85	17.83	17.81	17.91	Slightly decreasing water level depth since 2000.	The slight rise in water table depth may either be due to historic influences of brine water irrigation seepage from dam AMD14. The rising water level must be investigated.
AMB26S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	Damp. Satisfactory condition.	17.16	17.23	~	17.18	17.29	Slightly decreasing water level depth since 2000.	
AMB54	Monitoring borehole south of hazardous disposal site.	Class H site plus seepage from ash stack to geology below ash stack.	Satisfactory condition.	19.59	19.53	19.68	19.62	19.76	Slightly decreasing water level depth since 2000.	
AMB25D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	Casing rusted and damaged.	12.62	12.84	12.27	12.17	12.79	Slightly decreasing water level depth since 2000.	
AMB25S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	Too low to sample. Casing rusted and damaged.	10.89	11.45	11.36	11.2	11.68	Slightly decreasing water level depth since 2000.	
AMB24D	Monitoring borehole in ash stack on standby stack.	Seepage from ash stack to below ash.	Casing rusted and damaged.	28.84	29	28.97	29.04	28.08	Slightly decreasing water level depth since 2000.	
AMB24S	Monitoring borehole in ash stack on standby stack.	Ash stack water level and ash reference qualities.	Casing rusted and damaged.	25.87	26.12	26.12	26.48	26.08	Slightly decreasing water level depth since 2000.	

The slight rise in water table depth may either be due to historic influences of brine water irrigation or due to seepage from the clean north dam AMD14. Although the rise in water levels are extremely slow, it must be investigated as this means the ash is slowly becoming more saturated and must be investigated.

Table 30. Current phase chemistry – South-west of the Ash Stack.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System South West of the Ash Stack	*AMB55V	Conveyor belt south west of AMB55.	Ash spillages and general operations.	No Sample																				
	AMS50V	Sump at washing bay.	General operations.	Dirty Site No Sample																				
	*AMB55	Monitoring borehole east of rehabilitated remedial plant.	Seepage from remediation area.	No Sample																				
	AMS50	Dirty water southern toe drainage canal start at tanker refill point upstream from S48.	1st sampling point in dirty water trench west and south of ash stack	Dirty Site No Sample																				
	*AMS30	Small clean water trench downstream of offices and transfer area discharge into field.	1st Sampling point in clean water stream from west of the ash stack.	No Sample																				

Table 31. Current phase chemistry – Sites on Ash Stack and directly south of the ash stack - south-western drainage system.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System Sites On Ash Stack and directly south of the ash stack.	AMS17	Brine water irrigation on front stack.	Brine water irrigation quality.	Dirty Site		8.67	1118	2658	109	200	1100	4468	11.9	2.53	8828	129	0.05	0.001	0.054			0.086		
	*AMB26D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	Exceed	EC Mg Ca Cl NO3-N TDS	8.31	207	183	91.2	159	332	385	10.6	0.637	1364	3.77	0.00	0.001	0.035	112		0.044		The deep piezometers of boreholes AMB24, AMB25, AMB26 and borehole AMB54 were drilled through the ash into the dolerite sill below the ash stack. The concentration of 1450 mg/L of SO4, one of the primary indicator elements within the saturated ash on top of the geology and on average a recording of only 385 mg/L in the geology below, as well as the prolonged presence of the pollution source is an indication that pollution migrates slowly to the subsurface due to low permeabilities of the geology. This is the main reason why the pollution remains localized and is mainly detected in boreholes within close proximity to the pollution sources or surface activities that may impact upon groundwater. Saturation of the ash in the vicinity of the historic paleochannel possibly caused by dam AMD14 to the north of the ash stack remains a possible cause of leachate from the ash. **Investigate possibilities of either draining dam AMD14 or sealing the dam wall.**
	*AMB26S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	Dirty Site No Sample																				
	*AMB54	Monitoring borehole south of hazardous disposal site.	Class H site plus seepage from ash stack to geology below ash stack.	Exceed	Mg Cl	8.43	145	80.2	89.3	103	226	178	3.99	0.28	868	7.15	0.00	0.077	0.156	13.9		0.028		
	*AMS52	Clean water stream south of the ash stack.	2nd sampling point in clean water system from west and south of the ash stack.	No Sample																				
	*AMB25D	Monitoring borehole in ash stack on standby stack.	Class H site plus seepage from ash stack to geology below ash stack.	Exceed	EC Mg Ca Cl NO3-N TDS	8.22	197	105	101	172	385	217	13.4	0.362	1216	7.17	0.00	0.001	0.051	102		0.026		
	*AMB25S	Monitoring borehole in ash stack on standby stack.	Class H site plus ash stack water level and ash reference qualities.	Dirty Site		8.71	565	980	10.1	325	844	1637	8.49	1.2	3958	71.5	0.00	0.001	0.034	122		0.031		
	AMS48	Dirty water southern toe drainage trench downstream from AMS50.	2nd sampling point in dirty water trench west and south of ash stack	Dirty Site		8.38	727	1300	93.7	359	973	2302	0.299	0.431	5162	40.2	0.00	0.001	0.449			0.028		
	*AMS54	Clean water trench south of the ash stack downstream from AMS52.	3rd sampling point in clean water system from west and south of the ash stack.	No Sample																				

Although the EC values and Mg, Ca, Cl and TDS concentrations are exceeded at AMB25D, AMB26D, AMB54 (only Mg and Cl), the trend graphs are stable, increasing slightly. As the purpose of these boreholes are to monitor the Hazardous Waste site, they had to be drilled directly into ash stack. The deep piezometers extend into the dolerite sill below the ash stack. Even in the presence of the ash stack, groundwater and groundwater drainage will tend to follow the historic stream system or paleochannel coming from the dam north of the ash stack. The groundwater in the sill occurs between the dolerite sill and thinly covered geology on top of it (so-called bedding plane fractures) where the borehole acts as a sump collecting this seepage. **It must be requested that the boreholes drilled into the ash stack be removed from the WUL as it can be expected that the ash stack would impact on the geology directly below it.**

3.3.3 Drainage from the south-west with boreholes directly south and further downstream of the ash stack – western drainage system

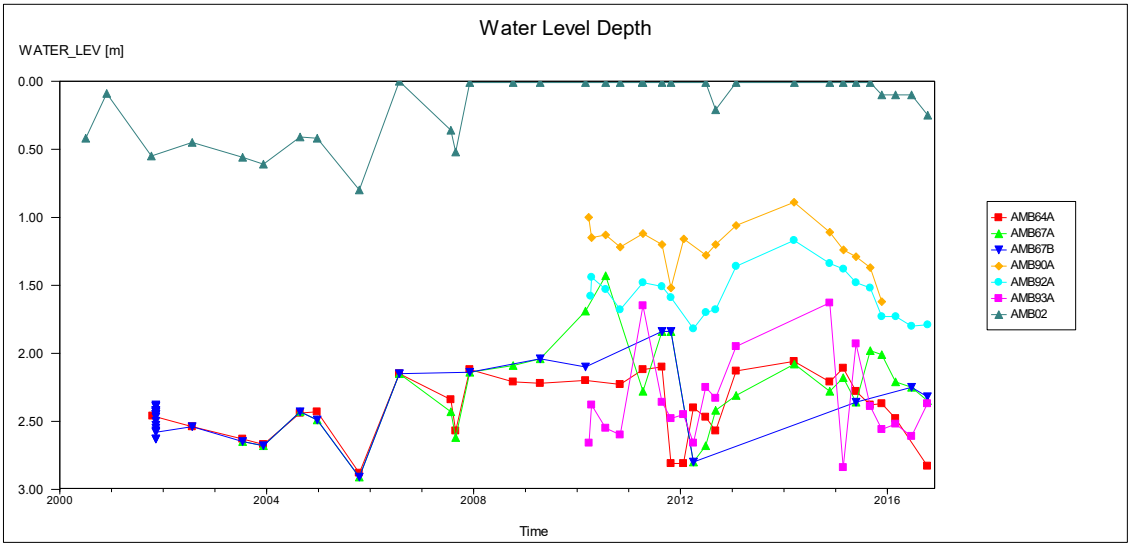

Figure 4. Water level depths (mbgl) of boreholes monitoring the south-western drainage system of ash stack.

Table 32. Water level trends (mbgl) of boreholes monitoring the south-western drainage system of ash stack.

Boreholes Monitoring the South-Western Drainage System										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase 52**	**Trend**	**Comment**
AMB92A	Monitoring borehole on south-eastern corner of ash stack - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	Satisfactory.	1.52	1.73	1.73	1.8	1.79	Slightly increasing water level depth since 2014.	The water levels of all these boreholes have recoverded to nearly the same levels of 2012 prior to the rising since 2014.
AMB90A	Monitoring borehole south of ashing area east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	No marker post. Unable to open.	1.37	1.62	~	~	~	Not enough data to establish a trend.	
AMB67A	Monitoring borehole south of ashing area.	Seepage from ash stack to deep aquifer.	Satisfactory condition.	1.98	2.01	2.21	2.25	2.35	Slightly increasing water level depth since 2014.	
AMB67B	Monitoring borehole south of ashing area.	Seepage from ash stack to upper aquifer.	Satisfactory condition.					2.32	Slightly increasing water level depth since 2014.	
AMB93A	Monitoring borehole south of ashing area and AMB90 and east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	No marker post.	2.39	2.56	2.52	2.61	2.37	Decreased since the previous phase.	
AMB64	Monitoring borehole south of ashing area.	Seepage from ash stack.	Satisfactory condition.	2.38	2.37	2.48	2.56	2.83	Increased since the previous phase.	
AMB02	Monitoring borehole upstream ashing area settling dam.	Impacts from ash stack and southern dirty water trenches upon western clean water diversion and drainage system.	No Plinth. Casing bent and difficult to remove cap.	Art	0.1	0.1	0.1	0.25	Borehole use to be artesian for the last phases. Water level depth has increased since the previous phase.	

The same pattern with decreasing groundwater level depths in 2012, increasing thereafter are apparent. Some variability seen at AMB93 may indicate surface water activities (such as the overflows of the silted southern dirty water trench which has been cleaned.

Table 33. Current phase chemistry – Sites directly south of the ash stack - south-western drainage system.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - Sites On Ash Stack and directly south of the ash stack.	AMS35	Dirty water southern toe drainage trench downstream from AMS48.	3rd sampling point in dirty water trench west and south of ash stack	Dirty Site		8.46	1079	2110	213	584	1707	3652	0.269	0.345	8416	28.2	0.04	0.001	0.332			0.05		
	*AMB24D	Monitoring borehole in ash stack on standby stack.	Seepage from ash stack to below ash.	Exceed	EC Na Mg Ca Cl SO4 TDS Mn	8.4	702	1015	174	474	1213	1784	5.49	0.396	4870	48	0.00	8.22	0.177			0.028		See AMB26D&S Above
	*AMB24S	Monitoring borehole in ash stack on standby stack.	Ash stack water level and ash reference qualities.	Dirty Site No Sample																				
	*AMS15	Clean water stream south of the ash stack downstream from AMS54.	4th Sampling point in the clean water stream from west and south of ash stack.	No Sample																				
	*AMB92A	Monitoring borehole on south-eastern corner of ash stack - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	Exceed	EC Na Mg Ca Cl SO4 TDS Mn NH4-N	8.15	559	461	333	476	1021	1569	0.824	0.263	3968	5.61	0.00	0.37	1.07			0.026		These boreholes are directly south of the ash stack, southern dirty water AWR trench and clean surface water streams possibly impacted by overflows or impaired flow of the dirty water trench. These impacts may be seen within the direct vicinity of the streams, but it is not reflected by that geology of the matrics where boreholes are further from the streams. These dirty water trenches have been cleaned. **Continue monitoring to record trends and possible improvements.**
	*AMB92B	Monitoring borehole on south-eastern corner of ash stack - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	Exceed	EC Na Mg Ca Cl SO4 TDS Mn NH4-N	8.22	538	396	313	445	992	1432	0.649	0.263	3679	5.23	0.00	0.256	1.26			0.027		
	*AMB90A	Monitoring borehole south of ashing area east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	No Sample																				
	*AMB90B	Monitoring borehole south of ashing area east of stream - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	No Sample																				

The deep piezometer of AMB24 (as explained earlier at AMB25D, AMB26D and AMB54) extend into the dolerite sill below the ash stack. Even in the presence of the ash stack, groundwater and groundwater drainage will tend to follow the historic stream system or paleochannel coming from the dam north of the ash stack. The groundwater in the sill occurs between the dolerite sill and thinly covered geology on top of it (so-called bedding plane fractures) where the borehole acts as a sump collecting this seepage. **It must be requested that borehole AMB24D drilled into the ash stack be removed from the WUL as it can be expected that the ash stack would impact on the geology directly below it.**

Borehole AMB92 is directly east of the stream running in a southerly direction from the ash stack (part of the historic stream or paleochannel from the north dam AMD14) of the ash stack where the southern dirty water trench was silted causing sporadic overflows being reflected in the shallow geology (AMB92B). The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion. **This borehole must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

Table 34. Current phase chemistry – Sites 200 meters and further south of the ash stack - south-western drainage system.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - South-western Drainage System Clean and Dirty Water Sites south of Ash Stack	*AMS29	Clean water stream south of the ash stack downstream from AMS15.	5th Sampling point in clean water stream from west and south of ash stack..	No Sample																				
	*AMB93A	Monitoring borehole south of ashing area and AMB90 and east of stream - Deep.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to deep aquifer.	Exceed	EC Na Mg Ca Cl SO4 TDS Fe NH4-N	7.53	450	739	83.4	245	810	1072	0.46	0.263	3059	5.28	0.35	0.097	1.27			0.005		See remarks at AMB92 above..
	*AMB93B	Monitoring borehole south of ashing area and AMB90 and east of stream - Shallow.	Seepage from ash stack, southern dirty water trench and clean water stream drainage to shallow aquifer.	Exceed	EC Na Mg Ca Cl SO4 TDS	8.13	449	774	80.4	229	820	1062	0.578	0.263	3036	5.29	0.00	0.001	0.775			0.026		
	*AMB67A	Monitoring borehole south of ashing area.	Seepage from ash stack to deep aquifer.	Exceed	EC Mg Ca Cl SO4 TDS	8.36	630	130	508	715	1269	1835	3.2	0.302	4579	0.387	0.00	0.001	0.042			0.027		
	*AMB67B	Monitoring borehole south of ashing area.	Seepage from ash stack to upper aquifer.	Exceed	EC Mg Ca Cl SO4 TDS	8.49	507	124	365	546	968	1276	5.8	0.358	3413	1.18	0.00	0.001	0.022			0.108		
	*AMB64	Monitoring borehole south of ashing area.	Seepage from ash stack.	Below		8.81	83.7	185	6.17	9.6	88.2	64	0.31	0.263	492	0.933	0.04	0.001	0.158			0.028		The fact that this borehole is clean and further from surface water impacts and the boreholes close to the streams reflect impacts confirms that the negative impacts are more prominent in close proximity to surface water activities.
	*AMS36	Clean water trench south of the ash stack downstream from AMS29.	6th sampling point in clean water stream from west and south of ash stack..	No Sample																				
	*AMB02	Monitoring borehole upstream ashing area settling dam.	Impacts from ash stack and southern dirty water trenches upon western clean water diversion and drainage system.	Exceed	EC Mg Ca Cl TDS	8.29	206	61.9	130	220	433	274	4.34	0.265	1265	0.964	0.00	0.001	0.071			0.032		This borehole is standing in the clean water stream system that has been impacted upon by the previously explained AWR trench that has now been cleaned. **Inspect and clean dirty water trench regularly and continue monitoring to record possible improving trend.**

Boreholes AMB93 and AMB67 are approximately 25m south of the ash stack where the southern dirty water trench was silted causing sporadic overflows being reflected in the shallow geology (AMB93B) as these boreholes are close to the south-western stream. The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion. **These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

Borehole AMB64 is 800m further south, and not close to streams indicating unaffected geology when not in close proximity to surface impacted sites. Borehole AMB02 is standing in the impacted stream (due to the silted southern dirty water trench which has been cleaned) running from the ash stack past boreholes AMB93 and AMB67. Increasing trends in some indicator element concentrations are noted, however, improvements are expected due to the cleaning of the southern dirty water trench.

3.3.4 Drainage from the south-east and boreholes directly south of the ash stack – eastern drainage system

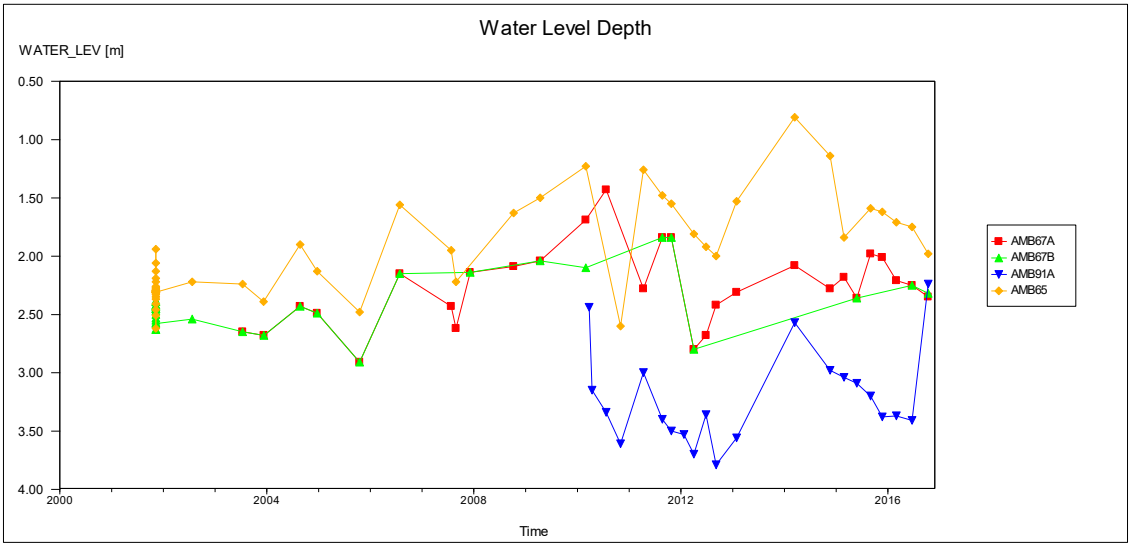

Figure 5. Water level depths (mbgl) of boreholes monitoring the south-eastern drainage system of Ash Stack.

Table 35. Groundwater level trends (mbgl) of boreholes monitoring the south-eastern drainage system (mbgl).

Boreholes Monitoring the South-Eastern Drainage System										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase52**	**Trend**	**Comment**
FBB320	Background borehole east of ash stack, just south of two old cement dams.	Upgradient borehole with higher peizometric head used for background sample as reference.	Not inspected during this monitoring event.	~	~	~	~	~	No data	The water levels of all these boreholes (except AMB91A) have recoverded to nearly the same levels of 2012 prior to the rising since 2014.
AMB91A	Monitoring borehole south of ashing area west of stream - Deep.	Seepage from ash stack, eastern dirty water trench and clean water stream drainage to deep aquifer.	No marker post.	3.2	3.38	3.37	3.41	2.24	Variability indicate surface water impacts. A sudden rise in more than a metre is aparrant.	
AMB65	Monitoring borehole south of ashing area.	Seepage from ash stack.	No locknut or pin.	1.59	1.62	1.71	1.75	1.98	Increased since the previous phase with an incresing trend since 2014.	
AMB67A	Monitoring borehole south of ashing area.	Seepage from ash stack to deep aquifer.	Satisfactory condition.	1.98	2.01	2.21	2.25	2.35	Increased since the previous phase. Increasing trend is visible.	

Boreholes AMB65 and AMB91 are directly south of the ash stack below the eastern clean water diversion underneath the ash. **These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

Table 36. Current phase chemistry – Sites south-east of ash stack - South eastern drainage system.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - South-eastern Drainage System Clean and Dirty Water Sites south of Ash Stack	*FBB320	Background borehole east of ash stack, just south of two old cement dams.	Upgradient borehole with higher peizometric head used for background sample as reference.	No Sample																				
	*AMS69	Clean water diversion under ash stack flowing to AMS68.	1st sampling point of eastern diversion of Wolwe Spruit.	No Sample																				
	*AMS68	Clean water stream east of ash stack flowing past AMB91 south of ash stack.	2nd sampling point of eastern diversion of Wolwe Spruit.	Exceed	EC Cl NO3-N	8.41	2588	6957	67.6	662	3804	10315	1.63	0.263	22218	293	0.00	0.001	0.383			0.093		Surface runoff from the ash stack is directly flowing into this stream. **Install dirty water trench at the south-eastern side of the ash stack.**
	*AMB91A	Monitoring borehole south of ashing area west of stream - Deep.	Seepage from ash stack, eastern dirty water trench and clean water stream drainage to deep aquifer.	Exceed	Na F	9.15	98	277	0.077	0.715	60.3	36.4	0.495	1.47	641	1.06	0.00	0.001	0.326			0.029		Surface run-off from the ash stack is directly running into stream AMS68 next to these boreholes and may thus impact on this borehole in close vicinity to the stream. **Install dirty water trench at the south-eastern side of the ash stack.**
	*AMB91B	Monitoring borehole south of ashing area west of stream - Shallow.	Seepage from ash stack, eastern dirty water trench and clean water stream drainage to shallow aquifer.	Exceed	Na F	9.18	93.8	258	0.12	1.04	50.4	37.8	0.53	1.24	603	1.01	0.00	0.001	0.363			0.027		
	*AMB65	Monitoring borehole south of ashing area.	Seepage from ash stack.	Exceed	EC Mg Cl	8.49	167	73.3	173	17.6	365	214	0.694	0.263	916	3.17	0.00	0.001	0.622			0.027		

Boreholes AMB65 and AMB91 are directly south of the ash stack below the eastern clean water diversion underneath the ash. The Na and Fl concentrations at AMB91A&B may be associated with geology. The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion**. A clean/dirty water separation system must be installed. These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

3.3.5 Dirty water dams – southern drainage system

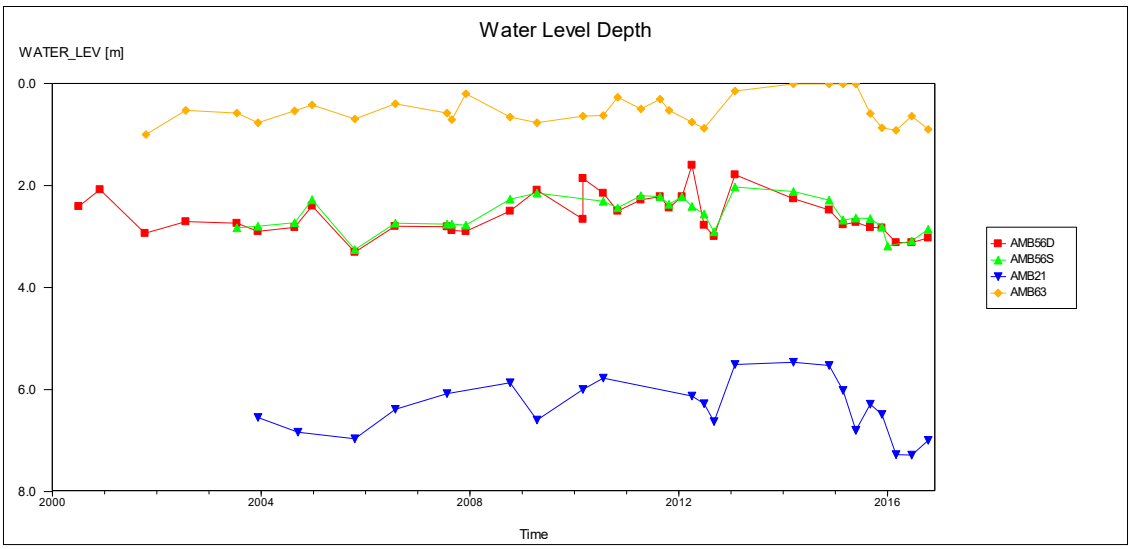

Figure 6. Water level depths (mbgl) of boreholes in the southern drainage system monitoring the dirty water dams.

Table 37. Water level trends (mbgl) of boreholes in the southern drainage system monitoring the dirty water dams.

Boreholes Monitoring the South-Eastern Drainage System - Dirty water dams										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase 52**	**Trend**	**Comment**
AMB63	Monitoring borehole below settling water dam.	Seepage from settling dam AMD09.	Cap damaged.	0.59	0.87	0.92	0.64	0.90	Increased since 2014. Overall stable.	The water levels of all these boreholes have recoverded to nearly the same levels of 2012 prior to the rising since 2014.
AMB21	Production borehole south of ash stack next to the clean water dam.	Seepage from dirty water dam AMD08	Satisfactory condition.	6.29	6.49	7.28	7.29	7.00	Fluctuations due to abstraction, but overall stable trend.	
AMB56D	Monitoring borehole between clean and dirty water dam. Deep.	Seepage from dirty water dam AMD08 to deep aquifer.	Satisfactory condition.	2.82	2.83	3.12	3.12	3.03	Increased since 2014. Overall stable.	
AMB56S	Monitoring borehole between clean and dirty water dam. Shallow.	Seepage from dirty water dam AMD08 to shallow aquifer.	Satisfactory condition.	2.65	2.81	3.19	3.09	2.86	Increased since 2014. Overall stable.	

The slightly deeper water level depth at AMB21 may be due to previous abstraction. The trends are however stable. It was confirmed that the electricity has been removed and that no further abstraction will be taking place.

Table 38. Current phase chemistry - Southern Drainage System. Dirty Water dams.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - Southern Drainage System Dirty Water Dams South of Ash Stack	AMD09	First dam (dirty settling dam) in dirty water system.	Dirty water settling dam qualities and operations.	Dirty Site		8.24	2126	4578	226	953	4140	6119	0.391	0.389	16311	205	0.02	0.001	0.325			0.027		
	*AMB63	Monitoring borehole below settling water dam.	Seepage from settling dam AMD09.	Exceed	EC Na Mg Ca Cl SO4 TDS	8.23	595	400	455	313	1383	978	1.29	0.284	3724	8.89	0.00	0.001	0.058			0.03		This borehole is directly below dam AMD09 and precipitated salts have been recorded in the dirty water trench connecting the overflow of this dam with the next dirty water dam AMD08 downstream. **The water level of dam AMD09 must be regulated to prevent overflows.**
	*AMB21	Production borehole south of ash stack next to the clean water dam.	Seepage from dirty water dam AMD08	Exceed	EC Mg Ca Cl TDS	8.31	258	68.9	173	259	602	344	5.79	0.292	1582	1.5	0.00	0.001	0.041			0.028		Abstraction was stopped whereby the dewatering cone causing gradients towards the borehole would recede. **Continue monitoring and keep preventing impacts from the dirty water trenches upon the clean water streams south of the ash stack.**
	AMD08	Second dam (dirty water dam) in the dirty water system.	Dirty water dam qualities and operations.	Dirty Site		8.1	4222	9779	953	790	9936	11083	0.369	0.867	32973	319	0.32	0.001	1.01			0.047		
	*AMB56D	Monitoring borehole between clean and dirty water dam. Deep.	Seepage from dirty water dam AMD08 to deep aquifer.	Below		8.6	59.4	109	12.4	22.5	15.2	0.141	7.55	0.467	363	4.61	0.00	0.001	0.77			1.54		
	*AMB56S	Monitoring borehole between clean and dirty water dam. Shallow.	Seepage from dirty water dam AMD08 to shallow aquifer.	Exceed	Cl NH4-N	8.34	109	65.1	12.6	138	228	69.9	0.381	0.263	597	6.48	0.00	0.001	2.83			0.284		Surface spillages or overflows from this dam may occur. The impacts on the shallow piezometer are reflected by the chemistry. **Prevent overflows by lowering the water level of dam AMD08.**

Impacts at borehole AMB63 directly below the first dirty water dam AMD09 may reflect impacts from the dam or historical overflows. Similar chemical concentration measured at borehole AMB02 and AMB21 may indicate recharge occurring from the same impacted region. Groundwater gradients created towards borehole AMB21 due to previous abstraction may have enhance the movement of contaminants from AMB02 to AMB21. As already stated, no abstraction is taking place anymore. **Monitoring must continue in order to establish improvement and possible cause due to earlier abstraction.**

Even though it might seem impacts from the second dirty water dam (either through overflows or seepage) are visible in the shallow piezometer of borehole AMB56, the absence of SO_4 (with a concentration of 11083 mg/L in the dam), this seems unlikely. The presence of Cl and NH_4 may be due to cattle utilizing the water directly below the dam wall. The farm is being evacuated. **Monitoring must continue in order to establish improvement and possible cause after evacuation of the land.**

3.3.6 Clean water dam – southern drainage system

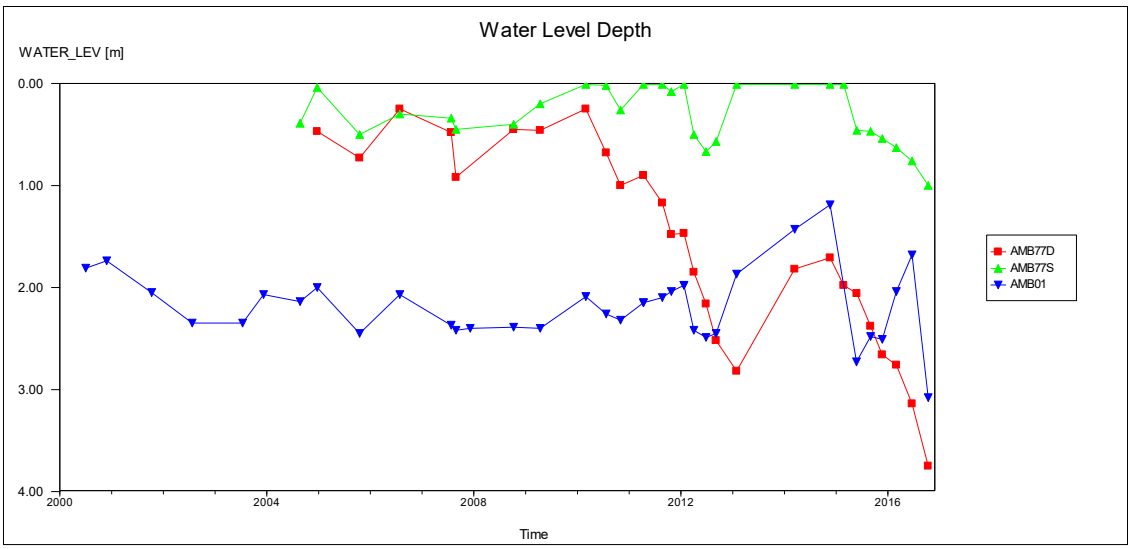

Figure 7. Water level depths (mbgl) of boreholes in the southern drainage system monitoring the dirty water dams.

Table 39. Water level trends (mbgl) of boreholes the in the southern drainage system monitoring the dirty water dams.

Boreholes Monitoring the South-Eastern Drainage System - Clean water dam										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Phase 52**	**Trend**	**Comment**
AMB77D	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to deep part of aquifer.	No cap and marker post.	2.38	2.66	2.76	3.14	3.76	Increasing trend since end of 2014.	These increasing trends reflect a general lower water table of between 1.5 and 2 meters since 2014.
AMB77S	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to shallow part of aquifer.	No cap and marker post.	0.47	0.54	0.63	0.76	1.00	Increasing trend since end of 2014.	
AMB01	Monitoring borehole south clean water dam.	Seepage from clean water dam.	No marker post or plinth. Old beehive in borehole.	2.48	2.51	2.04	1.68	3.08	Increasing trend since end of 2014.	

No abstraction is taking place that could cause the increase in groundwater depths. This may be due to general drier conditions experienced.

Table 40. Current phase chemistry - Southern Drainage System. Clean Water dam.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Wolwe Spruit Drainage System - Southern Drainage System - Clean Water Sites South of Ash Stack	*AMD07	Clean water dam at the end of the dirty water system.	Effectiveness of clean water bypass system to clean water dam.	Exceed	EC Cl NO3-N F	8.39	413	704	111	126	744	783	0.622	0.898	2683	30.4	0.00	0.001	0.195			0.086		Surface water impacts are evident at this dam. This can possibly be due to overflows from the upstream dirty water dams as well as the previous overflows from the silted southern dirty water trenches (which has been cleaned) into the clean water streams, as well as the absence of south-eastern clean/dirty water separation at AMS68 and AMS69. **The clean/dirty water system south of the ash stack must be regularly inspected and maintained.**
	*AMB77D	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to deep part of aquifer.	Exceed	F	8.87	78.2	168	12	18.3	31.6	34.6	0.91	1.61	489	6.17	0.00	0.001	0.038			0.629		The exceedances in Fluoride detected in borehole AMB77 may be attributed to the fact that Fluoride is easily released (via ion exchange) from rocks through natural processes due to slight changes in chemistry (or even artificial recharge) which may arise from the clean water dam AMD07 – this may dislodge fluoride from the geology as detected in boreholes AMB77. The fact that dam AMD07 contains polluted water may however enhance ion exchange and the release of F from the geology. **Impacts upon the clean water dam AMD07 must be prevented, as this may be reflected downstream from this dam.**
	*AMB77S	Monitoring borehole south of clean water dam AMD07.	Seepage from clean water dam AMD07 to shallow part of aquifer.	Exceed	Na F	9	84.4	230	0.157	2.06	26.2	2.51	1.64	1.21	519	1	0.00	0.001	0.038			0.163		
	*WSS61	Upstream from the confluence from WSS32.	Upstream from confluence.																					
	*WSS32	Tributary joining Wolwe Spruit from east just north of road.	Tributary background sample.	No Sample																				
	*AMB01	Monitoring borehole south clean water dam.	Seepage from clean water dam.	Exceed	Na F	8.92	77.1	204	3.61	8.06	27.7	11.5	0.352	1.78	515	1.51	0.00	0.001	0.123			0.028		The exceedances in Fluoride detected in borehole AMB01 may be attributed to the fact that Fluoride is easily released (via ion exchange) from rocks through natural processes due to slight changes in chemistry (or even artificial recharge) which may arise from the clean water dam AMD07 – this may dislodge fluoride from the geology as detected in borehole AMB01. The fact that dam AMD07 contains polluted water may however enhance ion exchange and the release of F from the geology. **Impacts upon the clean water dam AMD07 must be prevented, as this may be reflected downstream from this dam.**
	*WSS06	Stream leaving the ashing area at the southern side.	Stream leaving ashing area.	Exceed	EC Cl F PO4	8.57	131	80.8	111	73.4	58.4	60.5	0.465	0.523	818	12	0.00	1.56	11.6			2.93		The sample was obtained from stagnant water under the bridge which may possibly cause elevated concentrations due to concentration from evaporation. The upstream samples WSS61 coming from the overflow of dam AMD07, as well as the eastern tributary WSS32 were dry. **Impacts upon the clean water dam AMD07 must be prevented, as this may be reflected downstream from this dam. The quality limits must be revised.**

The exceedances in Fluoride detected in boreholes AMB77 and AMB01 may be attributed to the fact that Fluoride is easily released (via ion exchange) from rocks through natural processes due to slight changes in chemistry or water table depth (artificial recharge which may arise from the clean water dam AMD07 or receding water table due to diminishing rainfall) dislodging fluoride from the geology as detected in boreholes AMB77 and AMB01. This may be a natural process.

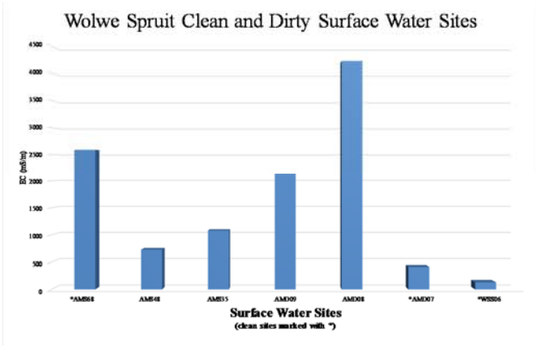

Figure 8. Bar charts of the electrical conductivity at sampling sites along the southern drainage system of the ash stack - Wolwe Spruit

Impacts upon the Wolwe Spruit may occur at the south-eastern corner of the ash stack in the absence of a clean/dirty separation system, which once again emphasize the **need for proper clean/dirty water separation**.

3.4 Affected Drainage Area 2 – Pretorius Spruit Drainage System

The fluctuations in the groundwater and piezometric levels that have been observed since 2005 in the boreholes of the Pretorius Spruit Area are shown in Figure 9, while the water level trends are described in Table 41.

3.4.1 South and south-eastern Power Station impacts

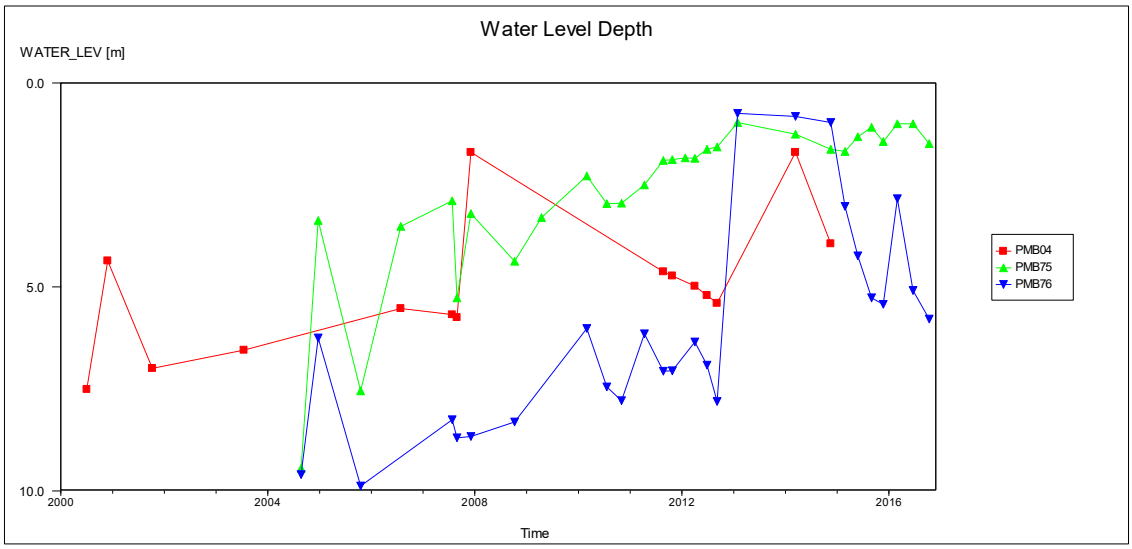

Figure 9. Water level depths (mbgl) of boreholes located in the Pretorius Spruit Drainage System (Drainage from south-east and east of the Power station.

Table 41. Water level trends (mbgl) of boreholes located in the Pretorius Spruit Drainage System (Drainage from south-east and east of the Power station.

Southern Drainage System - Power Station Impact										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Ph52**	**Trend**	**Comment**
PMB76	Monitoring borehole east of power station and north-east of old coal stockpile.	Seepage from temporary coal stockpile in PS area.	Satisfactory condition. Sudden increase in water level depth.	5.27	5.43	2.84	5.09	5.79	Increase since the previous phase.	
PMB75	Monitoring borehole south east of power station and south of conveyor.	Seepage from temporary coal stockpile in PS area.	Satisfactory condition.	1.09	1.44	1	1	1.49	Decreasing water level depth since 2004.	The rise in the water table is an indication of external influences on the groundwater table. There is no resemblance between the chemistry of this borehole and the possible seeping dam PMD24 to the north of it. These may either be due to leaking pipes or water from the coal transfer house.
PMB04	Monitoring borehole south-east of power station and Stein Muller Dam.	Seepage from Stein Muller Dam - PMD10.	Infested with bees and no locknut or pin.	~	~	~	~	~	Borehole infested with bees.	

The steady decrease in the water level depths may indicate external influences. There is however no comparison between the groundwater and that of the dam PMD24. **The presence of leaking pipes or water from the coal transfer house must be investigated.**

Table 42. Current phase chemistry – South and south-eastern Power Station Impacts.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Pretorius Spruit Power Station impacts from north-east and east.	AMD27	Raw Water dam. South of the shooting range.	Leakage detection of clean water losses.	No Sample																				
	*AMB61	Monitoring borehole west of ashing east of tar road.	Drainage to the southwest.	Exceed	Na Fe	8.83	98.4	221	11.7	22.8	51	86.1	0.471	0.541	629	2.35	0.70	0.001	0.053			0.069		When measured against WUL Quality Objectives, only Na and Fe areas exceeding. Surface water was detected flowing past the borehole in 2010. A leaking valve at the Raw Water Dam was consequently detected and repaired with the last surface water seen in 2015. It is unclear for how this has been leaking prior the eventually surfacing at the stream next to the borehole. The artificial recharge may have caused release of constituents from the geology due to disturbance in the natural balance. There are currently no Power Station activities directly influencing groundwater qualities at this borehole. **Continue monitoring to establish possible trends or recovery.**
	*AMS64	Clean Surface catchemnt upstream from AMB61.	Runoff from ash conveyor.	No Sample																				
	*PMS03	Small dam and wetland east of power station next to road.	Clean water run-off.	Exceed	EC Cl NO3-N F PO4	8.04	67.4	87.5	18	36.9	61.2	15.2	2.41	1.29	393	23.9	0.06	0.001	0.08			3.86		Surface run-off from the ash spillages from the ash conveyor may be reflected at this site (which may be exaggerated by concentration due to evaporation. **Inspect conveyor regularly and clean spillages.**
	*PSS59	Upstream sample point form the east flowing into PSD04.	Upstream from PSD04.	No Sample																				

The exceedance of Na and F at AMB61 has been historically recorded. The occurrence may be from local geology. **It is recommended that the WUL parameters be amended grouping boreholes into similar classification groups according to locality and geology. Inspect conveyor for ash spillage to minimise impact on PMS03.**

Table 43. Current phase chemistry – South-eastern Power Station impacts.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Pretorius Spruit Impacts from north-eastern part of Power Station	*PMB76	Monitoring borehole east of power station and north-east of old coal stockpile.	Seepage from temporary coal stockpile in PS area.	Exceed	Cl	8.75	103	172	19.2	14.5	215	4.6	0.647	0.349	544	20.1	0.00	0.001	0.095			0.028		Variability of Cl indicate that this borehole might have been impacted upon by surface activities of the temporary coal stockpile (now removed and rehabilitated). **Continue monitoring to establish possible trends or recovery.**
	PMD24	Small dam south of temporary coal stockpile.	Dams south of temporary CSP.	Dirty Site No Sample																				
	PMD24V	Temporary Coal Stockpile - Removed and rehabilitated.	General operations.	Dirty Site																				
	*PMB75	Monitoring borehole south east of power station and south of conveyor.	Seepage from temporary coal stockpile in PS area.	Exceed	Na	9.22	130	325	8.37	3.7	68.9	115	0.623	0.584	813	0.913	0.00	0.001	0.047			0.034		Even though this borehole is downgradient from the old emergency stockpile and small pollution control dam PMD24 in the power station, the recorded chemistry of this dam is not reflected at this borehole and it is thus not convincingly that this dam impacting on this borehole. The trend is however downward. **Continue monitoring and inspect site for possible leaking pipes.**
	*PMS65	Seepage water in vicinity of PMB75.	Seepage water in vicinity of PMB75.																					
	PMS41	Clean water run-off canal from power station to PMD10.	Run-off from PS & overflow from eastern cooling towers.	No Sample																				
	PMS41V	Emergency Stack	General operations.																					

Limited surface water impacts may be visible at PMB76 (upstream from now removed temporary coal stockpile) and PMB75 (downstream from coal transfer house) without resemblance between surface- and groundwater. **However, due to decreasing water level depth, the situation must be closely monitored to establish possible influences. Re-evaluation of WUL objectives must include these sites.**

Table 44. Current phase chemistry – South-eastern Power Station impacts (dirty water dam).

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Pretorius Spruit Power Station impacts from north-east (dirty dam)	59C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.																					
	PMD10	Stein Muller Dam south-east of the power station.	Stein Muller Dam downstream from S41.	Dirty Site		8.18	676	1311	81.2	145	726	2332	1.63	2.68	4835	73.3	0.01	0.001	0.08			0.162		
	*PMB04	Monitoring borehole south-east of power station and Stein Muller Dam.	Seepage from Stein Muller Dam - PMD10.	No Sample																				
	*PMS02	Stream south of the power station with drainage water from dam PMD10.	Overflow from PMD10.	No Sample																				
	*PSD04	Farm dam south of the power station. Water drains from dam PMD10 and PMS02.	Farm dam downstream from PMS02 & PMS03.	Exceed	EC Cl F	8.23	889	2053	140	198	974	3225	0.46	2.88	6902	72.3	0.00	1.15	0.656			0.055		Overflows from dam PMD10 may be reflected in this dam due to concentration by evaporation. **Regulate the water level of dam PMD10 and prevent overflows.**
	*PSS11	Tributary of Leeu Spruit south of the power station.	Downstream from PSD04.	No Sample																				

Although the exceedance of the elements at PSD04 may be exaggerated by concentration, dam PMD10 is the only contaminated upstream source. **This once again emphasizes the control of the water level of this dam.**

3.4.2 South and south-western Power Station impacts

Table 45. Current phase chemistry – South-western Power Station Impacts.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Pretorius Spruit Power Station Impact from the north-east.	*PMS58	Stream south of the power station with drainage water from dam in bird sanctuary.	Overflow from dam in bird sanctuary.	No Sample																				
	*PMD16	Small dam next to the western security gate of the power station area.	Clean water dam.	Exceed	NO3-N	7.97	28.8	18.7	14.2	22.3	14.4	39.7	0.662	0.313	170	5.02	0.00	0.001	0.145			0.035		None of the power station actives are impacting upon this site. **Determine the source of inflow near the western security gate.**
	*PMS21	Stream south of the power station with drainage water from dam PMD16.	Overflow from PMD16.	No Sample																				
	*PMS66	Possible fountain west of PMD11 and north of fence.	Possible fountain west of PMD11 and north of fence.	No Sample																				
	PMS70V	Contractors area south of western cooling towers south of Power Station	Remove oil containers and placed in oil sump.																					
	PMS70	Canal flowing into PMD29.	General operations.	Dirty Site No Sample																				
	PMS70V	Contractors area south of western cooling towers south of Power Station	Remove oil containers and placed in oil sump.	Dirty Site N																				
	PMD29	Ash settling ponds in Power Station.	General operations.	Dirty Site No Sample																				
	107C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.																					

The source of the water flowing into dam PMD16 must be determined.

Table 46. Current phase chemistry – South-western Power Station impacts (dirty dam)

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Pretorius Spruit Power Station Impact from the north-east (dirty dam)	PMS56	Clean water run-off canal from power station to PMD11.	Run-off from PS.	No Sample																				
	77C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.																					
	PMS47	Canal from the cooling towers west to PMD11.	Run-off from PS & overflow from western cooling towers.	Dirty Site No Sample																				
	PMD11	DB Thermal Dam south of power station.	DB Thermal Dam downstream from PMS47.	Dirty Site		8.51	277	571	33	84.7	260	845	0.559	1.1	1968	31.6	0.00	0.001	0.104			0.302		
	PMS01	Stream south of the power station with drainage water from dam PMD11.	Overflow from PMD11.	Exceed	EC Cl NO3-N F PO4	8.39	277	561	33.2	95.3	262	849	0.507	1.06	1981	31.6	0.00	0.001	0.061			0.295		This is the direct overflow of dam PMD11. **Regulate the water level of dam PMD10 and prevent overflows.**
	PMD18	Farm dam south of the power station. Water drains from PMD11 & PMD16.	Farm dam downstream from PMS01, PMS21 & PMS58.	Exceed	EC Cl F	8.68	333	682	40.1	108	334	996	0.494	1.25	2376	33.4	0.00	0.001	0.117			0.099		This dam is the confluence of PMS58, PMS21, PMS66, PMS01 (overflow of PMD11). With PMS58, PMS21 and PMS66 being dry, the exceeding concentrations are most probably emanating from dam PMD11. **Regulate the water level of dam PMD11 and prevent overflows.**
	*PMS10	Tributary of Pretorius Vlei Spruit downstream of PMD18.	Down stream from PMD18.	Exceed	EC Cl F	8.4	397	744	116	124	427	1102	0.447	0.964	2820	25.4	0.00	0.001	0.582			0.071		This dam is downstream from PMD18 and is merely a reflection of this dam and upstream activities. The higher concentrations are probable due to concentration by evaporation. **Regulate the water level of dam PMD11 and prevent overflows.**

PMS01, PMD18 and PMS10 are all directly downstream from the dirty water dam PMD11. **This once again emphasizes the control of the water level of this dam.**

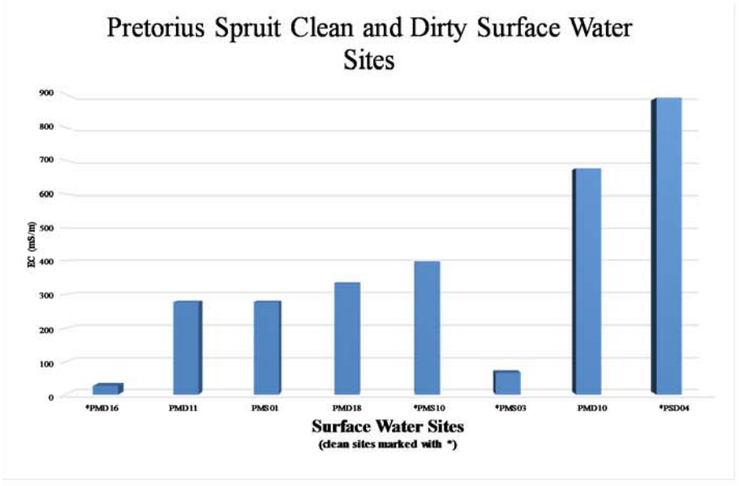

Figure 10. Pretorius Spruit EC bar Chart.

3.5 Affected Drainage Area 3 – Racesbult Spruit Drainage System

The fluctuations in the groundwater and piezometric levels that have been observed since 2005 in the boreholes of the Racesbult Spruit Drainage System and are shown in Figure 11 to Figure 13. Figure 11 shows the groundwater depths of the boreholes drilled to the north of the Power Station area in metres below ground level (mbgl) while Figure 12 gives the water levels of boreholes drilled to the north of the Domestic Waste Site area. Figure 13 shows the water levels in the boreholes drilled to the south of the Coal Stockyard Area. The trends in the groundwater and piezometric levels are described in the associated tables below each graph.

3.5.1 Northern Power Station impacts

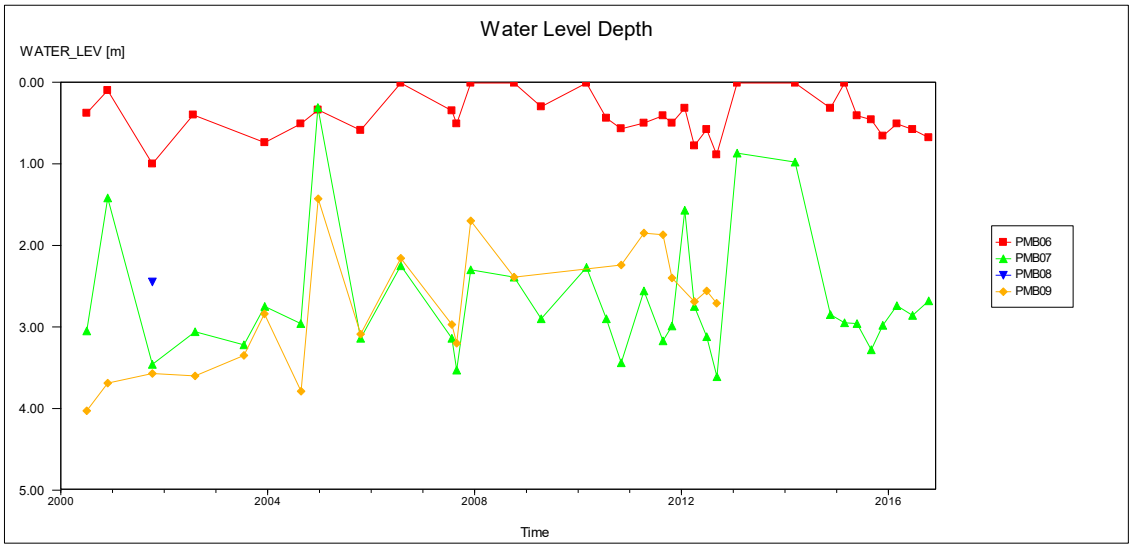

Figure 11. Water level depths (mbgl) of boreholes drilled to the north of the Power Station.

Table 47. Water level trends (mbgl) of boreholes drilled to the north of the Power Station.

Northern Drainage system - Power Station Impact										
BH no.	Site Description	Site Objective	Current State	Phase 48	Phase 49	Phase 50	Phase 51	Ph52	Trend	Comment
PMB06	Monitoring borehole north of the power station and North Potable Dam.	Seepage from North Potable Dam - PMD12	Borehole collar casing completely rusted.	0.46	0.66	0.51	0.58	0.68	Increased since last sampled. Stable trend.	The water levels exibit the same pattern with PMB07, decreasing levels in 2012 and increasing thereafter.
PMB07	Monitoring borehole north-east of the power station and Dirty Water Dam.	Seepage from Dirty Water Dam PMD13.	Satisfactory condition. (Note that there is currently a decomposing rat in the borehole which could effect chemistry)	3.28	2.98	2.74	2.86	2.68	Variable trend.	Variability may be reflecting external surface water activities. The water levels exibit the same pattern with PMB06, decreasing levels in 2012 and increasing thereafter.
PMB08	Monitoring borehole north of the rehabilitated old Domestic Waste Site.	Seepage from old waste site	Borehole infested with bees.	~	~	~	~	Blocked	Unable to establish the latest trend as the level was last measured October 2001.	
PMB09	Monitoring borehole next to the stream from dam below Sewage Plant.	Seepage from sewage plant	Borehole is currently blocked by old beehive.	~	~	~	~	Blocked	Borehole infested with bees.	Variability may be reflecting external surface water activities.

The water levels of PMB06 and PMB07 exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. However, variability at PMB07 may be a reflection of surface water activities (run-off from the conveyor). The same variability was also visible at PMB09 downstream from dam PMD03.

Table 48. Current phase chemistry - North-western Power Station impacts (dirty dam).

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit Power Station impacts from the south-east.	PMS20	Canal from the cooling towers west to PMD12.	Run-off from PS & overflow from western cooling towers	Dirty Site No Sample																				
	PMS27	Clean water run-off canal from power station to PMD12.	Run-off from PS.	Dirty Site No Sample																				
	PMS26	Canal from the cooling towers east to PMD12.	Run-off from PS & overflow from eastern cooling towers.	Dirty Site No Sample																				
	PMD12	North Potable dam north of the power station.	North Potable dam downstream from PMSS20, PMS26 & PMS27.	Dirty Site		9.17	332	696	44.3	59.8	345	1063	0.53	1.03	2329	38	0.00	0.001	0.174			0.054		
	*PMB06	Monitoring borehole north of the power station and North Potable Dam.	Seepage from North Potable Dam - PMD12	Below		8.46	113	145	43.8	43.4	184	62.6	0.597	0.263	634	6.79	0.00	0.017	0.093			0.03		
	*PMS24	Stream north of the power station. Drainage from dam PMD12 or a spring.	Overflow from PMD12	Dirty Site No Sample																				

Table 49. Current phase chemistry – North-eastern Power Station impacts (dirty station dams, maturation pons and old domestic waste site).

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit Power Station impacts from the south-east (station dams)	PMD20	Dam west of conveyor used during cleaning of station drain dams PMD17.	Settling dam west.	Dirty Site No Sample																				
	*PMS24	Stream north of the power station. Drainage from dam PMD12 or a spring.	Overflow from PMD12	Dirty Site No Sample																				
	PMD13V	Oil skimmers	Operational standards.	Dirty Site No Sample																				
	PMD17	Settling dams above dirty water dam PMD13, overflow into PMD13.	Settling dams.	Dirty Site No Sample																				
	PMD19	Small dam next to settling ponds, PMD17.	Small settling dam.	Dirty Site No Sample																				
	PMD13	Dirty Water Dam in the north-east of the power station.	Dirty water dam.	Dirty Site		8.31	476	1042	59.4	83.6	461	1678	3.54	1.3	3489	60.3	0.00	0.001	0.096			0.038		

Table 50. Current phase chemistry – North-eastern Power Station impacts (downstream station dams).

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit Power Station impacts from the south-east (downstream station dams	PMS34	Containment canal just beneath PMD13.	Overflow from Dirty Water Dam PMD13.	Dirty Site		8.34	212	390	66.5	53.4	196	582	0.489	0.707	1473	8.35	0.00	0.001	0.215			0.064		
	10C	Sewage transfer pit in south-western corner.	Monitoring status of equipment.																					
	*PMB07V	Leaking water between PMD20 & PMD21 and flowing towards PMB07	General Operations.																					
	PMD21	Small dam north of station drain outlets.	Small settling dam.	Dirty Site No Sample																				
	*PMB07	Monitoring borehole north-east of the power station and Dirty Water Dam.	Seepage from Dirty Water Dam PMD13.	Exceed	Na	8.45	119	314	7.51	15	81.1	0.141	0.621	0.53	774	2.79	0.00	0.001	0.629			0.821		Analyses in general indicate this site to be virtually unaffected. Variations occurs between exceedance of Na and Fe without any resemblance between water from this borehole and dam PMD13. However, surface run-off from the coal conveyor as well as water previously pumped from the pump house west of the conveyor may have been impacted upon this borehole. **Continue monitoring and prevent run-off from the coal conveyor.**
	*PMS23	Stream overflow from dirty water dam PMD13 and PMS34.	Overflow from PMS34 & Dirty Water Dam PMD13.	No Sample																				

Na is the only exceeding at PMB07. **Keep monitoring and prevent surface run-off from the coal conveyor.**

Table 51. Current phase chemistry – Impacts from old domestic waste and sewage plant from the south east.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Old waste Site East of Power Station	*PMB08	Monitoring borehole north of the rehabilitated old Domestic Waste Site.	Seepage from old waste site	No Sample																				
Sewage plant East of Power Station	*PMD03	Dam west sewage plant.	Maturation Dam	Dirty Site		7.68	63.3	57	21.1	42.5	51.7	6.15	0.343	0.485	356	14.9	0.00	0.275	6.95	150	10	1.36		
	*PMB09	Monitoring borehole next to the stream from dam below Sewage Plant.	Seepage from sewage plant	No Sample																				

3.5.2 Domestic Waste Site

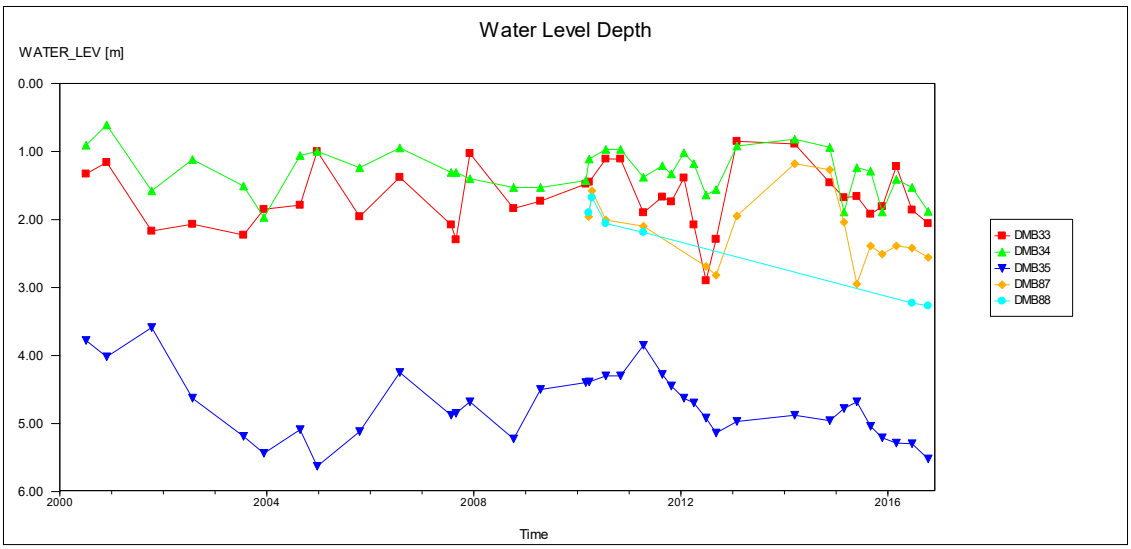

Figure 12. Water level depths (mbgl) of boreholes monitoring the Domestic Waste Site.

Table 52. Water level trends (mbgl) of boreholes monitoring the Domestic Waste Site.

Northern Drainage System - Domestic Waste Site Impact										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Ph52**	**Trend**	**Comment**
DMB35	South of the solid waste site and next to the entrance.	Upstream from waste site.	No locking pin.	5.04	5.21	5.29	5.3	5.52	Stable increasing, althought slightly variable. Increasing since 2014.	~
DMB33	North of the solid waste site.	Seepage from waste site.	Satisfactory condition.	1.92	1.81	1.22	1.86	2.06	Stable, althought slightly variable. Increasing since 2014.	~
DMB87	North west of new proposed extension.	Seepage from waste site.	Satisfactory condition.	2.39	2.51	2.39	2.42	2.56	Increased since the previous phase.	~
DMB34	North of the solid waste site.	Seepage from waste site.	Satisfactory condition.	1.29	1.89	1.41	1.53	1.88	Stable, althought slightly variable. Increasing since 2014.	~
DMB88	North west of new proposed extension.	Seepage from waste site.	Was able to open borehole using magnet. However the extreme corrosion is still an ongoing issue.	~	~	~	3.23	3.27	Increasing trend since 2010.	~

The water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. Borehole DMB35 upstream from the waste site exhibit a steeper increase since 2015.

Table 53. Current phase chemistry – Impacts from domestic waste site.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit Domestic Waste Site	*DMB35	South of the solid waste site and next to the entrance.	Upstream from waste site.	Exceed	NO3-N	8.46	80.2	63.1	30.3	59	25.1	49.2	23.3	0.324	597	34.9	0.00	0.001	0.06	77.3		0.03		This is an upstream borehole where NO3 has been exceeded since 2000. Impacts can only occur if enough artificial recharge is occurring to create a gradient towards the borehole. The water level of the borehole is currently still above the waste site and none of the downstream boreholes reflect the same impacts making it unlikely that this is from the waste site.. **Continue monitoring.**
	*DMS44	Surface water east of waste site. Collect runoff from dump in excavation.	Run-off from site.	No Sample																				
Racesbult Spruit - Northern Drainage System - Domestic Waste Site Impact	*DMB35V	Old and New Domestic Waste Site	General operations.	Dirty Site No Sample																				
	DMT01	Sump on north-eastern corner.	Seepage from waste site.	Dirty Site No Sample																				
	*DMB34	North of the solid waste site.	Seepage from waste site.	Exceed	Mg	8.54	129	101	76	107	31.9	203	0.855	0.363	948	24.6	0.00	0.001	0.069	19.5		0.042		Mg has been exceeded since 2000. Groundwater gradients are towards the north-east and not in the direction of this borehole. **Continue monitoring.**
	DMD31	New dam situated below the domestic waste site.	Dam next to DMB86.	Dirty Site No Sample																				
	*DMB33	North of the solid waste site.	Seepage from waste site.	Exceed	EC Mg	8.5	155	99.6	117	89.6	154	147	0.704	0.34	969	5.73	0.00	0.001	0.081	34.6		0.029		Possible impacts from the historic part of the domestic waste site may be reflected at this borehole with a slightly increasing trend in the concentrations of Mg. **It was agreed upon by GHT and Tutuka that a numerical model will be constructed in 2017 for the Waste site as part of the monitoring contract to quantify possible impacts.**
	*DMB86	Old borehole with piezometer north of the solid waste site.	Seepage from waste site.	No Sample																				
	*DMB89	West of proposed new extension and north of the borrow pit.	Seepage from waste site.	No Sample																				
	*DMB87	North west of new proposed extension.	Seepage from waste site.	Below		8.66	88.1	86.2	63.7	35.4	30.3	100	0.64	0.263	588	7.33	0.00	0.001	0.181	14.5		0.026		
	*DMS37	Streamlet northeast of waste disposal site.	Run-off from site.	No Sample																				
	*DMB88	North west of new proposed extension.	Seepage from waste site.	Below		8.66	47.3	110	1.27	3.96	33	18.3	0.69	0.263	292	0.866	0.00	0.001	0.101	24.9		0.027		

The occurrence of NH_4 upstream from DMB35 is uncertain. **It is recommended that a numerical model be constructed for the domestic waste site to quantify impacts detected at DMB33 or DMB34 (downstream form the site as natural drainage are not in the direction of this borehole).**

3.5.3 Southern Coal Stockyard impacts

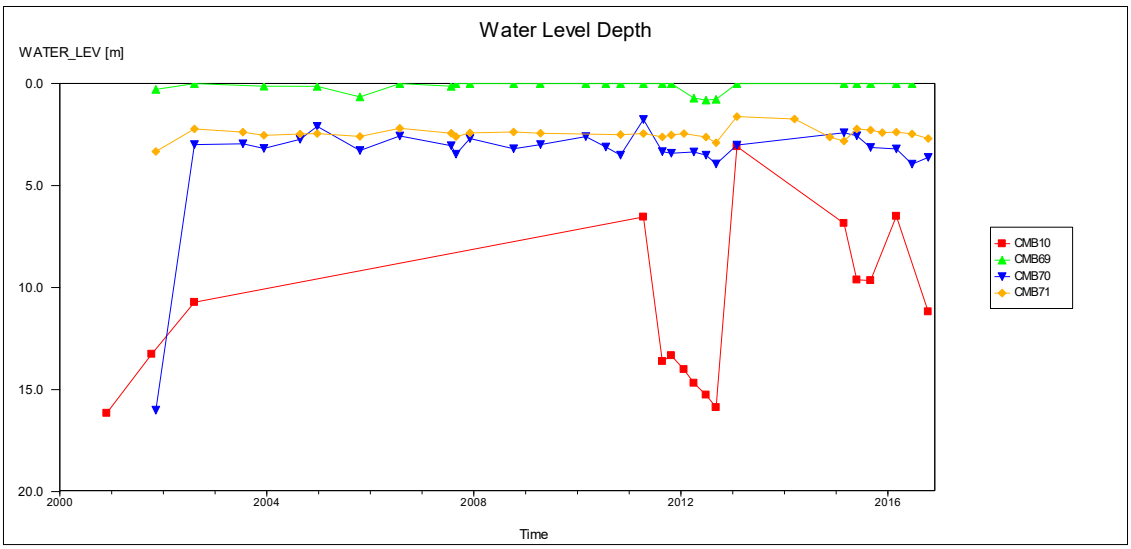

Figure 13. Water level depths (mbgl) of boreholes to the south of the Coal Stockyard Area.

Table 54. Water level trends (mbgl) of boreholes to the south of the Coal Stockyard Area.

Southern Drainage System - Coal Stockyard Impact										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Ph52**	**Water level depth**	**Comment**
CMB10	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	No locking pin and bees are removed at the borehole.	9.66	~	6.51	~	11.19	Huge variability with an increasing trend 2013/2014.	The water levels exhibit the same variable pattern with decreasing levels from 2012 to 2014 increasing thereafter. The variability at CMB10 indicate possible surface water activities.
CMB69	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	Casing and marker post damaged. Bees are active.	Art	~	0.01	0.01	~	Bees - unable to take level, yet stable trend.	
CMB71	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from CMS22 and stock pile.	No locking pin.	2.28	2.41	2.39	2.47	2.70	Stable.	
CMB70	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from stock pile.	No locking pin. Number plate damaged.	3.14	~	3.21	3.96	3.63	Stable.	

The variability at CMB10 may indicate possible surface water activities and **must be closely monitored.**

Table 55. Current phase chemistry - Coal Stockyard impacts from the east.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
				GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit Upstream from the east	*RSD01	Dam next to the Bethal Road upstream site.	Farm dam background sample.	No Sample																				
	*RSS04	Downstream from RSD01 upstream site. Could be a spring.	Downstream from RSD01.	Exceed	EC Cl NO3-N F	8.24	92.1	82.1	41.7	64.2	79.2	116	0.884	1.3	565	18.7	0.00	0.001	0.095			0.07		This a natural dam/steam upstream from any power station or coal stockyard activities and concentration may be due to concentration by evaporation.
Racesbult Spruit - Southern Drainage System - Coal Stockyard Area Impact east of conveyor	*CMB69	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	No Sample																				
	CMS62	Tanker refill point at southern fence of coal stockyard.	Tanker refill point and surrounding area.	No Sample																				
	*CMB10V	Coal transfer house near CMB10.	General operations.																					
	*CMB10	Monitoring borehole south of coal stock yard.	Seepage from stock pile.	Exceed	Na NH4-N	8.84	131	302	16.2	32.4	83.7	35.2	0.275	0.498	837	4.16	0.00	0.096	1.14			0.038		The exceedance of NH4 can most probably be contributed to the old decaying beehive in the borehole. **The occurrence of Na must be investigated as the same element is exceeded at CMB10, CMB70, CMB71 and PMB76 as it can be from natural origin.**
	*CMB70	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from stock pile.	Exceed	Na	8.98	99.9	273	3.54	6.45	60.7	4.36	0.292	0.602	645	1.78	0.00	0.001	0.089			0.026		See CMB10 above and CMB71 below. **Continue monitoring.**
	*RSS49	Downstream from RSS04 about 100 m east of conveyor.	Downstream from RSS04.	No Sample																				

The upstream qualities at RSS04 cannot be attributes to power station activities. These poor upstream qualities will have a detrimental effect on downstream sites to which Tutuka must adhere. **This also indicate that the WUL objectives may have to be adjusted for surface water sites that the power station is held accounted for and are not influenced by the power station.**

Table 56. Current phase chemistry – Impacts from Coal Stockyard Area east of conveyor up to Leeu Spruit.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Racesbult Spruit - Southern Drainage System Coal Stockyard Area Impact east of conveyor	CMS22	Sample at point of outflow from sump west of conveyor.	Surface runoff from transfer house.	Dirty Site		8	169	65	56.9	264	21.6	807	0.673	0.585	1287	9.47	0.00	0.112	0.051			0.026		
	CMD23	Illegal temporary dam receing overflows from CMS22	Legal compliance.	No Sample																				
	*CMB71	Monitoring borehole south of coal stock yard next to Racesbult Spruit.	Seepage from CMS22 and stock pile.	Exceed	Na	8.39	99.1	265	8.26	18	20.2	0.269	0.66	0.422	661	1.65	0.00	0.001	0.053			0.029		Impacts at this borehole will naturally be associated with the overflows at CMS22. However, the vague resemblance between the chemistry of this borehole and the impacting pollution source, as well as similar chemistry at CMB70 and CMB10 east of this borehole suggest Na may be natural occurring emanating from the geology. **Continue monitoring.**
	*CMS60	Seepage or possible fountain west of conveyor and south-west of CSY.	Seepage southwest of CSY.	Exceed	EC Cl F	8.09	559	1091	130	232	608	2019	0.259	0.676	4344	80.9	0.00	0.001	0.199			0.068		Similarity (although higher possibly due to concentration by evaporation) between chemistry of this water and that of CMS22 suggest this may be seepage from upstream surface water impacts. This site will impact on downstream surface water sites and eventually the Leeu Spruit. **This must be investigated to determine the source of water.**
Racesbult Spruit downstream	*RSS31	In stream west of conveyor.	Downstream from RSS49.	Exceed	EC Cl NO3-N F PO4	8.42	102	146	33.1	61.9	87.6	20.6	0.504	1.04	627	15.6	0.00	0.001	0.143			0.63		The exceedance at these sites must be viewed in relation to the upstream sites PSD01 and RSS04 (already exceeding limits not caused by New Denmark or Tutuka activities). However, as stated, CMS60 will impact on theses sites. **Therefore, once again the source at CMS60 must be investigated.**
	*RSS45	Downstream of RSS31, on Pieter Bosman's farm.	Downstream from RSS31.	Exceed	EC Cl NO3-N	8.26	47	44.4	19	30.4	34.2	47.4	0.541	0.386	278	7.49	0.00	0.001	0.529			0.138		
	*RSS09	At tar road crossing.	Downstream from RSS45.	Exceed	EC Cl	8.37	76.9	96.6	27.7	40.5	75.9	69.4	0.498	0.489	456	11.3	0.00	0.001	0.102			0.033		

As the upstream qualities at RSS04 cannot be attributed to power station activities, it is unclear what the contribution of the power station activities are as the stream is already externally affected. The issue at CMS22 has been taken up with New Denmark Colliery. The only exceeding parameter of Na is at CMB71 (which is also exceeded at CMB70 and CMB10 as explained earlier. **This once again indicate that the WUL objectives must be amended to grouping boreholes of similar locality and geology together.**

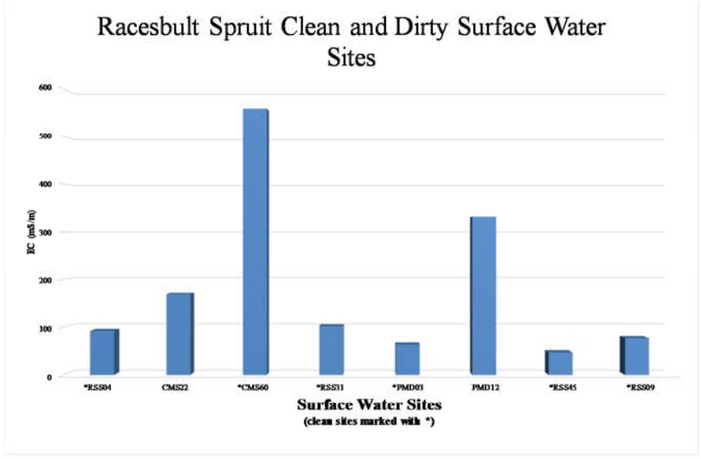

Figure 14. Racesbult Spruit EC bar Chart.

3.6 Affected Drainage Area 4 – Uitkyk Spruit Drainage System

The fluctuation in the groundwater and piezometric levels of the boreholes in the Uitkyk Spruit Drainage System Area are shown in Figure 15, while the water level trends are described in Table 57.

3.6.1 Northern Coal Stockyard impacts

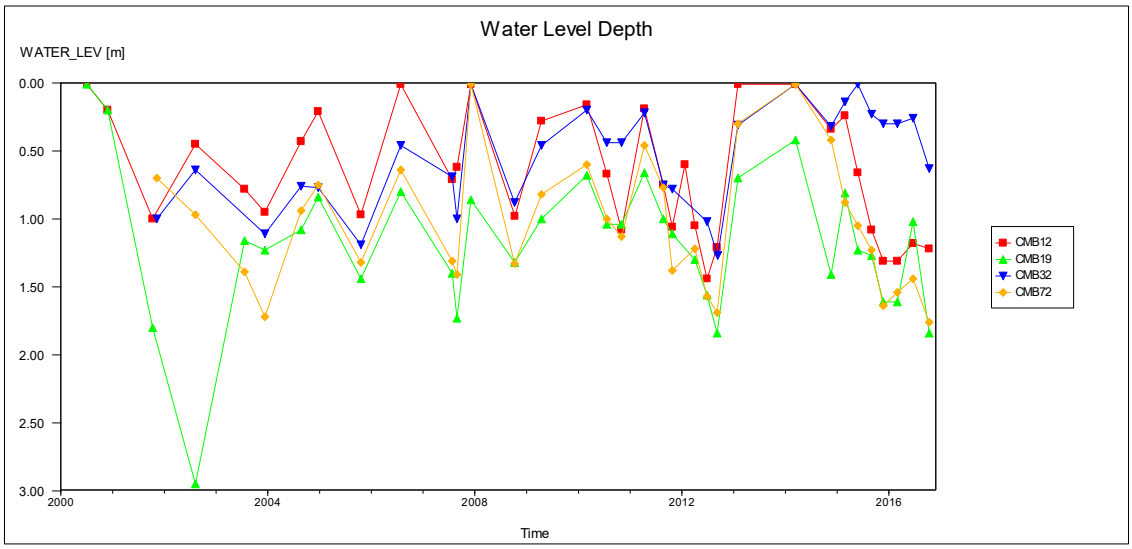

Figure 15. Water level depths (mbgl) of boreholes to the north of the Coal Stockyard.

Table 57. Water level trends (mbgl) of boreholes to the north of the Coal Stockyard.

Uitkyk Spruit Drainage - Drainage to the North - Coal Stockyard Impact										
BH no.	**Site Description**	**Site Objective**	**Current State**	**Phase 48**	**Phase 49**	**Phase 50**	**Phase 51**	**Ph52**	**Water level depth**	**Comment**
CMB32	Monitoring borehole north of coal stock yard.	Seepage from stock pile and CMS63.	No Cap. Borehole is blocked at 15m.	0.23	0.3	0.3	0.26	0.63	Slight variability, increasing trend since 2014.	Although variability in groundwater levels indicate possible surface water activities, the water levels exhibit the same variability over vast distances between them. Furthermore the water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter.
CMB19	Monitoring borehole north of coal stock yard below dam CMD15.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.	No Locknut. Casing damaged.	1.27	1.61	1.61	1.02	1.84	Slight variability, increasing trend since 2014.	
CMB12	Monitoring borehole below pollution control dam next to Uitkyk Spruit.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.	No locking pin.	1.08	1.31	1.31	1.18	1.22	Slight variability, increasing trend since 2014.	
CMB72	Monitoring borehole north of coal stock yard next to Uitkyk Spruit.	Seepage from dam CMD15, CMS63 & stock pile.	No locknut and Cap.	1.23	1.64	1.54	1.44	1.76	Slight variability, increasing trend since 2014.	

Although variability in groundwater levels indicate possible surface water activities, the water levels exhibit the same variability over vast distances between them. Furthermore, the water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter.

Table 58. Current phase chemistry – Coal Stockyard impacts from the south-east.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
				GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Uitkyk Spruit Coal Stockyard Area Impacts from south-east.	CMS71	Canal and small settling pan in Coal Stockyard.	Coal water canal.	Dirty Site No Sample																				
	CMD28	Dam inside Coal Stockyard.	Coal settling pans.	Dirty Site No Sample																				
	CMS28	Overflow of draining system at coal stock pile flowing into CMD15.	Run-off from stock pile.	Dirty Site		8.52	435	1055	57.1	46.4	382	1229	1.78	3.47	3189	7.58	0.00	0.001	0.083			0.051		
	CMD26	Coal settling pans north-west of coal stockyard.	Settling pan and silt trap south of CMS57.	Dirty Site No Sample																				
	*CMS57	Run-off water from coal stockyard flowing towards Uitkyk Spruit.	Run-off from northern settling ponds at CSY.	No Sample																				
	*CMS63	Storm water pipe and seepage north of Coal Stockyard.	Storm water pipe and seepage from coal stack.	No Sample																				
	*CMB32	Monitoring borehole north of coal stock yard.	Seepage from stock pile and CMS63.	Exceed	EC Mg Ca SO4 TDS	8.47	175	49.3	133	202	55.7	783	0.299	0.263	1406	41.5	0.00	0.001	0.054			0.027		The close proximity of this borehole to both Coal Stockyard, the french drains and the storm water pipe CMS63 (which had surface water coming from the Coal Stockyard) may be reflecting local impacts. **Improve the clean/dirty separation of the Coal Stockyard and continue monitoring.**

Borehole CMB32 may show signs of impacts. **Improve the clean/dirty separation of the Coal Stockyard and continue monitoring.**

Table 59. Current phase chemistry – Coal Stockyard impacts from the south-east.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Uitkyk Spruit - Northern Drainage System - Coal Stockyard Area Impact	*CMS46	Water from sewage pits next to fence flowing towards dam CMD15.	Overflow from sewage pit.	Exceed	EC Cl Feacal Coliforms PO4	7.89	69.8	65.1	19	35.8	53.8	5	0.316	0.429	378	15.5	0.00	0.673	13.3		187	3.79		The overflow of the french drains is treated with Cl, hence the exceedance. In spite of this treatment, Faecal Coliforms are exceeded impacting upon dam CMD15. **Investigate reason for french drain and ensure proper treatment and operations.**
	CMD15	Pollution control dam of New Denmark Colliery north of coal stockyard.	Pollution Control Dam.	Dirty Site		8.59	462	1091	69.8	52.6	451	1401	0.491	3.34	3365	8.51	0.00	0.001	0.072			0.03		
	*USS38	CMD15's overflow.	Overflow from CMD15.	No Sample																				
	*CMB19	Monitoring borehole north of coal stock yard below dam CMD15.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.	Below		8.86	68	140	9.01	20.4	44.4	17.8	0.367	0.355	403	1.06	0.00	0.001	0.059			0.03		
	*CMB12	Monitoring borehole below pollution control dam next to Uitkyk Spruit.	Seepage from dam CMD15, Uitkyk Spruit & stock pile.	Below		8.87	73.3	161	7.52	18.2	28.3	42.4	0.352	0.487	455	1.72	0.00	0.001	0.047			0.026		
	*CMB72	Monitoring borehole north of coal stock yard next to Uitkyk Spruit.	Seepage from dam CMD15, CMS63 & stock pile.	Exceed	Na	8.44	98.7	295	0.545	5.32	16.2	0.232	0.275	0.833	669	0.638	0.06	0.001	0.281			0.689		This borehole is exceeding Na (the same as at boreholes CMB32, CMB10, CMB71 and CMB72). The occurrence may be due to natural geology although the common denominator namely the coal conveyor is raising suspicion. Borehole CMB12 is however also close to and little upstream from the conveyor without any impacts. **Continue monitoring.**
	*USS12	Stream north of coal stockyard downstream from dam CMD15.	Downstream from CMS38.	No Sample																				

The problem at CMS46 was discussed with New Denmark Colliery personnel. These are french drains or septic tanks where chlorination is taking place to prevent bacteriological impacts. This overflow enters the coal stockyard pollution control dam CMD15. **It must be requested that this site be considered as a dirty water site.** Once again with Na being the only exceeding parameter at CMB72, **it is recommended that the WUL be amended by grouping of boreholes according to geology and locality.**

3.7 Affected Drainage Area 5 – Leeu Spruit Drainage System

Table 60. Current phase chemistry – Leeu Spruit.

Site Information				Water Use License Classifications		pH	EC	Na	Mg	Ca	Cl	SO_4	NO_3-N	F	TDS	K	Fe	Mn	NH_4-N	COD	Faecal Coliforms	PO4	NH_3-N	Remarks.
Area with Possible Env. Hazard	No. On Map	Site Description	Site Objective	GW Quality Objectives		5-9.5	150	200	70	150	200	400	10	1	1000	50	0.20	0.20	1					
				SW Quality Objective		6-9.0	30				20		0.5	0.5						20	60	0.25	0.5	
				WUL Class	Exceeding Elements		mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	mg/L	mg/L	
Leeu Spruit Area - Southern Drainage System	*LSS13	Crossing of road over Leeu Spruit - background value.	Leeu Spruit sampling point 1.	Exceed	EC	8.22	37.5	24.1	22.1	30.1	13.4	47.4	0.358	0.332	236	4.82	0.00	0.001	0.081			0.048		This is the upstream sampling point north of all operations and indicate that the stream is already impacted upon by upstream activities. **This must be taken into account when evaluating downstream qualities.**
	*LSS33	Crossing of road over Tributary of Leeu Spruit downstream from LSS13.	Tributary to Leeu Spruit.	Exceed	EC	8.13	43.5	29.4	25.7	33.7	14	36	0.5	0.412	255	5.47	0.00	0.001	0.057			0.061		This is an upstream tributary north of all operations and indicate that the stream is already impacted upon by upstream activities. **This must be taken into account when evaluating downstream qualities.**
	*LSS14	Crossing of road over Leeu Spruit downstream from LSS13.	Leeu Spruit sampling point 2.	Exceed	EC	8.35	36.8	22.2	22.4	30.1	12.3	36.4	0.33	0.369	221	4.82	0.00	0.001	0.072			0.036		This sampling point represents the confluence of LSS13 and LSS33 as well as the contribution from the Uitkyk Spruit. There is another tributary in between this point and USS12 which is not currently part of the monitoring network. This tributary must be added to the monitoring network. GHT Consulting will include this sample in the next monitoring event.
	*NMS67	Storm water trench next to road at corner of road to NDC	Runoff, seepage or overflow from upstream dam.	No Sample																				
	*NMS40	Mine sewage plant - effluent overflow - sample in Spruit next to tar road.	Effluent overflow from mine sewage plant.	No Sample																				
	TE01V	Thuthukani Sewage Plant	Monitor general operational standards.																					
	*TE01	Thuthukani Sewage Plant final purified sewage effluent discharge point.	Monitor sewage effluent discharge quality.	Exceed	EC Cl NO3-N COD PO4	8.11	57.2	63.8	15.8	27.5	45.2	74.4	15.3	0.276	354	11.8	0.00	0.001	0.107	32	10	0.516		The samples collected at this site is just below the discharge point within the mostly stagnant pools. Samples can thus be somewhat concentrated. The water is utilized by cattle and sheep from the local village that can contribute to the faecal coliforms. **The limits must be revised.**
	*LSS07	Crossing of road over Leeu Spruit downstream from LSS14 at Grootdraai Dam.	Leeu Spruit sampling point 3.	Exceed	EC Cl	8.58	77.3	94.5	32.5	40.9	55.8	119	0.275	0.434	488	8	0.00	0.001	0.067			0.036		This is the last downstream sampling point reflecting all but the one excluded point as described at LSS14. Even though the contribution of all the tributaries can be calculated as 252 mg/L (TDS), these limits are clearly too stringent. The background or external values of the tributaries to the system (LSS13,LSS33, RSD01, RSS04, PSS59) are most of the times exceeding the objectives. **These limits must be revised.**

Upstream qualities are already above the WUL quality objectives for EC. Although EC and Cl are the only elements exceeded at the downstream site LSS07, the concentration of SO_4 (which is not part of WUL objectives for surface water sites) has increased by 70 mg/L. The microbiological exceedance may be due to inadequate chlorination or cattle utilising the water. **Future samples are to be taken from the discharge point and not in-stream.**

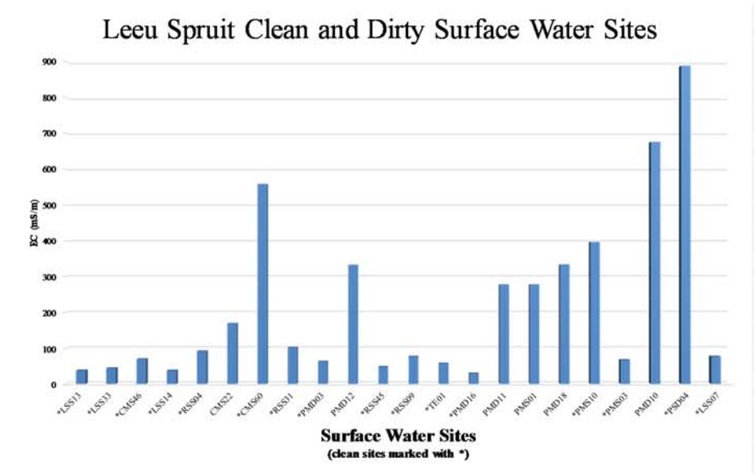

Figure 16.EC Bar charts of the Leeu Spruit (including tributaries).

Upstream qualities are already above the WUL quality objectives for EC. Although EC and Cl are the only elements exceeded at the downstream site LSS07, the concentration of SO_4 (which is not part of WUL objectives for surface water sites) has increased by 70 mg/L. These impacts are clearly from CMS60, PMD11 and PMD10.

3.8 Surface- and groundwater quality – hydrocarbon analyses

The results of the hydrocarbon analyses are presented in Table 61.

Table 61. Results of the petroleum hydrocarbon analyses.

Site	Total Hydrocarbons mg/L	Ethanol mg/L	Benzene mg/L	TAME mg/L	Toluene mg/L	Ethylbenzene mg/L	o-Xylene mg/L	m+p-Xylene mg/L	Naphtalene mg/L	TOX mg/L
AMB25D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<10
AMB25S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<10
PMS34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AMB54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<10
AMB26D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<10
PMB07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PMD10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PMD11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PMD12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PMD13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table 61 indicates that no hydrocarbon compounds were detected for the analysed samples by using the employed analyses methods.

4 CONCLUSIONS AND RECOMMENDATIONS

Response tables attached in Appendix D must be completed by the relevant personnel of Tutuka Power Station and send to GHT Consulting before the next Site Assessment and Audit takes place in January 2017. These tables serve as a control to evaluate the actions taken in addressing the identified problems and upon completion to be included in future monitoring reports.

The defects pertaining to the monitoring system will be omitted from the conclusions and recommendations as the maintenance whereby all boreholes will be fitted with a marker post and bee-proof cap is being planned early January 2017. Additional boreholes (deep and shallow pairs) will also be drilled at Thuthukani, dam PMD11 and downstream from PMS34.

The following conclusions and recommendations have been made on the basis of site observations, monitoring measurements and analyses of laboratory test results:

4.1 Current State

4.1.1 Affected Drainage Area 1 – Wolwe Spruit Drainage System

- Dam AMD14 was inaccessible and not sampled. Arrangements have been made to have the keys available during the following monitoring event.
- It is unknown if borehole AMB31 is still used as a production borehole to supply water for the game **and must be determined prior to maintenance scheduled in 2017.**
- **The borehole on the eastern side of the ash stack (FBB320) must be incorporated into the monitoring system as valuable monitoring information can be recorded prior to ashing close to the borehole. The windmill must be removed so that a cap can be fitted during the planned maintenance.**
- The dirty water trench south of the ash stack has been cleaned. There is however a part on the south-eastern side of the ash stack where there is no dirty water inception. Surface run-off can flow into the stream at AMS69 and AMS68 impacting upon this site (as reflected by the exceedance of EC, Cl and NO_3 at this site). **A proper diversion strategy must be investigated and the dirty water trench must be extended from the east to the west at the sump near site AMS35 which divert the ash water to dam AMD09.**

4.1.2 Affected Drainage Area 1 – Pretorius Spruit Drainage System

- **The water levels of the dirty water dams PMD10, PMD11 and PMD24 must be controlled.**

4.1.3 Affected Drainage Area 1 – Racesbult Spruit Drainage System

- **The water levels of the dirty water dam PMD12 must be controlled.**
- Although the problems at CMS22 have been taken up with New Denmark Colliery, **this facility must be properly operated and the illegal emergency dam below the sump must either be registered and lined or removed.**

4.1.4 Affected Drainage Area 1 – Uitkyk Spruit Drainage System

- Dam AMD14 was inaccessible and not sampled. Arrangements have been made to have the keys available during the following monitoring event.

4.2 Groundwater levels and chemical analyses results

4.2.1 Affected Drainage Area 1 – Wolwe Spruit Drainage System

4.2.1.1 Upstream and Background Boreholes

- The same pattern with decreasing groundwater level depths in 2012, increasing thereafter are apparent. Except for borehole AMB31 where possible abstraction is causing a slightly steeper increasing trend since 2015, stable, slightly decreasing trends are visible with no visible influence from power station activities.

- The boreholes AMB31 and AMB51 are used for background purposes and are not within the natural drainage of the ash stack. The origin of ammonium may be attributed by agricultural purposes and cannot be regarded as a contravention of the WUL due to ashing activities. There was a sudden unaccounted increase in Mn at AMB51 since beginning of 2016. **Continue monitoring to establish possible trends of both these parameters.**

4.2.1.2 Drainage from the south-west and boreholes drilled on the ash stack

- The slight rise in water table depth may either be due to historic influences of brine water irrigation or recharge occurring through the top. Although the rise in water levels are extremely slow, it must be investigated as this means the ash is slowly becoming more saturated. This may be due to seepage from the clean north dam AMD14.

- Although the EC values and Mg, Ca, Cl and TDS concentrations are exceeded at AMB25D, AMB26D, AMB54 (only Mg and Cl), the trend graphs are stable, increasing slightly. As the purpose of these boreholes are to monitor the Hazardous Waste site, they had to be drilled directly into ash stack. The deep piezometers extend into the dolerite sill below the ash stack. Even in the presence of the ash stack, groundwater and groundwater drainage will tend to follow the historic stream system or paleochannel coming from the dam north of the ash stack. The groundwater in the sill occurs between the dolerite sill and thinly covered geology on top of it (so-called bedding plane fractures) where the borehole acts as a sump collecting this seepage. **It must be requested that the boreholes drilled into the ash stack be removed from the WUL as it can be expected that the ash stack would impact on the geology directly below it.**

4.2.1.3 Drainage from the south-west with boreholes directly south and further downstream of the ash stack – western drainage system

- The same pattern with decreasing groundwater level depths in 2012, increasing thereafter are apparent. Some variability seen at AMB93 may indicate surface water activities (such as the overflows of the silted southern dirty water trench which has been cleaned.

- The deep piezometer of AMB24 (as explained earlier at AMB25D, AMB26D and AMB54) extend into the dolerite sill below the ash stack. Even in the presence of the ash stack, groundwater and groundwater drainage will tend to follow the historic stream system or paleochannel coming from the dam north of the ash stack. The groundwater in the sill occurs between the dolerite sill and thinly covered geology on top of it (so-called bedding plane fractures) where the borehole acts as a sump collecting this seepage. **It must be requested that borehole AMB24D drilled into the ash stack be removed from the WUL as it can be expected that the ash stack would impact on the geology directly below it.**

- Borehole AMB92 is directly east of the stream running in a southerly direction from the ash stack (part of the historic stream or paleochannel from the north dam AMD14) of the ash stack where the southern dirty water trench was silted causing sporadic overflows being reflected in the shallow geology (AMB92B). The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion. **This borehole must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

- Boreholes AMB93 and AMB67 are approximately 25m south of the ash stack where the southern dirty water trench was silted causing sporadic overflows being reflected in the shallow geology (AMB93B) as these boreholes are close to the south-western stream. The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion. **These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

- Borehole AMB64 is 800m further south, and not close to streams indicating unaffected geology when not in close proximity to surface impacted sites. Borehole AMB02 is standing in the impacted stream (due to the silted southern dirty water trench which has been cleaned) running from the ash stack past boreholes AMB93 and AMB67. Increasing trends in some indicator element concentrations are noted, however, improvements are expected due to the cleaning of the southern dirty water trench.

4.2.1.4 Drainage from the south-east and boreholes directly south of the ash stack – eastern drainage system

- Boreholes AMB65 and AMB91 are directly south of the ash stack below the eastern clean water diversion underneath the ash. **These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

- Boreholes AMB65 and AMB91 are directly south of the ash stack below the eastern clean water diversion underneath the ash. The Na and Fl concentrations at AMB91A&B may be associated with geology. The trench has been cleaned and improvements are expected. The deep horizon is sampled below the sill reflecting possible impacts below the sill. The similar chemistry of the deep and shallow horizon may however reflect diffusion**. A clean/dirty water separation system must be installed. These boreholes must be plugged prior to extension of the ash stack. Future boreholes must be drilled as deep and shallow pairs to be able to distinguish between water from above and below the sill.**

4.2.1.5 Dirty water dams – southern drainage system

- The slightly deeper water level depth at AMB21 may be due to previous abstraction. The trends are however stable. It was confirmed that the electricity has been removed and that no further abstraction will be taking place.

- Impacts at borehole AMB63 directly below the first dirty water dam AMD09 may reflect impacts from the dam or historical overflows. Similar chemical concentration measured at borehole AMB02 and AMB21 may indicate recharge occurring from the same impacted region. Groundwater gradients created towards borehole AMB21 due to previous abstraction may have

enhance the movement of contaminants from AMB02 to AMB21. As already stated, no abstraction is taking place anymore**. Monitoring must continue in order to establish improvement and possible cause due to earlier abstraction.**

- Even though it might seem impacts from the second dirty water dam (either through overflows or seepage) are visible in the shallow piezometer of borehole AMB56, the absence of SO4 (with a concentration of 11083 mg/L in the dam), this seems unlikely. The presence of Cl and NH4 may be due to cattle utilizing the water directly below the dam wall. The farm is being evacuated**. Monitoring must continue in order to establish improvement and possible cause after evacuation of the land.**

4.2.1.6 Clean water dam – southern drainage system

- No abstraction is taking place that could cause the increase in groundwater depths. This may be due to general drier conditions experienced.

- The exceedances in Fluoride detected in boreholes AMB77 and AMB01 may be attributed to the fact that Fluoride is easily released (via ion exchange) from rocks through natural processes due to slight changes in chemistry (or even artificial recharge) which may arise from the clean water dam AMD07 – this may dislodge fluoride from the geology as detected in boreholes AMB77 and AMB01. This may be a natural process due to the presence of the dam (possibly even prior to the construction of the ash dam.

- Impacts upon the Wolwe Spruit may occur at the south-eastern corner of the ash stack in the absence of a clean/dirty separation system, which once again **emphasize the need for proper separation.**

4.2.2 Affected Drainage Area 2 – Pretorius Spruit Drainage System

The fluctuations in the groundwater and piezometric levels that have been observed since 2005 in the boreholes of the Pretorius Spruit Area are shown in Figure 9, while the water level trends are described in Table 41.

4.2.2.1 South and south-eastern Power Station impacts

- The steady decrease in the water level depths may indicate external influences. There is however no comparison between the groundwater and that of the dam PMD24. **The presence of leaking pipes or water from the coal transfer house must be investigated.**

- The exceedance of Na and F at AMB61 has been historically recorded. The occurrence may be from local geology**. It is recommended that the WUL parameters be amended grouping boreholes into similar classification groups according to locality and geology. Inspect conveyor for ash spillage to minimize impact on PMS03.**

- Limited surface water impacts may be visible at PMB76 (upstream from now removed temporary coal stockpile) and PMB75 (downstream from coal transfer house) without resemblance between surface- and groundwater. However, due to decreasing water level depth, **the situation must be closely monitored to establish possible influences. Re-evaluation of WUL objectives must include these sites.**

- Although the exceedance of the elements at PSD04 may be exaggerated by concentration, dam PMD10 is the only contaminated upstream source**. This once again emphasizes the control of the water level of this dam.**

4.2.2.2 South and south-western Power Station impacts

The source of the water flowing into dam PMD16 must be determined.

PMS01, PMD18 and PMS10 are all directly downstream from the dirty water dam PMD11. **This once again emphasizes the control of the water level of this dam.**

4.2.3 Affected Drainage Area 3 – Racesbult Spruit Drainage System

The fluctuations in the groundwater and piezometric levels that have been observed since 2005 in the boreholes of the Racesbult Spruit Drainage System and are shown in Figure 11 to Figure 13. Figure 11 shows the groundwater depths of the boreholes drilled to the north of the Power Station area in metres below ground level (mbgl) while Figure 12 gives the water levels of boreholes drilled to the north of the Domestic Waste Site area. Figure 13 shows the water levels in the boreholes drilled to the south of the Coal Stockyard Area. The trends in the groundwater and piezometric levels are described in the associated tables below each graph.

4.2.3.1 Northern Power Station impacts

The water levels of PMB06 and PMB07 exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. However, variability at PMB07 may be a reflection of surface water activities (run-off from the conveyor). The same variability was also visible at PMB09 downstream from dam PMD03.

Na is the only exceedance at PMB07. **This once again indicate that the WUL objectives must be amended to grouping boreholes of similar locality and geology together. Keep monitoring and prevent surface run-off from the coal conveyor.**

4.2.3.2 Domestic Waste Site

The water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter. Borehole DMB35 upstream from the waste site exhibit a steeper increase since 2015.

The occurrence of NH_4 upstream from DMB35 is uncertain. **It is recommended that a numerical model be constructed for the domestic waste site to quantify impacts detected at DMB33 or DMB34 (downstream form the site as natural drainage are not in the direction of this borehole).**

4.2.3.3 Southern Coal Stockyard impacts

The variability at CMB10 may indicate possible surface water activities and **must be closely monitored.**

The upstream qualities at RSS04 cannot be attributes to power station activities. These poor upstream qualities will have a detrimental effect on downstream sites to which Tutuka must adhere. **This also indicate that the WUL objectives may have to be adjusted for surface water sites that the power station is held accounted for and are not influenced by the power station.**

As the upstream qualities at RSS04 cannot be attributed to power station activities, it is unclear what the contribution of the power station activities are as the stream is already externally affected. The issue at CMS22 has been taken up with New Denmark Colliery. The only exceeding parameter of Na is at CMB71 (which is also exceeded at CMB70 and CMB10 as explained earlier. **This once again indicate that the WUL objectives must be amended to grouping boreholes of similar locality and geology together.**

4.2.4 Affected Drainage Area 4 – Uitkyk Spruit Drainage System

The fluctuation in the groundwater and piezometric levels of the boreholes in the Uitkyk Spruit Drainage System Area are shown in Figure 15, while the water level trends are described in Table 57.

4.2.4.1 Northern Coal Stockyard impacts

Although variability in groundwater levels indicate possible surface water activities, the water levels exhibit the same variability over vast distances between them. Furthermore, the water levels exhibit the same pattern with decreasing levels from 2012 to 2014 increasing thereafter.

Borehole CMB32 may show signs of impacts. **Improve the clean/dirty separation of the Coal Stockyard and continue monitoring.**

The problem at CMS46 was discussed with New Denmark Colliery personnel. These are french drains or septic tanks where chlorination is taking place to prevent bacteriological impacts. This overflow enters the coal stockyard pollution control dam CMD15. **It must be requested that this site be considered as a dirty water site.** Once again with Na being the only exceeding parameter at CMB72, **it is recommended that the WUL be amended by grouping of boreholes according to geology and locality.**

4.2.5 Affected Drainage Area 5 – Leeu Spruit Drainage System

Upstream qualities are already above the WUL quality objectives for EC. Although EC and Cl are the only elements exceeded at the downstream site LSS07, the concentration of SO_4 (which is not part of WUL objectives for surface water sites) has increased by 70 mg/L.

Upstream qualities are already above the WUL quality objectives for EC. Although EC and Cl are the only elements exceeded at the downstream site LSS07, the concentration of SO_4 (which is not part of WUL objectives for surface water sites) has increased by 70 mg/L. these impacts are clearly from CMS60, PMD11 and PMD10 which **emphasize the control of water levels of these dams**.

4.3 Hydrocarbon analyses

Table 61 indicates that no hydrocarbon compounds were detected for the analysed samples by using the employed analyses methods.

APPENDIX C: HARZADOUS WASTE MONITORING REPORT [LATEST QUATERLY REPORTS]

GHT CONSULTING SCIENTISTS

Tutuka Power Station

HAZARDOUS WASTE SITE
3RD QUARTER 2016

FINAL REPORT

PROJECT TEAM
L.J. van Niekerk
S. Staats
C. Makhanya

for

Eskom

TUTUKA POWER STATION

Project no.:	002-24-mon.724	Start Date:	January 2015
Current Phase:	3rd Quarter 2016	Start Date:	October 2016
Report no.:	RVN 724.19/1690	Report Date:	December 2016

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06 December 2016 GHT ref.: RVN 724.19/1690

The Manager
Tutuka Power Station
Private Bag 2016
Standerton
2430

FOR ATTENTION: Mrs. Ilse Coop
Tel: 017 749 9410
Cell: 060 414 9308

Dear Ilse,

Hazardous Waste Site Monitoring Report 3rd Quarter 2016

It is our pleasure to enclose a copy of the report RVN 724.19/1690 "Hazardous Waste Site Monitoring – Report".

We trust that the report will fulfil the expectation of the Power Station and we will supply any additional information if required. Yours sincerely,

Louis J van Niekerk (Pr.Sci.Nat.)

Copies: One printed copy and one compact disc copies to Mrs Ilse Coop – Environmental Manager (coopi@eskom.co.za)

TABLE OF CONTENTS

1 INTRODUCTION

This report summarizes the 3rd Quarter monitoring performed by GHT Consulting as external monitoring. For continuation purposes, this report also reflects on any progress and feedback since the previous monitoring.

1.1 Scope of Monitoring

The operation of Tutuka Power Station's Hazardous Waste Site requires routine monitoring, as contained in the permit of the Department of Water Affairs and Forestry (Section 6). It is therefore illegal to operate the Hazardous Waste Site without conducting monitoring.

Monitoring includes background monitoring (Paragraph 6.6) and detection monitoring (Paragraph 6.7). Detection monitoring includes:

- ***Monthly surface water monitoring*** - ***Responsibility of Internal Monitoring: Environmental Department, Tutuka Power Station***
- ***Quarterly surface and groundwater monitoring*** - ***Responsibility of External Monitoring: GHT Consulting***

Background monitoring forms part of the quarterly groundwater monitoring programme.

1.1.1 Monthly surface water monitoring - Responsibility of Internal Monitoring – Environmental Department, Tutuka Power Station

The monthly surface water monitoring forms the first part of the Detection Monitoring programme. According to the conditions of the Hazardous Waste Permit, monthly surface water monitoring is to be conducted and in this instance, will include the leakage detection system and storm water drains on, and adjacent to the site. The monthly monitoring programme must also include:

- The collection of water samples for chemical analysis.
- The preparation of a written report to the management of Tutuka Power Station summarizing monitoring results and the general condition of the site.
- The minutes of the monthly meetings with the Site SEA and Roshcon the operator in control must be included in the monthly reports.
- Submission of the report to external auditor for evaluation and inclusion into the quarterly report.

1.1.2 Quarterly surface and groundwater monitoring - Responsibility of External Monitoring by GHT Consulting

The quarterly water monitoring forms the second part of the Detection Monitoring programme. According to the conditions of the Hazardous Waste Permit, ground and surface water monitoring is to be conducted every three months. The following actions are included as part of the quarterly routine monitoring of the Hazardous Waste Site.

- The collection of water samples for chemical analysis of the surface and groundwater sites.
- The collation of monthly records outlining the type and quantity of waste deposited.
- Monitoring of site conditions and operation.
- Monitoring and evaluation of weekly and monthly reports, including monthly surface water monitoring by the Environmental Department of Tutuka Power Station.
- The submission of a summary report with conclusions and recommendations to the Management of Tutuka Power Station.
- Quarterly meeting with the management and interested and affected parties to discuss the conclusions and recommendations of the monitoring reports. The discussions during this meeting, the way forward and feedback on the previous reports will be included in the quarterly reports.

Response forms have been included in the monitoring reports to ensure that corrective actions are recorded for management purposes (refer to Appendix B). These forms must be completed and faxed to GHT within 14 days of the issue date of a monitoring report to ensure compliance with report recommendations.

2 FEEDBACK ON THE 2ND QUARTER 2016 REPORT

The previous inspection of the Hazardous Waste Site was conducted on the 21st of June 2016 by Shaun Staats from GHT Consulting, Mr. JJ Nkabinde (the site operator from Roshcon), Mr T. van Niekerk, (the site manager from Tutuka), and Mr. J. Venter (civil engineer at Tutuka). A detailed discussion followed regarding the concerns raised with respect to the leakage into the detection sump.

The condition of the site was rated as Good due to the leaking of seepage from the top of the liner into the leakage detection sump, as well as the slightly deteriorating signage at the gates. The site operation and day-to-day operations and management by the site SEA received a rating of Excellent. A rating of Excellent was awarded to the Environmental Department. External factors received a rating of Excellent as the pump-back system and sprayers are fully operational. The site received an overall rating of Excellent.

2.1 Feedback and corrective actions

Table 1. Corrective actions taken at Hazardous Waste Site since previous phase

Problem	First Reported	Mitigation Proposed	Responsible Person	Date of Compliance
Signage at the gate is faded.	Feb-16	Inspect and upgrade if necessary		Signage was replaced

Discussion

The following feedback was received from the Environmental department and from the Site SEA concerning the previous phase:

- The signage was upgraded.

3 MONITORING: 3RD QUARTER 2016

The Hazardous Waste Site was inspected on the 11th of October 2016 by Shaun Staats and Chrisjan Makhanya from GHT Consulting, Mr. JJ Nkabinde (the site operator from Roshcon) and Mr T. van Niekerk, (the site manager from Tutuka. A detailed discussion followed regarding the concerns raised with respect to the leakage into the detection sump.

3.1 State of the Hazardous Waste Site

The condition of the site was rated as Good due to the leaking of seepage from the top of the liner into the leakage detection sump and the absence of cell numbers against the fence. The site operation and day-to-day operations and management by the site SEA received a rating of Excellent. A rating of Excellent was awarded to the Environmental Department. External factors received a rating of Excellent as the pump-back system and sprayers are fully operational. The site received an overall rating of Excellent.

A graphical representation of the site layout and the monitoring site positions is given in Figure 1.

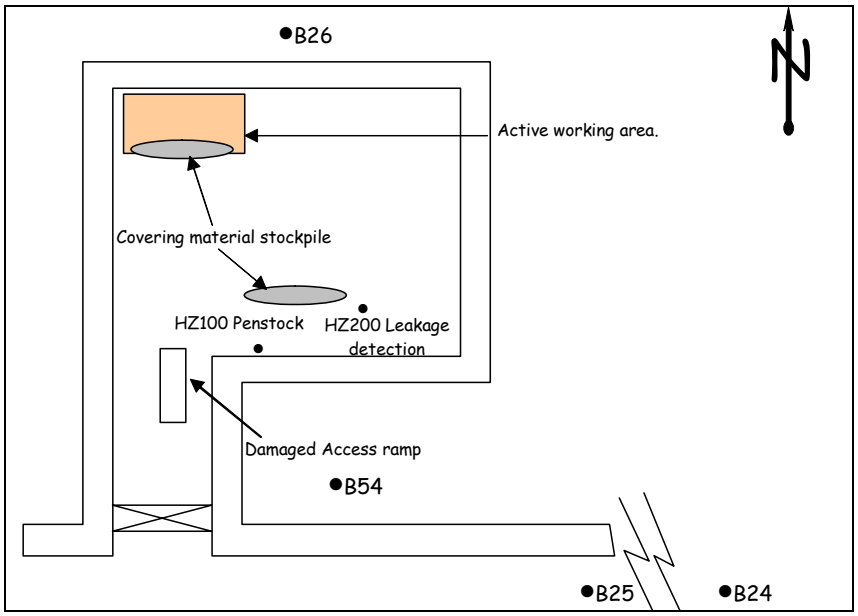


Figure 1. Site Plan and Monitoring Locations at Hazardous Waste Site.

Observations made with respect to the site conditions are presented in the photos below, while a summary of the conditions of specific characteristics at the hazardous waste site during the time of inspection are given in Table 2.

Photo 1 General site conditions

Photo 2 Renewed signage.

Photo 3 Renewed signage.

Table 2. Summary of the condition of specific characteristics at the Hazardous Waste Site during the time of inspection

Site Feature	Specific Characteristic	Condition	Max Points	3nd Q 2016
Condition of Site				
Access control	Signposts	Excellent	5	5
	Access roads	Excellent	5	5
	Gate and Lock	Excellent	5	5
	Fence	Excellent	5	5
	Cell Numbers (A,B… 1,2…)	Dismal	5	0
Site drainage	Drainage slopes	Excellent	5	5
	Maintenance	Excellent	5	5
	Slopes grass cover	Excellent	5	5
Penstock	Clean	Excellent	5	5
	Settling pond	Excellent	5	5
	Access	Excellent	5	5
	Pump back system, sprayers, etc.	Excellent	5	5
Flexible membrane liner	Visibility	Excellent	5	5
	Damage	Excellent	5	5
	Sufficient	Excellent	5	5
	Plants & Bushes	Excellent	5	5
Leakage detection system	Clean	Dismal	5	0
	Silicon seal	Dismal	5	0
	Access	Excellent	5	5
Monitoring boreholes	Caps and locks	Excellent	5	5
	Surrounding area	Excellent	5	5
Other		Excellent	5	5
Rating of Condition of Site		**Good**	**100%**	**86.4%**
Site Operation & Management (Site SEA)				
Cell construction	Bund walls	Excellent	5	5
	Size	Excellent	5	5
	Dump operation	Excellent	5	5
	Cover	Excellent	5	5
Cover material	Waste visibility	Excellent	5	5
	Surface residue	Excellent	5	5
	Sufficient	Excellent	5	5
	Position of stockpile	Excellent	5	5
Feedback & reporting (Site SEA)		Excellent	5	5
Rating of Site Operation & Management (Site SEA)		**Excellent**	**100%**	**100.0%**
Site Management (Environmental Department)				
Feedback & reporting (Environmental Department)		Excellent	5	5
Monthly monitoring & audit (Environmental Department)		Dismal	5	0
Other		Excellent	5	5
Rating of Site Management (Environmental Department)		**Excellent**	**100%**	**100.0%**
External Factors				
Electricity etc.		Excellent	5	5
Rating of External Factors		**Excellent**	**100%**	**100%**
Overall		**Excellent**	**100%**	**90.0%**

Points classification	Excellent	>90%
	Good	80 - 90%
	Fair	60 - 80%
	Poor	40 - 60%
	Very poor	20 - 40%
	Dismal	<20%

Discussion

The following aspects were noted during the current and previous field inspection and discussed during the meeting as indicated in the first paragraph of this chapter:

- **Signage –** Signage at the gate has been upgraded.

- **Cell Numbers –** There are no cell numbers of the numbering system of A, B … and 1, 2, …etc. These numbers were fixed to the security fence to designate the numbering blocks A1, A2, B1, B2…. etc. used in recording what has been dumped where.

- **Leakage detection system (Manhole)** – The conditions at the bottom of the sump are unchanged with seepage from the top of the liner dripping into the seepage inspection sump at the bottom. The seal between the cement ring and the liner is an inherent design problem and is unlikely to be completely and permanently mendable. With the on-going problem of seepage between the cement ring and the liner, it is recommended that the system be revised with a protection ring as indicated in Figure 2. The water can then be scooped from the upper area. It should be handled as hazardous and handled accordingly when discarded at the current cell where waste is being dumped. It was further confirmed by Mr. Johan Venter that there is a liner still beneath the seepage inspection sump and that water seeping backwards into the seepage inspection pipes would therefore not leak into the groundwater below the sump.

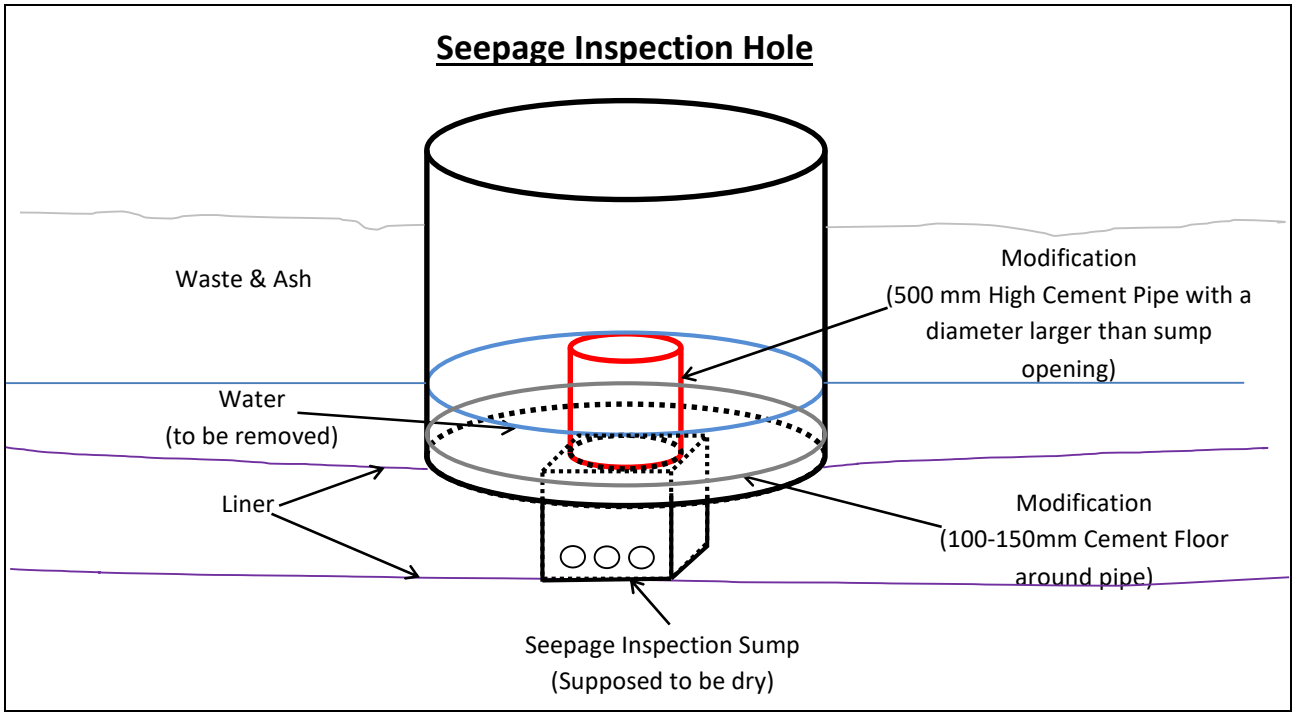


Figure 2. Proposed modification.

3.2 Water Samples

3.2.1 Location of Monitoring Sites

The position of surface water (HZ100 - penstock and HZ200 - leakage detection system), groundwater (AMB25 and AMB54), and background groundwater sampling sites (AMB26 and AMB31) are shown in the locality map in Appendix A.

3.2.2 Surface water sites

The penstock HZ100 is dry and no water sample was obtained. The pipe next to the leakage detection hole HZ200 is currently also dry and no water sample could be obtained. This pipe system was installed to enable sampling of seepage that collects on top of the liner.

Table 3. Sampling and field information of surface water sites.

Sites	Site No.	Prev Date	Prev Finding	Date Sampled	Current WL	Sampled	Comments
HW Monitoring Sites	HZ100	21-Jun-15	Low	11-Oct-16	Dry	N	Satisfactory condition.
	HZ200		Dry		Unable to obtain sample.	N	Seepage visible through cement rings.

3.2.3 Groundwater sites

Five groundwater samples were collected and submitted with the surface water sample for chemical analyses. Table 4 lists information regarding the sampling of the groundwater sampling sites.

Table 4. Sampling and field information of groundwater monitoring sites.

Sites	Site No.	Prev Date	Prev WL	Date Sampled	Current WL	Sampled	Comments
HW Monitoring Sites	AMB25 (deep piezometer)	21-Jun-15	12.71	11-Oct-16	12.79	Y	Sample depth - 15 m (1 glass bottle)
	AMB25 (shallow piezometer)		11.2		11.68	Y	Sample depth - 20 m (1 glass bottle)
	AMB26 (deep piezometer)		17.81		17.91	Y	Sample depth - 25 m (1 glass bottle)
	AMB26 (shallow piezometer)		17.18		17.29	N	Not enough water to obtain sample
	AMB54		19.62		19.76	Y	Sample depth - 21 m (1 glass bottle)
	AMB31 (Background)		13.4		13.64	Y	Sample depth - 15 m (1 glass bottle)

3.2.4 Results and discussion of the chemical analysis

The results of all the chemical analyses that have been performed on water samples from Tutuka Power Station during the current and previous phases of the monitoring program are available in an electronic database for review. The results of the chemical analyses of the current monitoring phase are given in table format in Table 6. Graphs of the concentrations of the various chemical parameters recorded over time are shown in Appendix B. These graphs may be used to examine the temporal behaviour of the particular chemical parameters.

Table 5. Results of chemical analyses.

Locality	Date	pH	EC	TDS	Na	Mg	Ca	Cl	SO_4	NO_3	F	K	Fe	Mn	NH_4	COD	PO4
			mS/m	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AMB31	20-Oct-2016	7.87	59.9	397	35.4	31.9	51.1	27.6	23.5	3.86	0.363	3.57	0.004	0.846	1.36	69	0.052
AMB26D	20-Oct-2016	8.31	207	1364	183	91.2	159	332	385	10.6	0.637	3.77	0.004	0.001	0.035	112	0.044
AMB54	20-Oct-2016	8.43	145	868	80.2	89.3	103	226	178	3.99	0.28	7.15	0.004	0.077	0.156	13.9	0.028
AMB25D	20-Oct-2016	8.22	197	1216	105	101	172	385	217	13.4	0.362	7.17	0.004	0.001	0.051	102	0.026
AMB25S	20-Oct-2016	8.71	565	3958	980	10.1	325	844	1637	8.49	1.2	71.5	0.004	0.001	0.034	122	0.031

Locality	Alkilinity	NO2	B	Cd	Pb	Hg	Cr	Cr6+	CN - free	Phenol	Cu	Al	Zn	TOC	TOX	As
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AMB31	252	3.79	0.013	0.002	0.004	0.004	0.003	0.002	0.01	0.02	0.002	0.002	0.002	4.19	0	0.01
AMB26D	212	0.122	0.15	0.002	0.004	0.004	4.51	4.15	0.01	0.02	0.002	0.002	0.002	3	0	0.01
AMB54	231	0.962	0.013	0.002	0.004	0.004	0.003	0.002	0.01	0.02	0.002	0.002	0.002	1.82	0	0.01
AMB25D	203	0.114	0.097	0.002	0.004	0.004	0.434	0.321	0.01	0.02	0.002	0.002	0.002	2.21	0	0.01
AMB25S	62.5	0.36	6.12	0.002	0.004	0.004	11.6	10.5	0.01	0.02	0.002	0.002	0.002	8.15	0	0.019

Discussion:

From the data in Table 6 and the time graphs in Appendix B the following observations can be made with regards to water quality at the sampling sites near the hazardous waste site:

- No impacts from the Hazardous Waste site is apparent when inspecting the time graphs. The boreholes are drilled directly into the ash, and as such are reflecting the properties of the ash itself. For comparison, time graphs have also been included for site AMB24S and AMB24D which are also drilled within the ash, but are not within the drainage from the Hazardous Waste site. This was done to compare analyses of water from the monitoring boreholes not only with the upstream borehole AMB31, but to detect possible anomalies when comparing analyses of water from the monitoring boreholes drilled in the as with water from another borehole also drilled in the ash.

- Even though the surface surface-runoff collection sump and penstock (HZ100) was dry and water could not be obtained from the seepage inspection hole (HZ200), these sites were included in the time graphs to be used as indicator of contaminants inside the Hazardous Waste site to possibly distinguish between Hazardous Waste site impacts and that of the ash. No leakage or seepage from the Hazardous Waste Site is suspected as concentrations of constituents not readily associated with ash that are present at HZ100 and HZ200 inside the waste site were not detected in water from the monitoring boreholes of the site.

4 CONCLUSIONS AND RECOMMENDATIONS

The Hazardous Waste Site was inspected on the 11th of October 2016 by Shaun Staats and Chrisjan Makhanya from GHT Consulting, Mr. JJ Nkabinde (the site operator from Roshcon) and Mr T. van Niekerk, (the site manager from Tutuka. A detailed discussion followed regarding the concerns raised with respect to the leakage into the detection sump.

The condition of the site was rated as Good due to the leaking of seepage from the top of the liner into the leakage detection sump and the absence of cell numbers against the fence. The site operation and day-to-day operations and management by the site SEA received a rating of Excellent. A rating of Excellent was awarded to the Environmental Department. External factors received a rating of Excellent as the pump-back system and sprayers are fully operational. The site received an overall rating of Excellent.

The following aspects were noted during the field inspection and discussed during the meeting as indicated in the first paragraph of this chapter:

- **Signage –** Signage at the gate has been upgraded.

- **Cell Numbers –** There are no cell numbers of the numbering system of A, B … and 1, 2, …etc. These numbers were fixed to the security fence to designate the numbering blocks A1, A2, B1, B2…. etc. used in recording what has been dumped where.

- **Leakage detection system (Manhole)** – The conditions at the bottom of the sump are unchanged with seepage from the top of the liner dripping into the seepage inspection sump at the bottom. The seal between the cement ring and the liner is an inherent design problem and is unlikely to be completely and permanently mendable. With the on-going problem of seepage between the cement ring and the liner, it is recommended that the system be revised with a protection ring as indicated in Figure 2. The water can then be scooped from the upper area. It should be handled as hazardous and handled accordingly when discarded at the current cell where waste is being dumped. It was earlier confirmed by Mr. Johan Venter that there is a liner still beneath the seepage inspection sump and that water seeping backwards into the seepage inspection pipes would therefore not leak into the groundwater below the sump.

The following conclusions can be made with regards to leakage detection through monitoring and chemical analyses:

- No impacts from the Hazardous Waste site is apparent when inspecting the time graphs. The boreholes are drilled directly into the ash, and as such are reflecting the properties of the ash itself. For comparison, time graphs have also been included for site AMB24S and AMB24D which are also drilled within the ash, but are not within the drainage from the Hazardous Waste site. This was done to compare analyses of water from the monitoring boreholes not only with the upstream borehole AMB31, but to detect possible anomalies when comparing analyses of water from the monitoring boreholes drilled in the as with water from another borehole also drilled in the ash.

- Even though the surface surface-runoff collection sump and penstock (HZ100) was dry and water could not be obtained from the seepage inspection hole (HZ200), these sites were included in the time graphs to be used as indicator of contaminants inside the Hazardous Waste site to possibly distinguish between Hazardous Waste site impacts and that of the ash. No leakage or seepage from the Hazardous Waste Site is suspected as concentrations of

constituents not readily associated with ash that are present at HZ100 and HZ200 inside the waste site were not detected in water from the monitoring boreholes of the site.

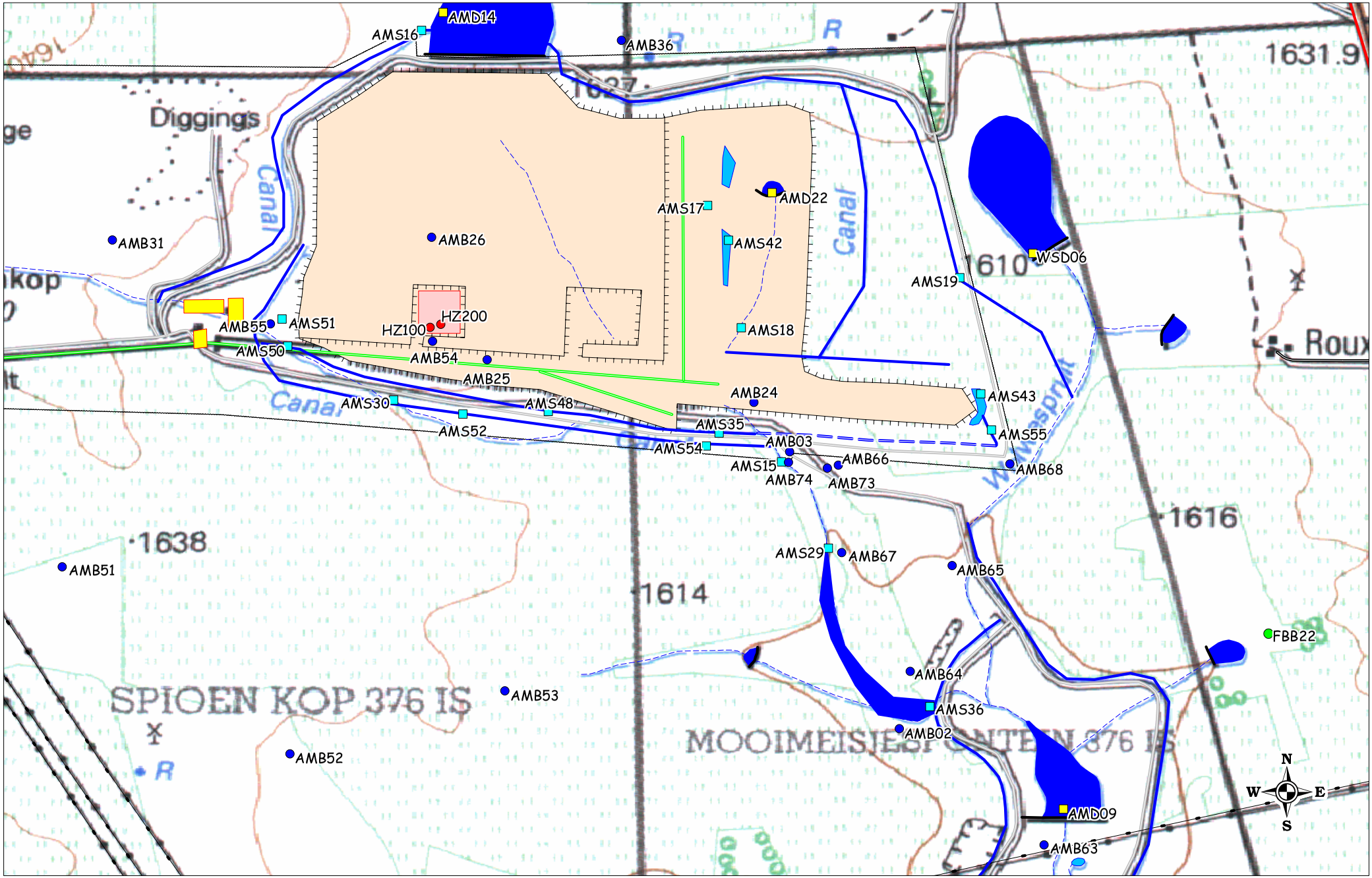
Louis van Niekerk

7 December 2016
Date

APPENDIX A
Locality Maps

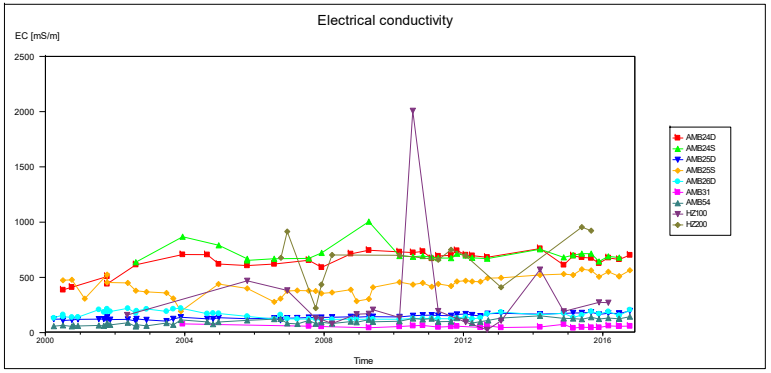
Tutuka Power Station

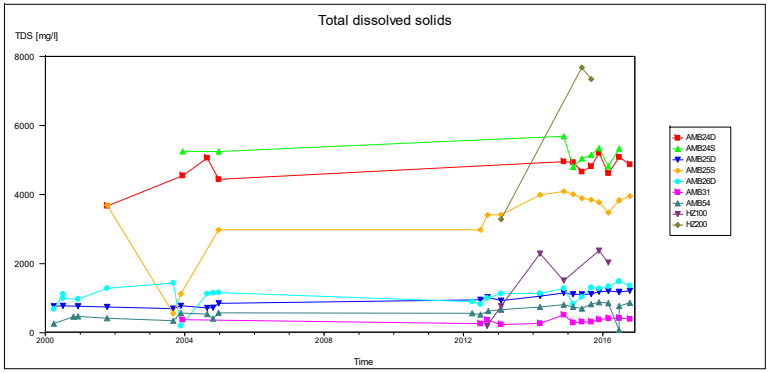
Hazardous Waste Site Monitoring Sites

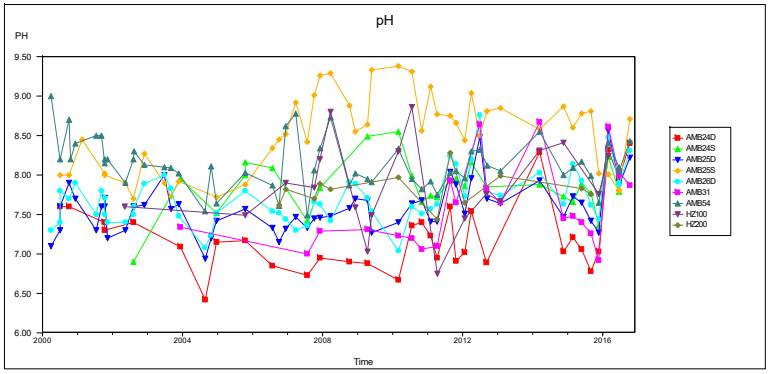


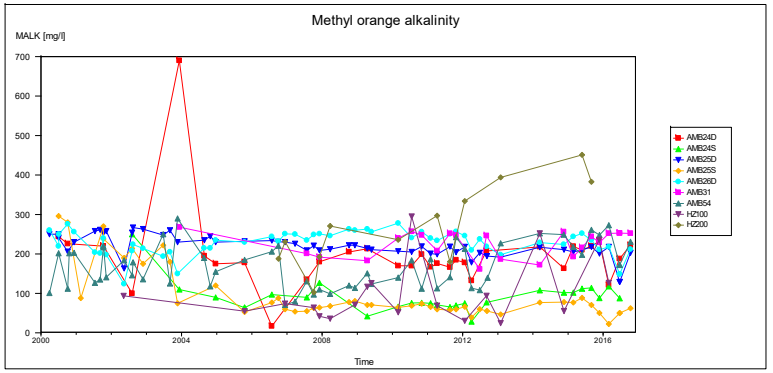
APPENDIX B
Chemical Graphs

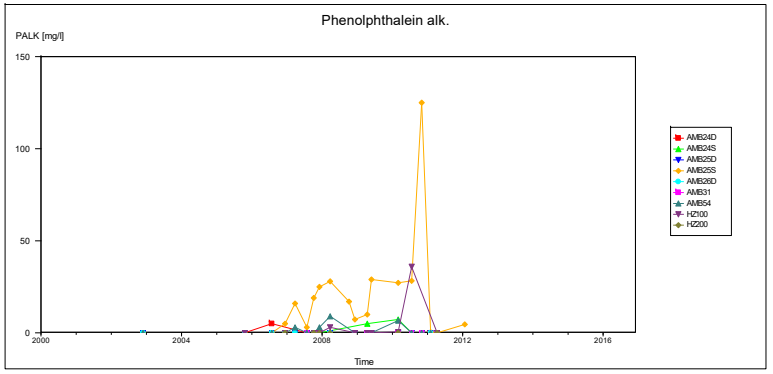
Hazardous Waste Site Area

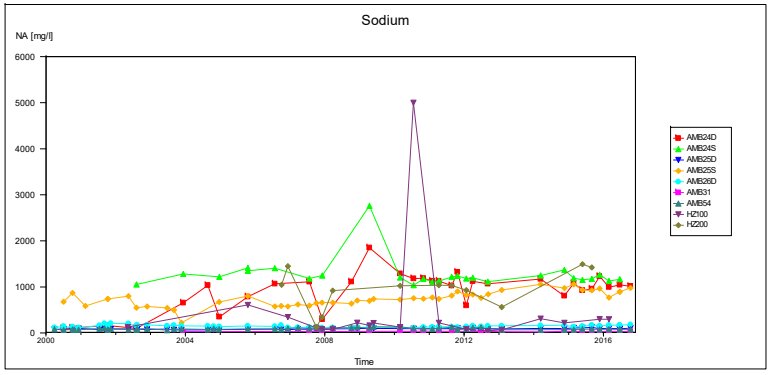


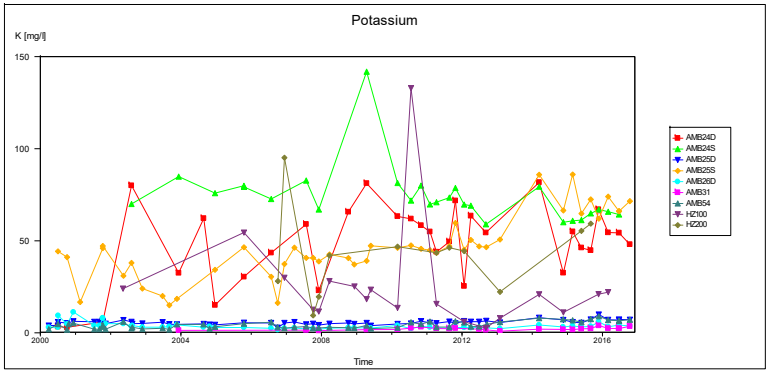


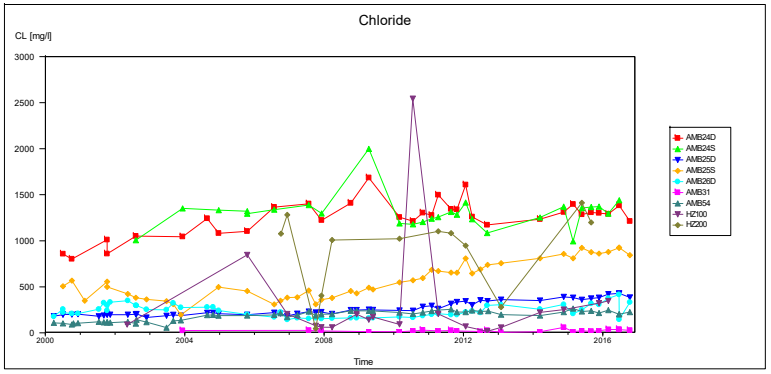









Potassium
K [mg/l]
150
100
50
0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200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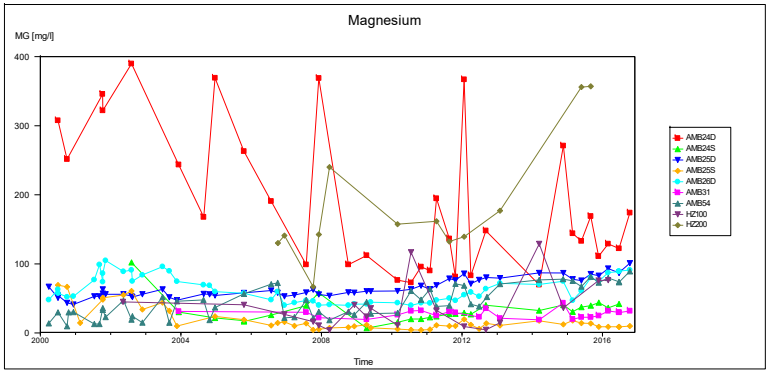
CL [mg/l]
3000
2500
2000
1500
1000
500
0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Magnesium
MG [mg/l]
400
300
200
100
0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
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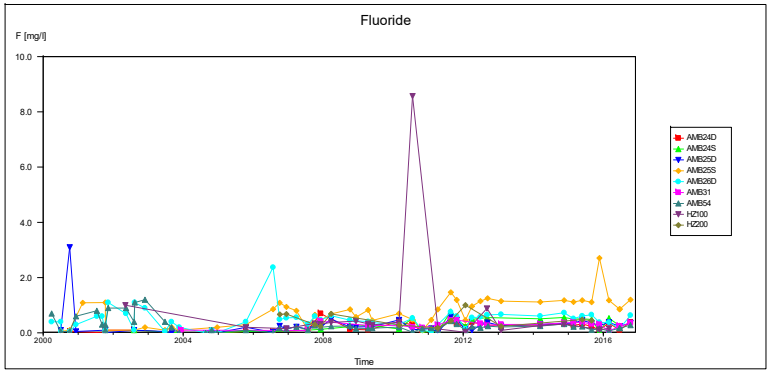
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Fluoride
F [mg/l]
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6.0
4.0
2.0
0.0
2000
2004
2008
2012
2016
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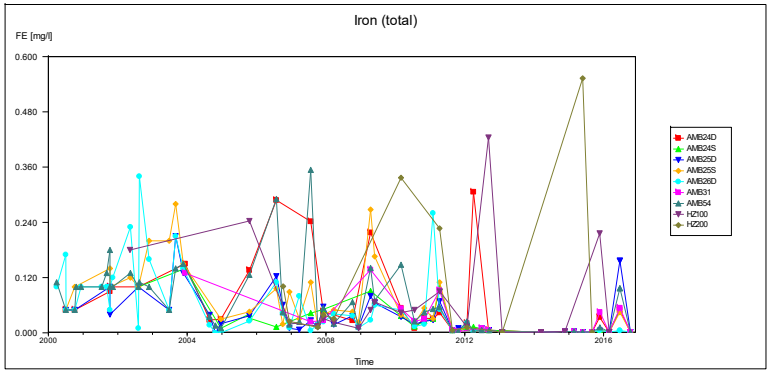
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Iron (total)
FE [mg/l]
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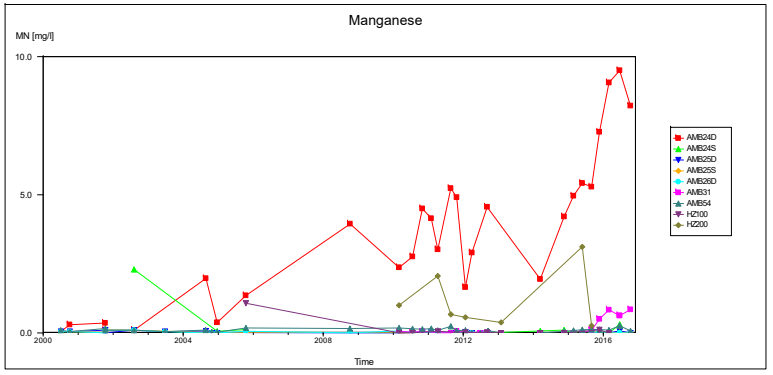
0.480
0.360
0.240
0.120
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Manganese
MN [mg/l]
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5.0
0.0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
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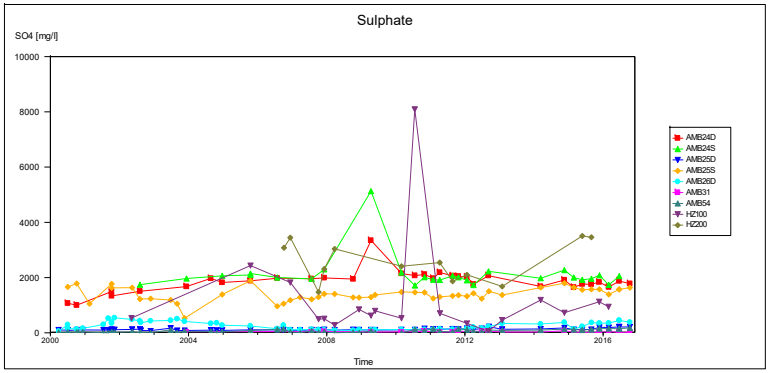
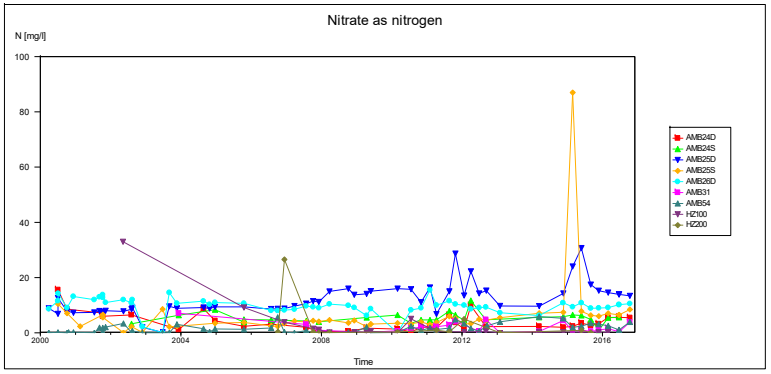
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Sulphate
SO4 [mg/l]
10000
8000
6000
4000
2000
0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Nitrate as nitrogen
N [mg/l]
100
80
60
40
20
0
2000
2004
2008
2012
2016
Time
AMB24D
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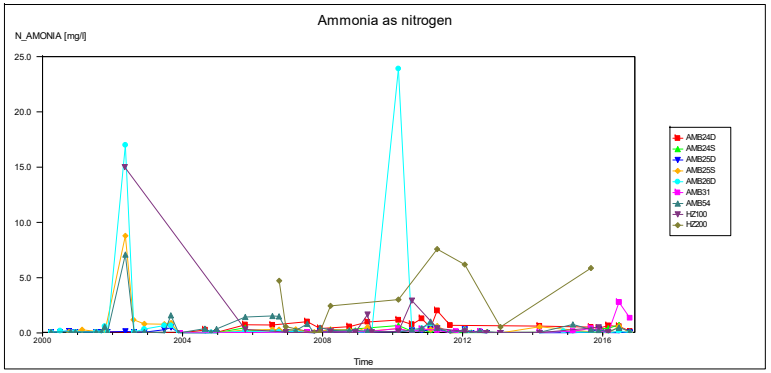
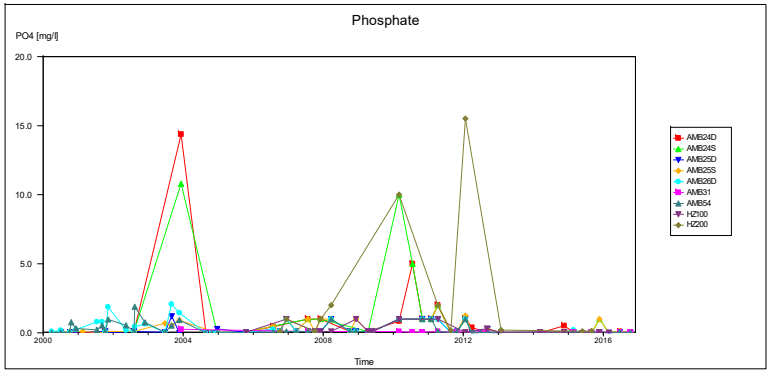
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Ammonia as nitrogen
N_AMONIA [mg/l]
25.0
20.0
15.0
10.0
5.0
0.0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Phosphate
PO4 [mg/l]
20.0
15.0
10.0
5.0
0.0
2000
2004
2008
2012
2016
Time
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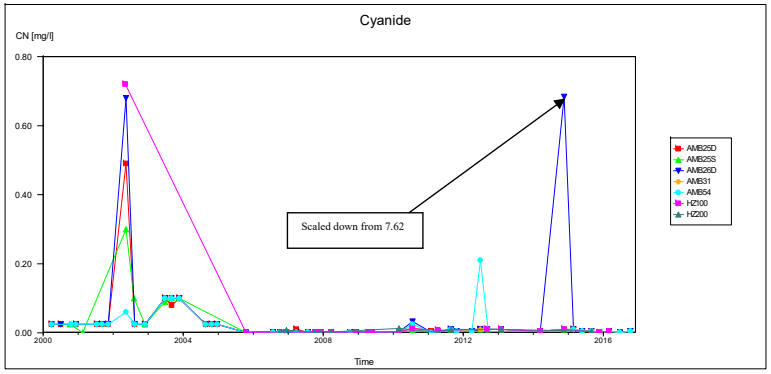
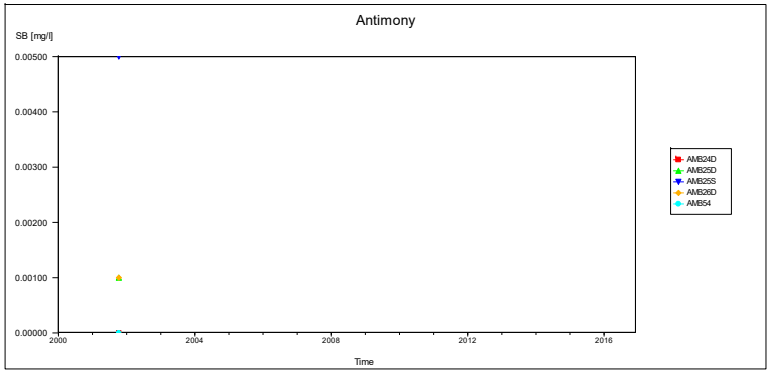
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Cyanide
CN [mg/l]
0.80
0.60
0.40
0.20
0.00
Scaled down from 7.62
2000
2004
2008
2012
2016
Time
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Antimony
SB [mg/l]
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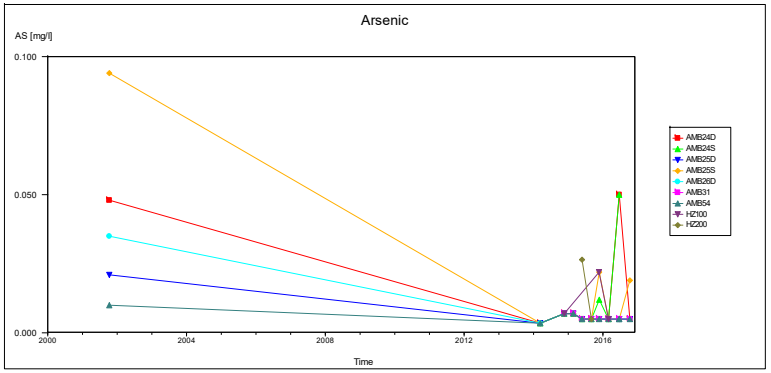
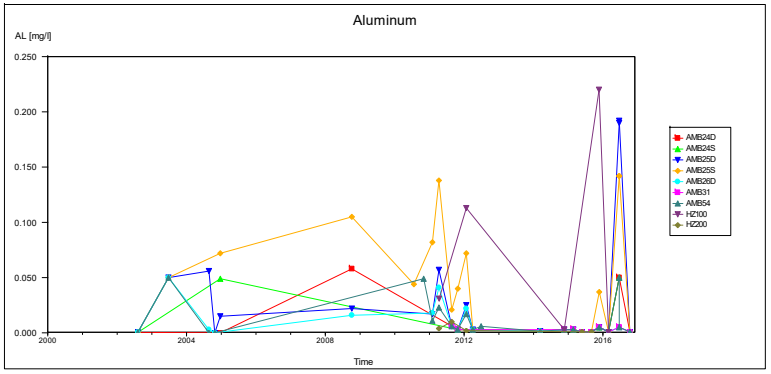
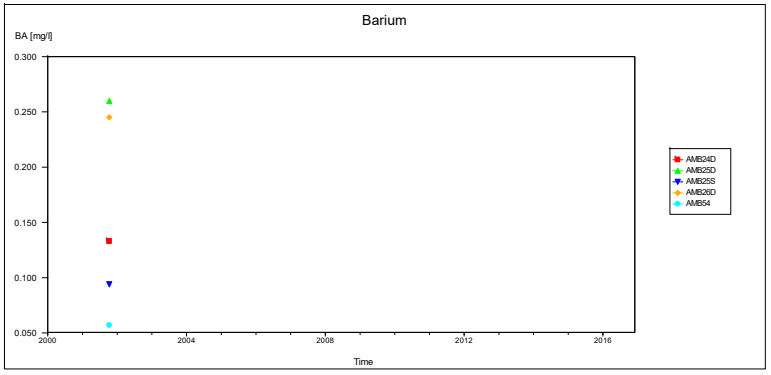
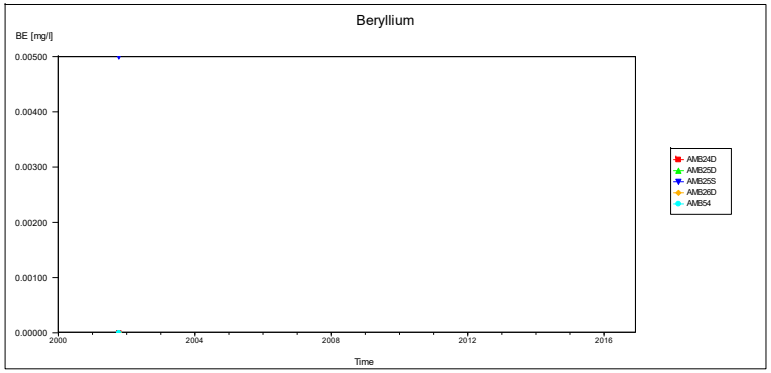
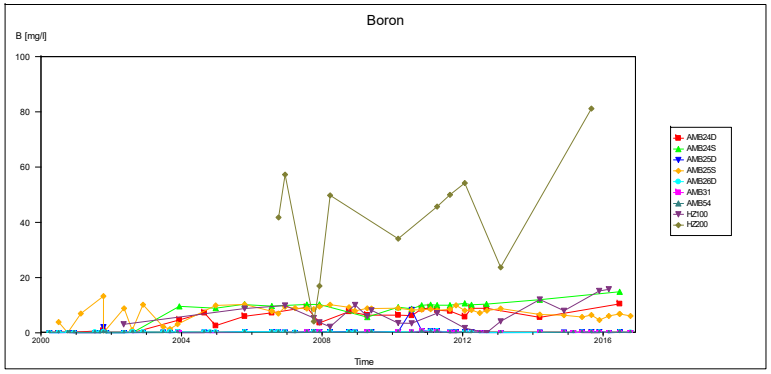
0.00400
0.00300
0.00200
0.00100
0.00000
2000
2004
2008
2012
2016
Time
AMB24D
AMB25D
AMB25S
AMB26D
AMB54

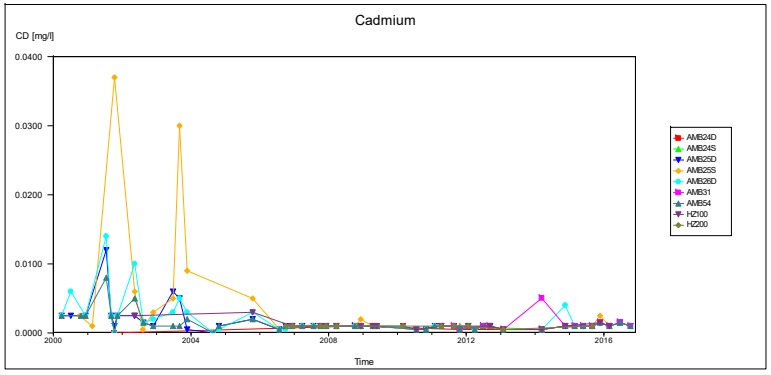

Arsenic
AS [mg/l]
0.100
0.050
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

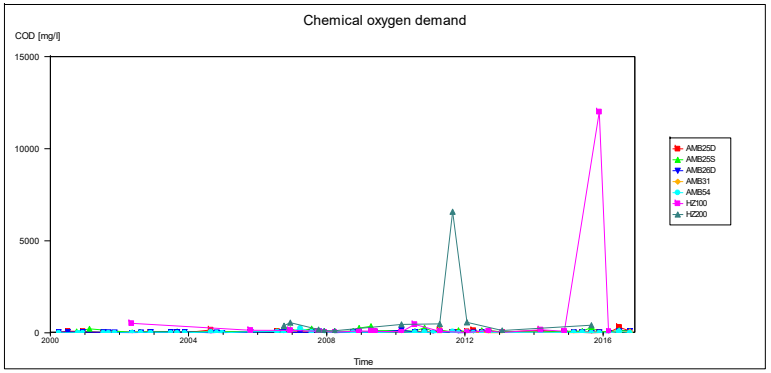

Aluminum
AL [mg/l]
0.250
0.200
0.150
0.100
0.050
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

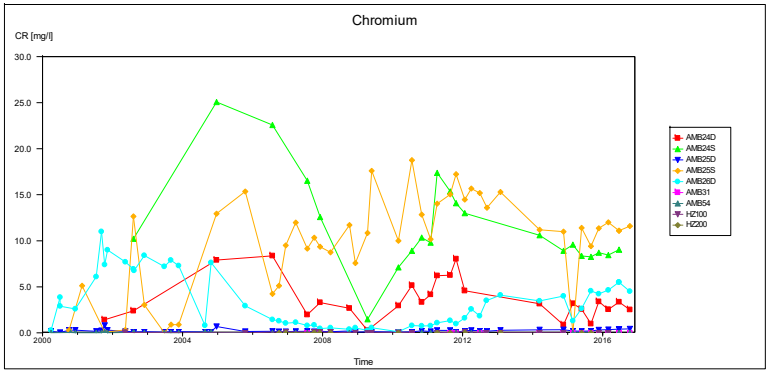

Barium
BA [mg/l]
0.300
0.250
0.200
0.150
0.100
0.050
2000
2004
2008
2012
2016
Time
AMB24D
AMB25D
AMB25S
AMB26D
AMB54

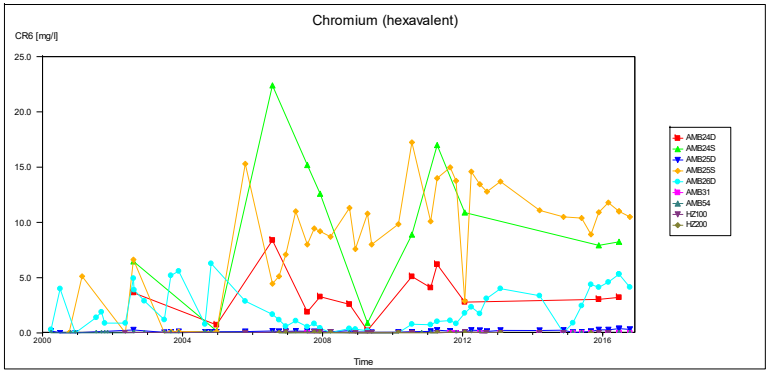

Beryllium
BE [mg/l]
0.00500
0.00400
0.00300
0.00200
0.00100
0.00000
2000
2004
2008
2012
2016
Time
AMB24D
AMB25D
AMB25S
AMB26D
AMB54

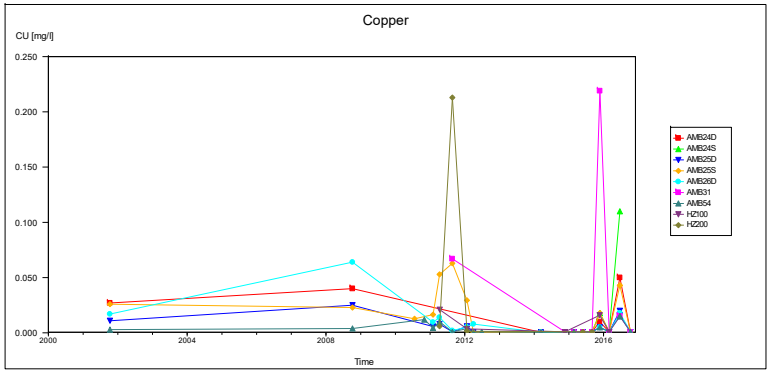

Boron
B [mg/l]
100
80
60
40
20
0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

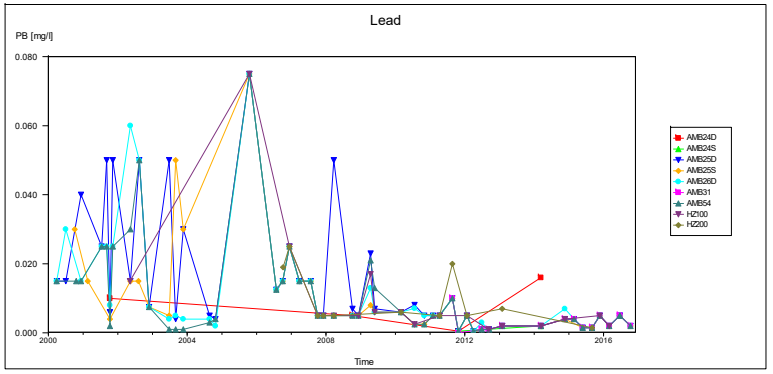

Cadmium
CD [mg/l]
0.0400
0.0300
0.0200
0.0100
0.0000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

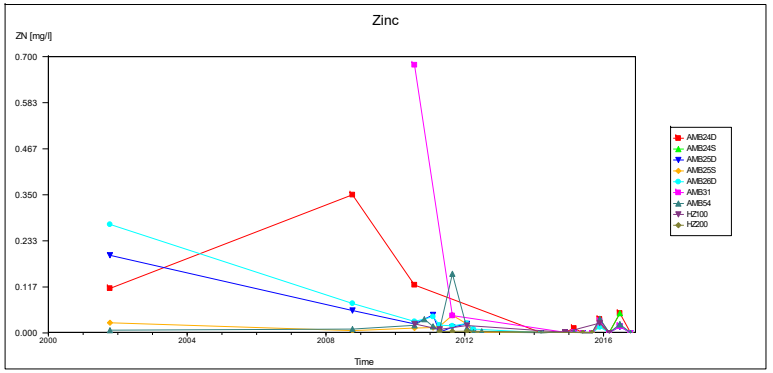

Chemical oxygen demand
COD [mg/l]
15000
10000
5000
0
2000
2004
2008
2012
2016
Time
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

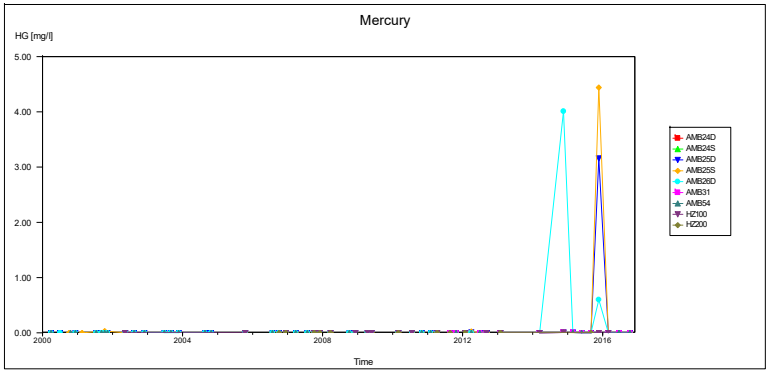

Chromium
CR [mg/l]
30.0
25.0
20.0
15.0
10.0
5.0
0.0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

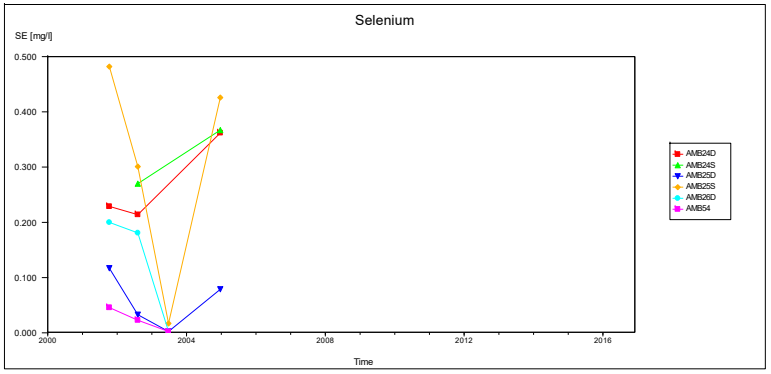

Chromium (hexavalent)
CR6 [mg/l]
25.0
20.0
15.0
10.0
5.0
0.0
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

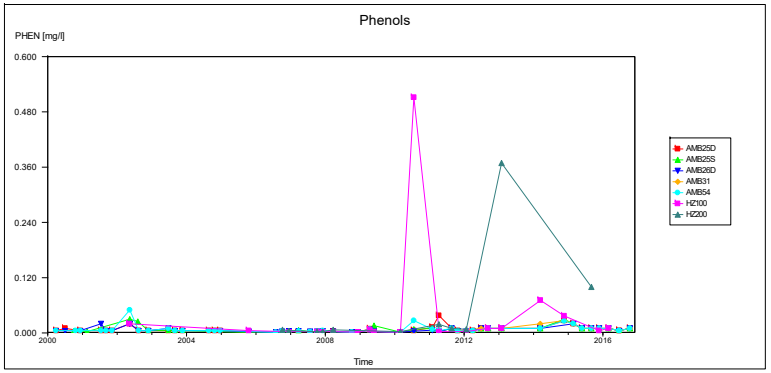

Copper
CU [mg/l]
0.250
0.200
0.150
0.100
0.050
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

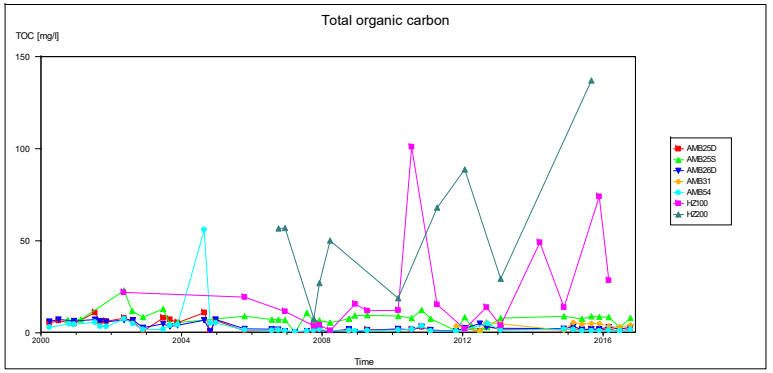

Lead
PB [mg/l]
0.080
0.060
0.040
0.020
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200

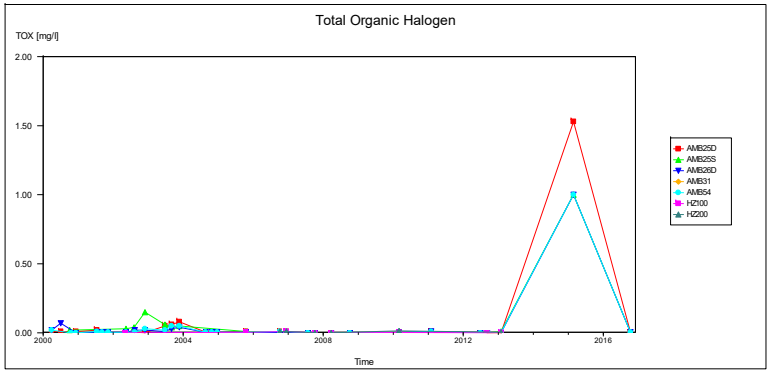

Zinc
ZN [mg/l]
0.700
0.583
0.467
0.350
0.233
0.117
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Mercury
HG [mg/l]
5.00
4.00
3.00
2.00
1.00
0.00
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Selenium
SE [mg/l]
0.500
0.400
0.300
0.200
0.100
0.000
2000
2004
2008
2012
2016
Time
AMB24D
AMB24S
AMB25D
AMB25S
AMB26D
AMB54


Phenols
PHEN [mg/l]
0.600
0.480
0.360
0.240
0.120
0.000
2000
2004
2008
2012
2016
Time
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Total organic carbon
TOC [mg/l]
150
100
50
0
2000
2004
2008
2012
2016
Time
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200


Total Organic Halogen
TOX [mg/l]
2.00
1.50
1.00
0.50
0.00
2000
2004
2008
2012
2016
Time
AMB25D
AMB25S
AMB26D
AMB31
AMB54
HZ100
HZ200