GEO-HYDRO TECHNOLOGIES OFS (Pty) Ltd
(Registration No. 94/05593/07)
t/a

GHT CONSULTING SCIENTISTS

SURFACE-, GROUNDWATER & ENVIRONMENTAL SCIENTISTS

Komati Power Station

ROUTINE MONITORING
NOVEMBER 2012
FINAL REPORT PHASE 49

By

GHT CONSULTING SCIENTISTS

PROJECT TEAM
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13 December 2012 Our ref.: RVN 581.16/1374

Thabo Mogashwa
Komati Power Station
Private Bag
Blinkpan
2250

FOR ATTENTION: Mr Thabo Mogashwa

Dear Sir

It is our pleasure in enclosing three copies of the report RVN 581.16/1374 "KOMATI POWER STATION - ROUTINE MONITORING –November 2012 – Phase 49".

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

Yours sincerely,

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

Copies: 3 (three) hard copies to Komati Power Station.

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APPENDICES

1 INTRODUCTION

1.1 General

Geo-Hydro Technologies (GHT) was commissioned to conduct a complete site assessment, as well as to assess hydro chemical data contained within the water quality database of the now decommissioned Komati Power Station, the data having been collected by laboratory staff as part of a routine monitoring programme. A map showing the localities of all the sites is presented in Appendix A.

The purpose of the site assessment is first of all to report on the current state of the monitoring network, and secondly to identify pollution sources as well as the target areas that may be impacted upon by these sources. This in turn will then be used to identify any inadequacies of the current monitoring network.

1.2 Date and number of the monitoring event

This investigation reports on the site assessment conducted by GHT Consulting Scientists (GHT) on the 14th of November 2012 as well as on the quality of surface water and groundwater at Eskom Komati Power Station as recorded by

A relevant numbering system for these monitoring reports reflecting both the date and the number of the monitoring event were deducted from the number of sample runs undertaken since 1990. This report is consequently numbered as follows November 2012 phase 49.

1.3 Approach to study

This report provides information on the current state of the monitoring system and the various monitoring sites, the water quality characteristics and the observed trends in the groundwater quality over time. Interpretations regarding the surface- and groundwater conditions are made by employing data tables and various graphical interpretation methods. This report contains:

- A description of the site assessment to identify contamination sources and impact zones;
- A description of the current state of the water monitoring system and infrastructure at Komati Power Station to identify any problems that may require attention;

Three different key areas with possible pollution source areas have been identified within the area under investigation, namely:

- The Ashing Area and Domestic Waste Site;
- The Power Station and Coal Stockyard Area;
- The Sewage Plant Area;

These pollution sources impact on groundwater and on two surface drainage regions, namely:

- The Eastern tributary to the KoringSpruit, hence forth called the Komati Spruit;
- The Western tributary to the KoringSpruit, hence forth called the Geluk Spruit;

The monitoring sites at Komati Power Station are classified according to their locations relative to the infrastructure and local natural streams. These three monitoring areas are shown in the location maps of Komati Power Station attached in **Appendix A** and a condensed table containing all the field data and information of the sites is attached in **Appendix B**. The proposed mitigation is shown in **Appendix D.**

2 SITE ASSESSMENT ANDCURRENTSTATE

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 firsthand 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. A detail site assessment has therefore been conducted as a prelude to the future monitoring phases in order to identify sources of contaminants as well as the zones impacted upon by these pollution sources.

2.2 Current state description table

The current states of the various monitoring sites are summarised in a revised site-specific fashion in Table 1 to Table 4. Also included are photographs taken during the site assessment of aspects relevant to the monitoring program. In the tables these photographs are referred to by number at the monitoring site location where the photographs were taken. A locality map indicating the position where these photos were taken is also attached in **Appendix A**.

The current state description tables should assist the Komati Power Station Environmental Department in managing the identified pollution sources and other problems related to the environment.

2.2.1 The Ashing Area

Table 1. Current state and description of the Ashing Area.

Site Information					Response From Previous Phase					Current State Description							Water quality
Area With Possible Env. Hazards	Sites	"Site Description/Objective"	Sample Depth (m)	Sample Type	First Reported	Problem Identified During Previous Phases	Mitigation or Maintenance Proposed During Previous Phase	Actions Taken Since Previous Phase	Rectified Since Previous Phase?	Date	Time	Water level (m) / Flow	Sampled	Photo nr.	Current State Description	Proposed Mitigation	Concentrations exceeded
Ashing Area	AB01	Monitoring borehole north and downstream of old rehabilitated domestic waste site.	15	N		No locknut.	Install locknut	None.	No.	14-Nov-12	18:13	3.11	Y	1	No locknut.	Install locknut	ARS - EC 187 mS/m, ARS - Mg 112 mg/l
	AB04	Monitoring borehole north-west of ash dams and south of dam AP02.	19	N		No locknut & cap	Install locknut & Cap	None.	No.	14-Nov-12	17:05	2.84	Y	2	No locknut & cap	Install locknut & Cap	ARS - S04 536 mg/l
	AB06	Monitoring borehole north and downstream of ash dams.	15	N	ph 48	No locknut.	Install locknut.	None.	No.	14-Nov-12	11:10	1.12	Y	3	No locknut.	Install locknut.	ARS - Mn 0.551 mg/l
	AB07	Monitoring borehole north and downstream of seepage recovery dam AP03.	15	N	ph 48	No locknut.	Install locknut	None.	No.	14-Nov-12	11:58	3.65	Y	4	No locknut.	Install locknut	ARS - S04 808 mg/l ARS - Mn 2.220 mg/l
	AB47	Monitoring borehole close to Komati Spruit ,west of power station.	9	N	ph 49	Satisfactory.				14-Nov-12	13:30		N	5	Cap rusted stuck	Fix cap	
	AB53	New Deep monitoring borehole Ash Area, west of ash dam below dam PD04. In town area	15	N		Satisfactory.				14-Nov-12	16:10	02:52	Y	6	Satisfactory.		
	AB54	New Shallow monitoring borehole Ash Area. west of ash dam below dam PD04, next to AB53	4	N		Satisfactory.				14-Nov-12	10:40	2.9	Y	7	Satisfactory.		

Ashing Area	AB55	New Deep monitoring borehole Ash Area. North of ash dam. Next to tar road at Entrance road to PS	15	N		Satisfactory.				14-Nov-12	10:11	7.07	Y	8	Satisfactory.		
	AB56	New Shallow monitoring borehole Ash Area. North of ash dam. Next to tar road at Entrance road to PS	4	N		Satisfactory				14-Nov-12	10:22	2	Y	9	Satisfactory		
	AB57	New monitoring borehole Ash Area. west of ash dam below dam PD04. Close to entrance gate to ash dam from the town area.	15	N		Satisfactory.				14-Nov-12	17:58	4.44	Y	10	Satisfactory.		
	AB58	New monitoring borehole Ash Area. South of ash dam. T junction - Witbank road.	15	N		Satisfactory.				14-Nov-12	08:07	9.53	Y	11	Satisfactory.		
	AB59	New Shallow monitoring borehole Ash Area South of ash dam. T junction - Witbank road.	6	N		Satisfactory.				14-Nov-12	09:08	5.43	Y	12	Satisfactory.		
	AB61	New Deep monitoring borehole Ash Area. East of ash dam. Next to Middelburg road.	15	N		Satisfactory.				14-Nov-12	09:05	Art	Y	13	Satisfactory.		
	AB62	New Shallow monitoring borehole Ash Area. East of ash dam. Next to Middelburg road.	4	N		Satisfactory.				14-Nov-12	09:11	1.45	Y	14	Satisfactory.		
	AB63	New monitoring borehole Ash Area. South west of ash dam. Below farmers land.	15	N		Satisfactory.				14-Nov-12	17:50	3.12	Y	15	No marker post.	Install marker post	
Ashing Area	*AC01	Clean water cut off canal between ash dam and old rehabilitated waste site	~	N		Overgrown.	Clear vegetation.	None.	No.	14-Nov-12	18:35	Dry	N	16	Overgrown.	Clear vegetation.	
	*AC02	Marshy area south of new ash water return dam AP08	~	N		Satisfactory.				14-Nov-12	16:38	Low	Y		Overgrown.	Clear vegetation.	
	AC03	Dirty ash water return canal on eastern side of ash dam.	~	N	Ph 43	Satisfactory. Overgrown	Clear vegetation.	None.	No.	14-Nov-12	18:30	Low	Y	17	Satisfactory. Overgrown	Clear vegetation.	
	*AC04	Clean water canal north-eastern corner of ash dam. Sample at culvert underneath sealed road.	~	N	Ph 43	Rubble close to canal.	Remove rubble.	None.	No.	14-Nov-12	10:15	Low Stagnant	Y		Rubble close to canal.	Remove rubble.	
	AC05	Dirty water canal north of ash dam. Sample at culvert underneath sealed road.	~	N		Satisfactory.				14-Nov-12	11:16	Low Stagnant	Y		Rubble close to canal.	Remove rubble.	ARS - EC 208 mS/m, ARS - Na 270 mg/l ARS - S04 872 mg/l ARS - F 1.6 mg/l

Ashing Area	*AC09	Small canal running parallel with new ash transfer pipes. Sample at culvert underneath sealed road.	~	N		Satisfactory.				14-Nov-12	18:44	Dry	N		Satisfactory.		
	AP01	Pool areas and dams on top of north-western part of ash dams.	~	V		Satisfactory.				14-Nov-12	18:40	Low	N	18	Satisfactory.		
	*AP02	Clean water dam where Komati Spruit originates west of ash water return dam.	~	N		Satisfactory.				14-Nov-12	17:30	Low	Y	19	Satisfactory.		ARS - EC 262 mS/m, ARS - Na 253 mg/l ARS - Mg 114 mg/l ARS - S04 1544 mg/l
	AP03	Seepage recovery dam north of ash dam complex & east of power station.	~	N	Ph 43	Satisfactory. Overgrown	Clear vegetation.	None.	No.	14-Nov-12	11:30	Full	Y	20	Satisfactory. Overgrown	Clear vegetation.	ARS - Mn 0.806 mg/l
	AP08	New ash water return dam.	~	V		Satisfactory.				14-Nov-12	18:40	Low	N		Satisfactory.		

ARS - Above recommended standard limit

Recommended standard limit

Photo 1. AB01

Photo 2. AB04

Photo 3. AB06

Photo 4. AB07

Photo 5. AB47

Photo 6. AB53

Photo 7. AB54

Photo 8. AB55

Photo 9. AB56

Photo 10. AB57

Photo 11. AB58

Photo 12. AB59

Photo 13. AB61

Photo 14. AB62

Photo 15. AB63

Photo 16. AC01

Photo 17. AC03

Photo 18. AP01

Photo 19. AP02

Photo 20. AP03

2.2.2 Coal Stockyard Area

Table 2. Current state and description of the Coal Stockyard Area.

Site Information					Response From Previous Phase					Current State Description							Water quality
Area With Possible Env. Hazards	Sites	"Site Description/Objective"	Sample Depth (m)	Sample Type	First Reported	Problem Identified During Previous Phases	Mitigation or Maintenance Proposed During Previous Phase	Actions Taken Since Previous Phase	Rectified Since Previous Phase?	Date	Time	Water level (m) / Flow	Sampled	Photo nr.	Current State Description	Proposed Mitigation	Concentrations exceeded
Coal Stockyard Area	CB49	Deep borehole west of Coal stockyard.	25	N		Satisfactory.				14-Nov-12	13:50	23.51	Y	21	Satisfactory.		ARS - F 2.6 mg/l
	CB50	Shallow borehole west of Coal stockyard.	10	N		Satisfactory.				14-Nov-12	14:20	8.53	Y	22	Satisfactory.		
	CB51	New monitoring borehole Coal Stockyard Area	12	N		Satisfactory.				14-Nov-12	13:11	4.20	Y	23	Satisfactory.		ARS - Mn 1.24 mg/l
	CB52	New monitoring borehole Coal Stockyard Area	20	N		Satisfactory.				14-Nov-12	14:58	9.85	Y	24	Satisfactory.		
	CC07	Coal stockyard dirty water run-off canal. Sample at security fence.	~	N	Ph 43	Silted with coal.	The canal must be cleaned to prevent overflows into the environment.	None.	No.	14-Nov-12	13:15	Low	Y	25	Silted with coal.	The canal must be cleaned to prevent overflows into the environment.	
	CP06	Coal stockyard settling pond and dirty water run-off dam.	~	V	PH 43	Satisfactory.	Arrange access when necessary	None.	No.	14-Nov-12	13:12	Low	N		Satisfactory.	Arrange access when necessary	
	CP07	Old coal stockyard settling and dirty water run-off dam.	~	N		Satisfactory.				14-Nov-12	13:13		N		Satisfactory.		

ARS - Above recommended standard limit

Recommended standard limit

Photo 21. CB49

Photo 22. CB50

Photo 23. CB51

Photo 24. CB52

Photo 25. CC07

2.2.3 Power Station and Sewage Plant Area

Table 3. Current state and description of the Power Station and Sewage plant area.

Site Information					Response From Previous Phase					Current State Description							Water quality
Area With Possible Env. Hazards	Sites	"Site Description/Objective"	Sample Depth (m)	Sample Type	First Reported	Problem Identified During Previous Phases	Mitigation or Maintenance Proposed During Previous Phase	Actions Taken Since Previous Phase	Rectified Since Previous Phase?	Date	Time	Water level (m) / Flow	Sampled	Photo nr.	Current State Description	Proposed Mitigation	Concentrations exceeded
Power Station Area	PB08	Monitoring borehole north and downstream of power station dirty water dams PP05.	13	N&H		Satisfactory.				14-Nov-12	12:55	4.04	Y	26	Satisfactory.		
	PB48	Monitoring borehole north of sewage plant	9	N&B		Satisfactory.				14-Nov-12	15:38	1.78	Y	27	Satisfactory.		
	PB60	New monitoring borehole Power Station Area	15	N & H		Satisfactory.				14-Nov-12	12:25	3.23	Y	28	Satisfactory.		
	*PC06	North-eastern power station clean water run-off outlet.	~	N		Satisfactory.				14-Nov-12	12:40	Low	Y		Satisfactory.		ARS - EC 185 mS/m, ARS - S04 845 mg/l
	*PC08	South-western power station clean water run-off outlet. Sample at culvert underneath sealed road.	~	N		Satisfactory.				14-Nov-12	16:05	Low Slow	Y		Satisfactory.		ARS - Mn 1.8 mg/l
	PE01	Purified sewage effluent discharge into natural dam.	~	N&B		No fence.		None.	No.	14-Nov-12	15:50	Low	Y		inadequate fence.	Sewage plant fence must be repaired.	ARS - NH4 8.8 mg/l ARS - N02 2 mg/l Bacteriological parameters to high
	PP04	Raw water dam east of Bethel Middelburg road.	~	V		Satisfactory.				14-Nov-12	10:10	Mod	N		Satisfactory.		
	PP05	Power station dirty water dams and oil skimmers north of power station.	~	N&H		Satisfactory.				14-Nov-12	13:20	Low	Y		Satisfactory.		ARS - S04 638 mg/l

ARS - Above recommended standard limit

Recommended standard limit

Photo 26. PB08

Photo 27. PB48

Photo 28. PB60

2.2.4 The GelukSpruit Area, the Komati Spruit Area and the KoringSpruit Area

Table 4. Current state and description of the GelukSpruit Area, the Komati Spruit Area and the KoringSpruit Area.

Site Information					Response From Previous Phase					Current State Description							Water quality
Area With Possible Env. Hazards	Sites	"Site Description/Objective"	Sample Depth (m)	Sample Type	First Reported	Problem Identified During Previous Phases	Mitigation or Maintenance Proposed During Previous Phase	Actions Taken Since Previous Phase	Rectified Since Previous Phase?	Date	Time	Water level (m) / Flow	Sampled	Photo nr.	Current State Description	Proposed Mitigation	Concentrations exceeded
Gluck Spruit Area	*GLR03	Gluck Spruit. Sample at culvert underneath sealed Bethel Middelburg road.		N		Satisfactory.				14-Nov-12	18:50	Full	Y	29	Satisfactory.		
	*GLR04	Gluck Spruit. Sample at culvert underneath conveyer.		N		Satisfactory.				14-Nov-12	13:18	Low	Y		Satisfactory.		ARS - Mn 2.1 mg/l
Komati Spruit Area	*KMR01	Komati Spruit downstream form dam AP02. Sample at culvert underneath sealed road.		N		Satisfactory.				14-Nov-12	15:08	Dry	N	30	Satisfactory.		
	*KMR02	Komati Spruit downstream form dam KMR01. Sample at culvert underneath sealed road.		N&B		The bacterial activity at these sites is an indication that inadequate treatment is taking place.	The sewage water/effluent must be treated properly.	None.	No.	14-Nov-12	13:38	Low	Y	31	The bacterial activity at these sites is an indication that inadequate treatment is taking place.	The sewage water/effluent must be treated properly.	Bacteriological parameters to high
	*KMR07	Komati Spruit downstream form dam KMR02 and dam receiving purified sewage effluent. Sample at culvert underneath dirt road.		N&B		The bacterial activity at these sites is an indication that inadequate treatment is taking place.	The sewage water/effluent must be treated properly.	None.	No.	14-Nov-12	15:40	Low Slow	Y		The bacterial activity at these sites is an indication that inadequate treatment is taking place.	The sewage water/effluent must be treated properly.	ARS - NH4 9.7 mg/l Bacteriological parameters to high
Koring Spruit Area	*KRR05	Koring Spruit upstream of power generation activities. Sample at culvert underneath sealed Bethel Middelburg road.		N		Satisfactory.				14-Nov-12	18:55	Dry	N		Satisfactory.		
	*KRR06	Koring Spruit downstream of KRR05. Sample at culvert underneath sealed road.		N		Satisfactory.				14-Nov-12	19:02	Low	Y		Satisfactory.		ARS - S04 597 mg/l

ARS - Above recommended standard limit

Recommended standard limit

Photo 29. GLR03

Photo 30. KMR01

Photo 31. KMR02

3 GROUNDWATER LEVELS

In this chapter observations regarding the temporal trends in the 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.

3.1 Ashing Area

The fluctuations in the groundwater levels in metres below ground level (mbgl) that have been observed are shown in Figure 1.

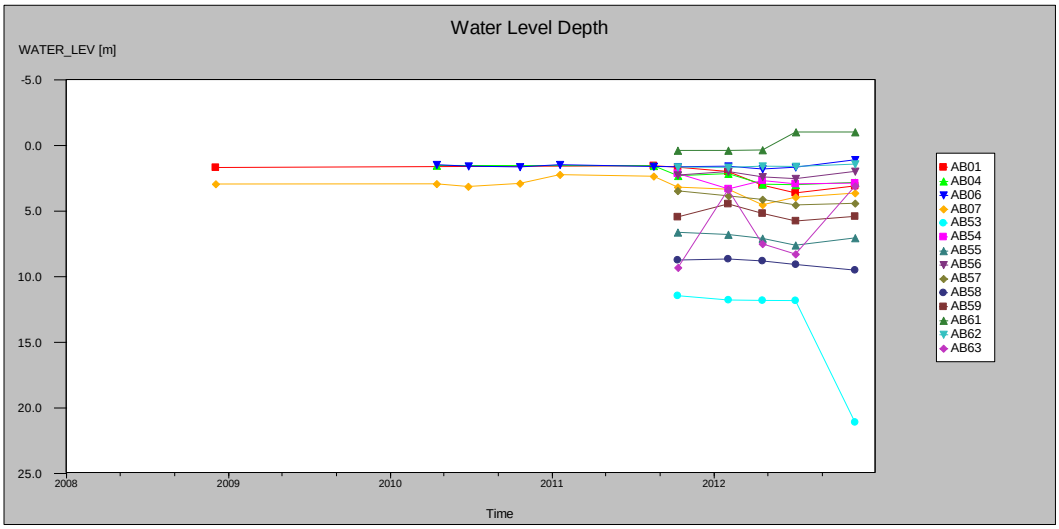

Figure 1. Groundwater depths in mbgl observed in the boreholes of the Ashing Area.

3.2 Power Station

The fluctuations in the groundwater levels (in mbgl) that have been observed are shown in Figure 2.

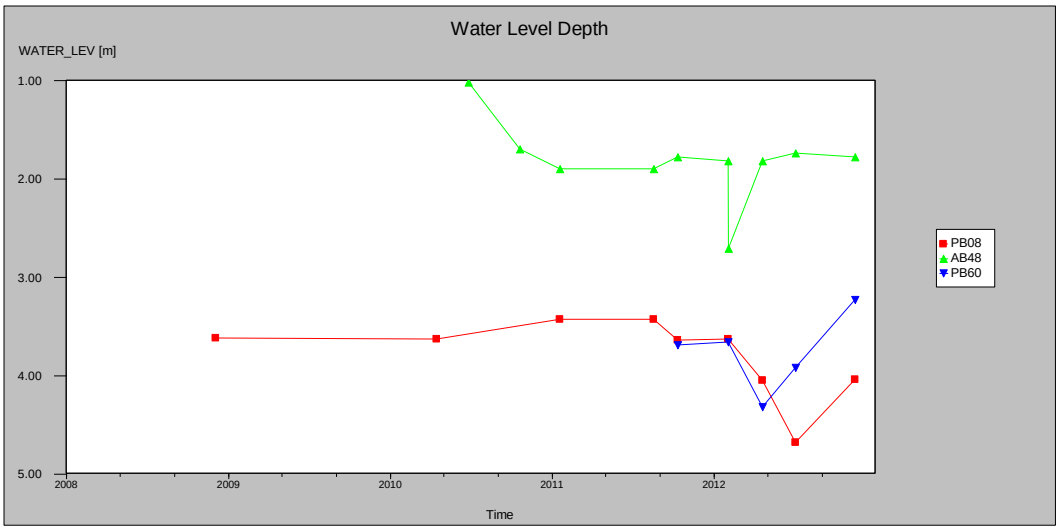

Figure 2. Groundwater depths in mbgl observed in the boreholes of the Power Station Area.

3.3 Coal Stockyard Area

The fluctuations in the groundwater levels (in mbgl) that have been observed are shown in Figure.

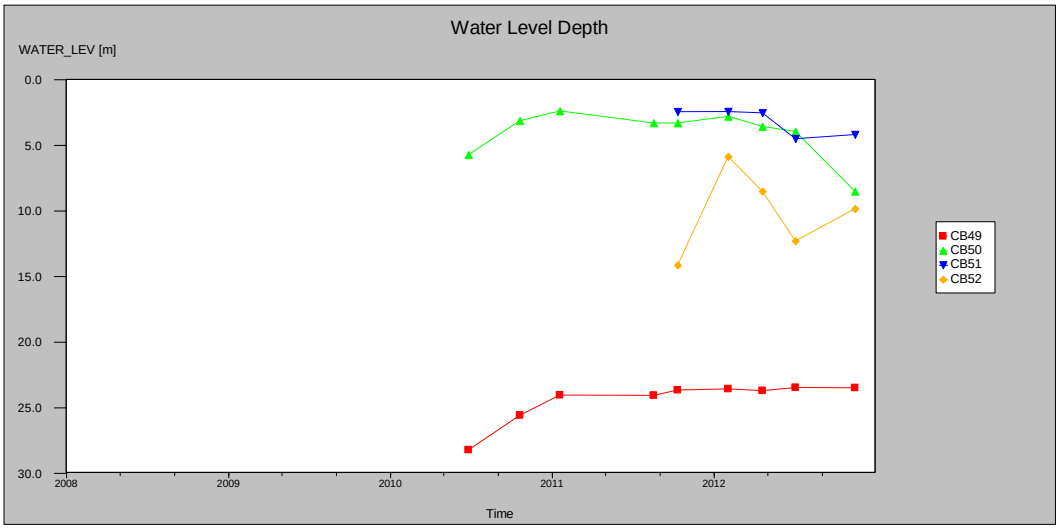

Figure 3. Groundwater depths in mbgl observed in the boreholes of the Coal Stockyard Area.

Discussion and Recommendations

Groundwater levels should be recorded on a monthly basis and forwarded to GHT Consulting for water level evaluation.

Ashing Area

The groundwater depths at the borehole of the ashing area show mostly stable table trends except at borehole AB53 and AB63. The increasing trend at AB53 is possibly due to a human error. AB63 has a decreasing trend.

Power Station Area

Decreasing trends is observed at the groundwater depth of most of the boreholes PB08 and PB60.

Coal Stockyard Area

Stable trends are observed at the groundwater depth of most of the borehole except at borehole CB52 and CB50. Decreasing trend is observed at borehole CB52 and an increasing trend is observed at CB50.

4 SURFACE- AND GROUNDWATER QUALITY – INORGANIC PARAMETERS

The results of the analyses (as obtained from the submitted database) are presented in this section by various graphical means and observations regarding the contamination status of the surface- and groundwater are made.

Although the concentrations of more than 17 inorganic chemical parameters in the water samples were determined during the chemical analyses, only eight parameters are used as indicators of contamination in the monitoring of the pollution potential in this system. These eight parameters are: the **pH**, the electrical conductivity (**EC**), the major ions **Ca, Na**, **Cl**, **SO_4, K** and **Mg**. The suitability of these parameters to act as *indicator elements* in the evaluation of water contamination was determined by GHT during previous investigations and reports. The additional information on the concentrations of the other elements is required to evaluate the accuracy and reliability of the chemical analyses.

4.1 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.

4.2 Chemical Data Presentation Formats

The results of the inorganic chemical analyses are presented in various formats in this report. These formats include Data Tables, MMAC plots and Time Graphs. 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.

4.2.1 Data Tables and Water Quality Tables

Data Tables

The results of all the inorganic chemical analyses that have been performed on water samples from Komati 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 **Appendix C**.

Water Quality Tables

In this tables the water samples from each monitoring site are classified according to the "South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWAF, First Edition 1993" and the "South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWAF, Second Edition 1996", as well as according to the publication "Quality of Domestic Water Supplies, DWAF, Second Edition 1998" as well as "SABS South African National Standard: Drinking water SANS 241-2:2011 Edition 1 and SANS 241:2006 Edition 6.1"according to the publication a description of the various classes is given in. Table 5

Table 5. Classification system used to evaluate water quality classes.

1998 Quality of Domestic Water Supplies, DWA&F, Second Edition 1998

Class 0	**- Ideal water quality** - Suitable for lifetime use.
Class 1	**- Good water quality** - Suitable for use, rare instances of negative effects.
Class 2	**- Marginal water quality** - Conditionally acceptable. Negative effects may occur in some sensitive groups
Class 3	**- Poor water quality** - Unsuitable for use without treatment. Chronic effects may occur.
Class 4	**- Dangerous water quality** - Totally unsuitable for use. Acute effects may occur.

2011 SABS South Africa National Standard: Drinking Water, SANS 241-2:2011 Edition 1

Class 1	**- Recommended standard limit** - Suitable for lifetime use.
ARS	**- Above recommended standard limit** - Unsuitable for lifetime human consumption.

2006 SABS South Africa National Standard: Drinking Water, SANS 241:2006 Edition 6.1

Class 1	**- Recommended operational limit** - Suitable for lifetime use.
Class 2	**- Maximum allowable limit** - Suitable for limited duration use only.
AMA	**- Above maximum allowable limit** - Unsuitable for human consumption.

*** (Ae) - Aesthetic standards.**

1993,1996 South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWA&F, First Edition 1993 & Second Edition 1996

NR	**- Target water quality range** - No risk.
IR	**- Good water quality** - Insignificant risk. Suitable for use, rare instances of negative effects.
LR	**- Marginal water quality** - Allowable low risk. Negative effects may occur in some sensitive groups
HR	**- Poor water quality** - Unsuitable for use without treatment. Chronic effects may occur.

4.3 Evaluation of Surface- and Groundwater Quality – Inorganic parameters

In this section the results of the chemical analyses of the water samples taken during the current monitoring phase is discussed and related to the results of previous monitoring phases. At the time of the latest sampling event, most of the streams at Komati Power Station were characterized by stagnant water. It is therefore fair to assume that the dilution effect of continuous stream flow was negligibly small during the months preceding the sampling event.

Table 6. Water Quality Table.

Site No.	Quality Class	pH	EC mS/m	Na mg/L	Ca mg/L	Mg mg/L	K mg/L	Cl mg/L	SO4 mg/L	F mg/L	NO_2-N mg/L	NO_3-N mg/L	Fe mg/L	Mn mg/L	NH_4-N (Ae) mg/L	Cr mg/L	B mg/L	MALK mg/L	Anion meq/l	Cation meq/l	Ionbal %
Reference Standard:	2011	2011	2011	2011	2006	2006	2006	2011	2011	2011	2011	2011	2011	2011	2011	2011	1993,1996				
AB01	ARS	7.3	187	198	154	112	25	81	499	0.351		0.0	0.003	0.365		0.001	0.003	728	27.25	26.16	-2.050
AB04	ARS	8.0	147	111	111	117	15	60	536	0.448		0.1	0.003	0.371		0.001	0.010	371	20.30	20.38	0.210
AB06	ARS	7.7	67	61	46	29	5	40	141	0.217		0.1	0.003	0.551		0.001	0.003	155	7.18	7.46	1.950
AB07	ARS	7.1	168	143	133	126	8	61	808	0.246		0.2	0.003	2.220		0.001	0.003	163	21.82	23.51	3.740
AB53	Class 1	8.4	27	14	24	12	6	18	2	0.364		0.2	0.003	0.035		0.001	0.008	133	3.24	2.99	-3.930
AB54	Class 1	9.3	66	115	5	17	6	99	1	0.356		0.2	0.003	0.004		0.001	0.003	195	6.74	6.82	0.580
AB55	Class 1	8.8	45	43	18	23	4	21	84	0.291		1.3	0.003	0.014		0.001	0.004	120	4.85	4.77	-0.840
AB56	Class 1	7.4	25	31	9	7	2	25	1	0.801		0.3	0.003	0.070		0.001	0.003	96	2.70	2.45	-4.930
AB57	Class 1	8.1	36	23	33	14	7	5	0	0.158		0.1	0.003	0.057		0.001	0.003	201	4.17	4.00	-2.070
AB58	Class 1	8.9	19	19	9	5	9	3	0	0.205		0.1	0.003	0.001		0.001	0.003	100	2.11	1.94	-4.370
AB59	Class 1	9.2	18	13	10	8	8	4	0	0.220		0.2	0.003	0.002		0.001	0.003	92	1.98	1.95	-0.970
AB61	Class 1	8.0	34	15	33	16	5	10	3	0.172		0.1	0.003	0.021		0.001	0.003	171	3.80	3.81	0.140
AB62	Class 1	9.3	52	61	11	25	8	51	62	0.227		0.1	0.003	0.014		0.001	0.003	134	5.43	5.42	-0.110
AB63	Class 1	7.8	25	17	15	12	6	16	13	0.122		5.3	0.003	0.011		0.001	0.003	80	2.71	2.57	-2.690
AC02	Class 1	7.8	110	125	108	5	40	57	383	0.204		0.0	0.003	0.096		0.001	0.735	124	12.08	12.27	0.800
AC03	Class 1	9.0	115	97	145	3	38	65	461	0.124		0.1	0.003	0.001		0.001	0.530	51	12.45	12.69	0.980
AC04	Class 1	7.4	81	67	67	33	9	48	235	0.206		0.2	0.003	0.205		0.001	0.027	128	8.82	9.24	2.300
AC05	ARS	7.9	208	270	149	91	28	148	872	1.600		0.2	0.003	0.006		0.001	0.036	135	25.13	27.39	4.310
AP02	ARS	7.0	262	253	329	114	42	122	1544	1.170		0.1	0.003	0.007		0.001	0.729	26	36.18	37.87	2.290
AP03	ARS	7.7	115	98	178	11	25	68	293	0.889		0.0	0.003	0.805		0.001	0.123	266	13.39	14.72	4.740
CB49	ARS	8.0	40	54	18	13	2	23	0	2.600		0.1	0.003	0.034		0.001	0.160	195	4.68	4.37	-3.470
CB50	Class 1	6.9	29	19	25	14	2	10	49	0.141		0.3	0.003	0.126		0.001	0.003	98	3.29	3.26	-0.500
CB51	ARS	7.7	76	51	64	48	0	22	115	0.591		0.1	0.003	1.240		0.001	0.044	285	8.75	9.41	3.660
CB52	Class 1	7.7	80	74	69	32	5	56	134	1.120		0.1	0.003	0.175		0.001	0.003	230	9.05	9.43	2.080
CC07	Class 1	7.6	144	94	148	79	40	60	493	1.110		0.1	0.003	0.006		0.001	0.003	277	17.55	19.00	3.960

Site No.	Quality Class	pH	EC mS/m	Na mg/L	Ca mg/L	Mg mg/L	K mg/L	Cl mg/L	SO4 mg/L	F mg/L	NO_2-N mg/L	NO_3-N mg/L	Fe mg/L	Mn mg/L	NH_4-N (Ae) mg/L	Cr mg/L	B mg/L	MALK mg/L	Anion meq/l	Cation meq/l	Ionbal %
Reference Standard:	**2011**	**2011**	**2011**	**2011**	**2006**	**2006**	**2006**	**2011**	**2011**	**2011**	**2011**	**2011**	**2011**	**2011**	**2011**	**2011**	**1993,1996**				
PB08	Class 1	7.2	86	129	40	25	3	63	157	0.684		0.3	0.003	0.271		0.001	0.021	222	9.53	9.72	0.970
PB48	Class 1	7.9	120	170	60	51	4	94	1	0.352	0.1	0.1	0.003	0.071	0.0	0.001	0.003	664	15.98	14.71	4.140
PB60	Class 1	8.2	50	55	26	23	4	29	13	0.498		0.2	0.003	0.164		0.001	0.005	238	5.88	5.63	2.170
PC06	ARS	7.8	185	146	201	92	11	71	845	0.564		0.0	0.003	0.003		0.001	0.117	246	24.56	24.23	0.660
PC08	ARS	7.4	69	14	113	27	3	6	106	0.592		0.2	0.003	1.800		0.001	0.021	273	7.89	8.60	4.260
PE01	ARS	7.4	54	53	24	12	11	54	61	0.311	2.0	2.1	0.003	0.008	8.8	0.001	0.014	121	5.38	4.80	5.680
PP05	ARS	7.9	149	96	115	90	29	93	638	1.450		4.1	0.003	0.003				77	17.82	18.06	0.670
GLR03	Class 1	7.0	23	9	19	8	8	10	51	0.727		0.5	0.003	0.005		0.001	0.003	40	2.22	2.23	0.220
GLR04	ARS	6.2	147	15	227	70	16	15	801	0.367		0.0	0.015	1.930		0.001	0.025	6			
KRR06	ARS	7.8	123	31	149	99	4	10	597	0.521		0.0	0.003	0.028		0.001	0.044	142	15.58	17.02	4.440
KMR02	Class 1	7.7	41	40	30	17	0	16	30	0.690	0.0	0.0	0.003	0.014	0.0	0.001	0.003	178	4.67	4.69	0.200
KMR07	ARS	7.3	49	35	27	13	7	31	72	0.309	0.0	0.1	0.003	0.012	9.7	0.001	0.015	122	4.83	4.17	7.420

4.3.1 Water Quality Tables - Petroleum hydrocarbon parameters

During the last monitoring phases water samples from three monitoring sites were taken and submitted to a recognised laboratory for petroleum hydrocarbon analyses. The samples were taken at sites PB08, PB60 and PP05. The results of the hydrocarbon analyses are presented in Table 7.

Table 7.Results of the petroleum hydrocarbon analyses.

Site	PB08	PB60	PP05
Total Hydrocarbons	0	0	0
Ethanol	0	0	0
Benzene	0	0	0
TAME	0	0	0
Toluene	0	0	0
Ethylbenzene	0	0	0
o-Xylene	0	0	0
m+p-Xylene	0	0	0
Naphtalene	0	0	0

All values in mg/L

4.3.2 Water Quality Tables - Bacteriological parameters

During the last monitoring phase, four water samples were taken and submitted for bacteriological analyses to the Institute for Groundwater Studies in Bloemfontein. The samples were taken at site PB48 (borehole next sewage plant), PE01 (final effluent discharged into 'n natural dam) KMR02 (Komati Spruit downstream form dam KMR01) and KMR07 (Komati Spruit downstream form dam KMR02 and dam receiving purified sewage effluent). The results of the analyses are listed in Table 8 and colour coded according to the system presented in Table 8 while the standards of the Department of Water Affairs (DWA) for bacterial activity in water are presented in Table 9.

Table 8.Bacteriological analyses results.

No.	Class	E. Coli count/100ml	Heterotrophic plate count count/ml	Total Coliforms count/100ml
PE 01	Class 4	>2419	>1000	>2419
PB48	Class 2	0	>1000	0
KMR02	Class 4	236	>1000	>2419
KMR07	Class 4	2	>1000	>2419

Quality of Domestic Water Supplies, DWA, Second Edition 1998

Class 0	- Ideal water quality - Suitable for lifetime use.
Class 1	- Good water quality - Suitable for use, rare instances of negative effects.
Class 2	- Marginal water quality - Conditionally acceptable. Negative effects may occur in some sensitive groups
Class 3	- Poor water quality - Unsuitable for use without treatment. Chronic effects may occur.
Class 4	- Dangerous water quality - Totally unsuitable for use. Acute effects may occur.

South Africa Water Quality Guidelines, Volume 1: Domestic Use, DWA&F, First Edition 1993 & Second Edition 1996

NR	- Target water quality range - No risk.
IR	- Good water quality - Insignificant risk. Suitable for use, rare instances of negative effects.
LR	- Marginal water quality - Allowable low risk. Negative effects may occur in some sensitive groups
HR	- Poor water quality - Unsuitable for use without treatment. Chronic effects may occur.

Table 9. DWA&F Standards for bacterial activity in water.

DWA&F - STANDARDS FOR BACTERIAL ACTIVITY
A - Total Coliform
A range of between 5 and 100 is indicative of inadequate treatment, post-treatment contamination or growth in the distribution system. Risk of infectious disease transmission with continuous exposure and slight risk with occasional exposure.
A range greater than 100 is indicative of poor treatment, post-treatment contamination or definite growth in the water distribution system. Significant and increasing risk of infectious disease transmission.
B - Faecal Coliform
A range between 0 and 10 has a slight risk of microbial infection with continuous exposure.
A range between 10 and 20 has a risk of infectious disease transmission with continuous exposure
A range greater than 20 has a significant and increasing risk of infectious disease transmission. As faecal coliform levels increase, the required amount of water ingested to cause infection decreases.

5 CONCLUSIONS AND RECOMMENDATIONS

The information supplied in the site assessment description and response table in the preceding section is summarised in this section. Additional comments are made about identified problems that are not site-specific and about action of mitigation that have been taken since previous monitoring phases.

There are still some problems that have been identified during previous monitoring phases that have not been attended to. These problems as well as newly documented incidents are listed below.

The Ashing Area

- Borehole AB01, AB06, AB07 has no locknut. Locknuts must be installed.
- A borehole cap must be installed at borehole AB04.
- The cap at borehole AB47 is wedged. Borehole cap repaired.
- Borehole AB63 has no marker post, marker post must be installed.
- Canals AC01 (clean water cut off canal between ash dam and old rehabilitated waste site) and AC03 (dirty ash water return canal on eastern side of ash dam.) are overgrown. Clear vegetation.
- The rubble at clean water canal AC01 (Clean water cut off canal between ash dam and old rehabilitated waste site) and AC04 (north-eastern corner of ash dam) must be removed.
- AP03 (seepage recovery dam north of ash dam complex & east of power station) is overgrown. Clear vegetation.
- The water quality of borehole AB01 is classified as above the recommended standard due to a high EC, Na, Ca and Mg concentrations.
- The water quality at borehole AB06 is classified as above the recommended standard due to a high Mn concentration.
- The water of boreholes AB04 and AB07 is classified as above the recommended standard due to the high SO_4 concentration.
- The water quality at site AC05 are classified above the recommended standard du tot EC, Na, S04 and F concentrations.
- The EC, Na, $S0_4$ and Mn concentrations observed at site AP02 exceeds the recommended standard and is unsuitable for human consumption.
- Surface water site AP03 is above the recommended standard and unsuitable for human consumption due to a high Mn concentration.

The Power Station, Sewage Plant and the Coal Stockyard Area

- Canal CC07 is silted up with coal. This canal must be kept clean to prevent any blockages and overflowing.
- The fence at the sewage plant area must be upgrade to prevent drowning accidents.
- Borehole CB49 has an above the recommended standard water quality due to high F concentration. The high F concentration is associated with the geology of this borehole.
- The Mn concentration observed at borehole CB51 exceeds the recommended standard and is unsuitable for human consumption.

- The water quality of surface water site PC06 is classified as above the recommended standard. Site PC06 is unsuitable for human consumption due to very high EC and $S0_4$ concentration.
- The water quality of site PP05 is classified above the recommended standard due to high $S0_4$ concentration
- **Water from site PE01 is classified as ARS due to very high NH_4-N concentration. This is an indication of poor sewage treatment, post-treatment contamination or definite growth in the water distribution system. The sewage water/effluent must be treated properly. The water quality ate site KMR07 are also classified ARS due to the NH4-N concentration. . The results of the bacteriological analyses suggest that the water in the vicinity of sites PB48, PE01, KMR02 and KMR07 has been contaminated. This is unacceptable. The bacterial activity at these sites is an indication that inadequate treatment is taking place. The count is high enough to be associated with significant risks of infectious disease transmission and is totally unsuitable for use at all the sites.**
- No petroleum hydrocarbon contamination was detected at the sites PB08, PB60 and PP05.

<u>The GelukSpruit Area, the Komati Spruit Area and the KoringSpruit Area</u>

- The water quality of sites GLR04 and KRR06 is classified above the recommended standard due to a high S04 concentration.
- **The water quality ate site KMR07 are classified as ARS due to the NH_4-N concentration. This again is indication that proper treatment is not taking place at the sewage plant. This issue need urgent attention. A major concern is that KMR07 is receiving purified water from the sewage plant and the results show that the treatment of this water is inadequate and will require immediate response. This issue need urgent attention**

13 December 2012

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L.J. van Niekerk (Pr. Sci. Nat.) ***Date***