WATER • ENVIRONMENTAL • EARTH SCIENCES • GIS

63 Wessel Road Rivonia 2128 PO Box 2597 Rivonia 2128 South Africa

Telephone: +27 (0)11 803 5726 Facsimile: +27 (0)11 803 5745 Web: www.gcs-sa.biz

SiVEST ENVIRONMENTAL DIVISION
Grootvlei Power Station
Hydrogeological Investigation

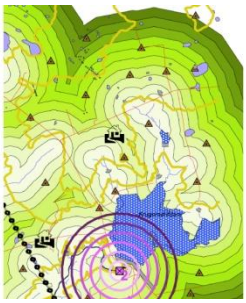
Report

Version – 1

September 11

SiVEST Environmental Division
GCS Project Number: 11-247

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SiVEST Environmental Division
11-247

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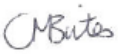
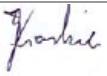
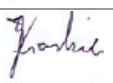
Author	Claudia Brites		September 2011
Document Reviewer	Kobus Troskie		September 2011
Document Authorisation	Kobus Troskie		September 2011

I. EXECUTIVE SUMMARY

GCS was appointed by SiVEST Environmental Division to conduct a baseline hydrogeological investigation for the installation of a bulk fuel storage oil tank of approximately 500m^3 at the Grootvlei Power Station. The study performed forms part of the Basic Assessment process.

The scope of work for the study included a desktop study to obtain all relevant geological and hydrogeological data, a site visit to inspect the two proposed sites, a hydrocensus of existing monitoring boreholes on site, sampling of three boreholes and a risk assessment.

Grootvlei Power Station is a coal fired burning power station which is located near the town of Balfour in Mpumalanga Province. The elevation of the site ranges from 1540 to 1568 mamsl (metres above mean sea level) with the topography of the site sloping in a south westerly direction.

Two non perennial rivers are located approximately 460m and 950m to the north east and south east of the proposed tank installation area. The river and dam are located downgradient of the site and are considered sensitive surface water receptors.

The site is underlain by the Ecca Group of the Karoo Supergroup consisting of shale, sandstone and coal of the Vryheid Formation. No structural components such as faults, dykes or lineaments are present in close proximity to the site which may alter the groundwater flow paths. The associated aquifer is an integranular and fractured aquifer.

During the site visit, a hydrocensus was conducted on the site whereby data was collected from five boreholes which form part of the monitoring programme. This included water levels, borehole depth and field parameters. The groundwater flow directions were determined using the static water level data. The groundwater flow contours indicates that the predominant flow direction is from the west to east across the site.

During the hydrocensus, three of these boreholes were sampled for TPH (Total Petroleum Hydrocarbon) analysis in order to determine the total amount of hydrocarbons compounds present within the groundwater on site. TPH methods generate a single number that represents the combined concentrations of all petroleum hydrocarbons in a sample, which are measurable by a particular method. From the analysis it is evident that no hydrocarbon compounds were detected in any of the three boreholes sampled as all measured concentrations were below 1mg/l.

A risk assessment methodology was incorporated in order to identify and quantify the risk that the proposed activity poses on the groundwater environment on the site. Firstly, the associated risks were identified and the significance of the impact was taken into consideration by determining the extent and severity of the impact. The impact was determined using the nature, scale and duration of effects on the environment for the operational phase of the project. Due to the close proximity of the two sites to each other, both sites will have very similar geological and hydrogeological conditions, similar topography and are associated with the same sensitive receptors and therefore the impacts determined apply for both of the alternative sites.

The proposed installation of the bulk fuel storage oil tank may result in negative impacts on the groundwater present on site. The impacts and rating have been summarised in the tableTable 7-3 below with a comparison made between pre- and post-mitigation phases. The most significant impact will be a negative effect on the groundwater quality if a spillage was to occur. The impact rating calculated before any mitigation measures are in place was 22, which results in a low negative impact. The rating calculated after mitigation measures have been included was 6, also resulting in a low negative impact.

Environmental parameter	Issues	Rating prior to mitigation	Rating	Rating post mitigation	Rating
Groundwater system	Fuel spillages	-22	Low Negative Impact	-6	Low Negative Impact

The mitigation measures includes bunding of the area surrounding the above ground fuel storage tank in order to prevent migration of any fuel spillages on site. It is therefore recommended that the necessary mitigation measures are enforced including the bunding of the areas surrounding the fuel storage tank for safety purposes to act as a barrier to prevent migration of spillages. It is recommended that the volume of the bunded area is 110% of the capacity of the fuel tank. In the event of a spillage, it is recommended that monitoring takes place at the boreholes in close proximity to the spillage area as well as selected boreholes downgradient of the spillage, both on site and off site. A contractor may be required for removal of the fuel spillage which is to be treated off site.

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1 INTRODUCTION

1.1 Terms of Reference

GCS (Pty) Ltd was appointed by SiVEST Environmental Division to conduct for the baseline hydrogeological investigation for the proposed installation of a bulk fuel storage oil tank of approximately 500m^3 at the Grootvlei Power Station. Grootvlei Power Station is a coal fired burning power station which is located near the town of Balfour in Mpumalanga Province. The study performed forms part of the Basic Assessment process.

2 SCOPE OF WORK

The scope of work for the study included the following:

- Desktop study;
- A site visit;
- Hydrocensus of existing monitoring boreholes on site;
- Data compilation;
- Groundwater sampling and chemical analyses;
- Compilation of a short baseline report.
- Report and risk assessment.

3 METHODOLOGY

3.1 Desktop Study

GCS assessed all available geological and hydrogeological data prior to the start of the fieldwork. All of the existing groundwater data (including monitoring data, hydrocensus data and water levels) were reviewed and assessed during the desktop study.

All available data on the National Groundwater Archive (NGA) boreholes was collected from the Department of Water Affairs (DWA). A study of the topographical maps, satellite images and geological maps was also included during the desk study.

All relevant public domain information was assessed including previous reports provided by the client. The following data sources will be used during the study:

- Topographic 1:50 000 maps;
- Geological 1:250 000 map;
- The groundwater resources of the Republic of South Africa, sheets 1 and 2 (Vegter 1995);

- GRDM, Groundwater Resource Directed Measures, GRDM Training Manual;
- The National Groundwater Archive (NGA) and
- Previous consultant reports in the area.

3.2 Site Visit and Hydrocensus

GCS conducted a site visit in order to become familiarised with the two (2) proposed site alternatives for the installation of the 500m^3 bulk fuel storage oil tank. Furthermore a survey of boreholes in close proximity to the proposed site alternatives were conducted at the Grootvlei Power Station. The following data was recorded where available:

- Groundwater levels;
- Borehole depths;
- Water quality; and
- Usage.

This data was used to indicate the location of the monitoring boreholes relative to the two proposed sites as well as to determine the groundwater flow gradients and groundwater level contours using the static groundwater level in this area.

3.3 Groundwater Sampling

The methodology in the collection and preservation of groundwater sample is important for the reliability of the analysis. A sample was collected and preserved to ensure a correct version of the on-site conditions at the site area. This work is undertaken in accordance to the following publications:

SABS ISO 5667-11:1993 Guidance on sampling of groundwater
SABS ISO 5667-1:1980 Guidance on the design of sampling programs
SABS ISO 5667-2:1991 Guidance on sampling techniques
SABS ISO 5667-3:1994 Guidance on the preservation and handling of samples

The samples were submitted to an accredited laboratory services for analysis according to South African Drinking Standards. Laboratory analyses included Total Petroleum Hydrocarbons (TPH) using the IR method (Infrared Spectroscopy).

4 SITE DESCRIPTION

4.1 Locality

The site is located in the suburb of Grootvlei in the Mpumalanga Province. The approximate elevation of the site ranges from 1540 to 1568 mamsl (metres above mean sea level). The elevation of the proposed area for the tank installation is approximately 1559mamsl. The topography of the site slopes in a south westerly direction.

A non perennial river is located approximately 460m to the north east of the proposed tank installation area as indicated on Figure 4-1. This river flows in a south easterly direction and flows into a dam further downstream outside of the Power Station boundary. Another non perennial river and dam are located 950m to the south east of the site on the property. The river and dam are located downgradient of the site and are considered sensitive surface water receptors.

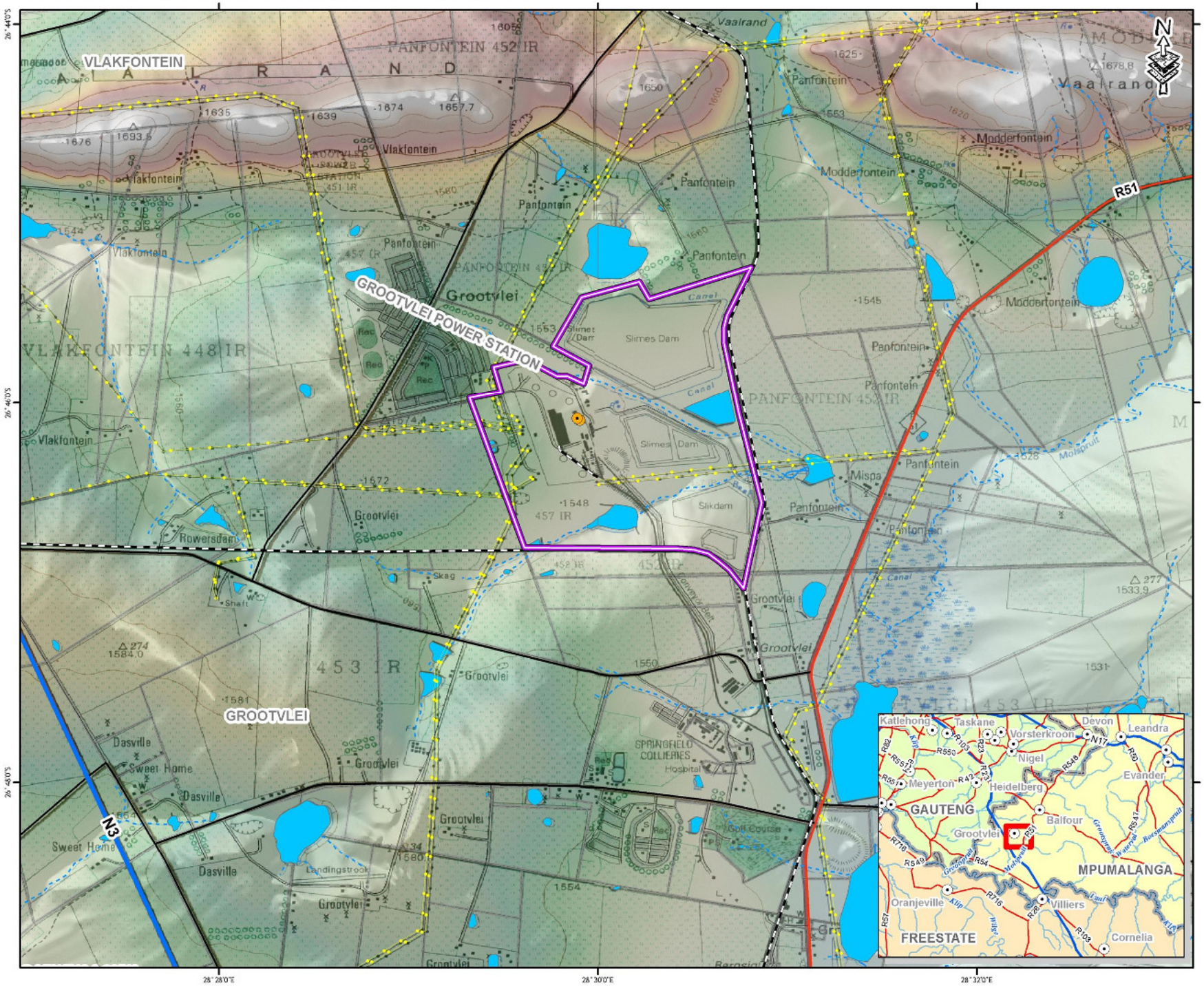
4.2 Geology and Hydrogeology

According the map sheet East Rand 2628, 1:250 000 (Council for Geoscience, 1986 2nd edition) the site is underlain by Ecca Group of the Karoo Supergroup as indicated in Figure 4-2. The lithology is comprised of shale, sandstone and coal of the Vryheid Formation. No structural components such as faults, dykes or lineaments are present in this area which would alter the groundwater flow paths.

The 1: 500 000 general hydrogeological map for Johannesburg (2526), indicates the aquifer underlying the site is an integranular and fractured aquifer. Groundwater generally occurs within the fractures and joints developed along the bedding planes, between the contact zones of different lithologies and associated with faults and shear zones (H. C. Barnard, 2007). Groundwater is stored in and transmitted through both the fractured and intregranular aquifer. The intergranular pore spaces may serve as primary storage and the fractures serve as the transport function.

No NGA (National Groundwater Archive) boreholes were identified within a 2km radius of the site.

GROOTVLEI POWER STATION: LOCALITY



LEGEND

- Towns
- Location Alternatives
- Powerline single
- Site Boundary

ROAD NETWORK

- National Route
- Main Road
- Secondary Road
- Street
- Railway line

RIVERS & STREAMS

- Perennial
- Non-Perennial
- Dams
- Parcel Boundaries

ELEVATION (mamasl)

High : 1748.91

Low : 1504.62

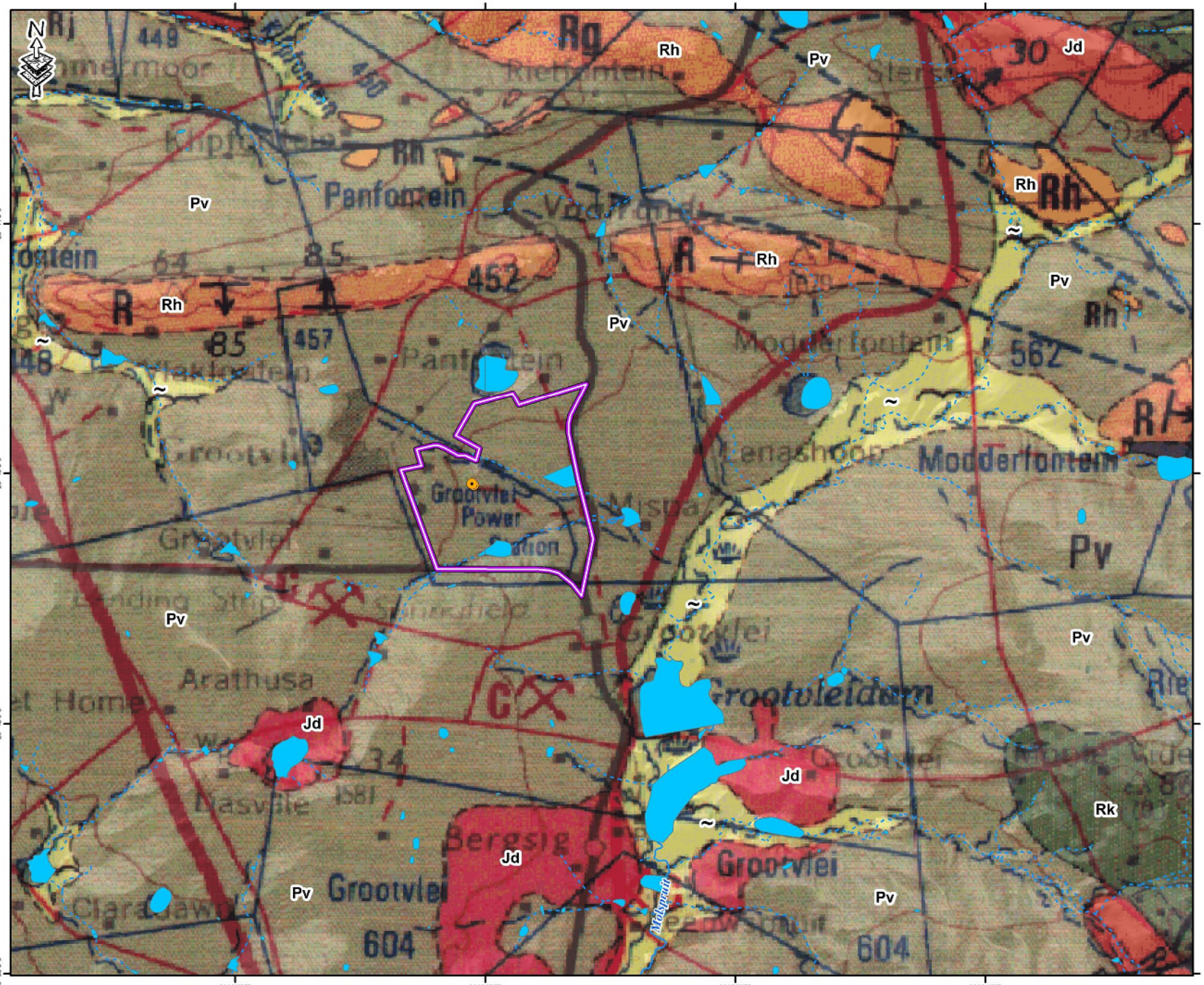
Data Sources: The Chief Directorate of Survey & Mapping
1:50 000 Topographical Series: 2628DA, DC, CB & CD

FIGURE NO.:	4.1
MAP NUMBER:	11-252-20110901-01
DRAWN BY:	L. DU PLESSIS GIS SPECIALIST (PGPT 0071)
REVIEWED BY:	J. VELTMAN EARTH SCIENCE CONSULTANT
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	1 SEPTEMBER 2011
CLIENT:	SIVEST
PROJECT:	GROOTVLEI POWER STATION (11-252)
SCALE:	1:36,000

0 0.25 0.5 1 Kilometers

GCS
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

GROOTVLEI POWER STATION: GEOLOGY



LEGEND

- Location Alternatives
- Site Boundary
- Dams

RIVERS & STREAMS

- Perennial
- Non-Perennial

LITHOLOGY

Jd - Dolerite

Pv - Sandstone, shale , coal beds

Rk - Basaltic lava, agglomerate, tuff

Rh - Shale (partly ferruginous), quartzite, banded ironstone (contorted bed)

~ - Alluvium

Data Sources: Council for Geoscience
1:250 000 Geological Series: 2628

FIGURE NO.:	4.2
MAP NUMBER:	11-252-20110901-01
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REVIEWED BY:	J. VELTMAN EARTH SCIENCE CONSULTANT
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	1 SEPTEMBER 2011
CLIENT:	SIVEST
PROJECT:	GROOTVLEI POWER STATION (11-252)
SCALE:	1:50,000

0 0.5 1 2 Kilometers

GCS
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

5 AVAILABLE HYDROGEOLOGICAL SITE SPECIFIC DATA

Previous hydrogeological investigations have been conducted at the Grootvlei Power Station and surrounding areas. This includes groundwater and surface water monitoring conducted on a quarterly basis as well as a hydrocensus conducted surrounding the area.

5.1 Groundwater Monitoring

The groundwater monitoring system has been in place since 1988 and is conducted on a quarterly basis which includes monitoring boreholes on site, hydrocensus boreholes and surface water monitoring points. All details regarding the boreholes and other monitoring points are available in the monitoring report - Groundwater Monitoring Report for Grootvlei Power Station, April 2011 (Dr D. Vermeulen).

5.2 Hydrocensus

A hydrocensus was conducted within a 5km radius of the site by the Institute of Groundwater Studies (IGS) in July 2009, in order to identify groundwater users within this zone that may be impacted on by the activities of the Power Station. A comparison was made between the upstream and downstream water qualities. A total of 19 boreholes were identified, other than those sampled as part of the monitoring routine (Vermeulen, Vermaak, 2009). Groundwater levels measurements and groundwater samples were obtained from all boreholes. The chemistry analysis indicated localized areas of marginal impact of power station infrastructure (Vermeulen, Vermaak, 2009).

6 FIELD INVESTIGATION

6.1 Site Visit and Hydrocensus

A site visit was conducted on the 8th September 2011 in order to visit the two sites for the installation of the proposed 500m^3 bulk fuel storage tank (refer to Appendix A for the Photo Log). The two alternative sites are referred to as Alternative 1 and Alternative 2 and are located within the area of the northern fuel storage plant area. Currently there are a total of three (3) bulk fuel storage tanks in this area, each with the capacity of 500m^3. The southern fuel storage plant area also consists of three (3) bulk fuel storage tanks. Each fuel tank is bunded for safety purposes to act as a barrier to contain spillages.

During the site hydrocensus conducted on the site, the boreholes closest to the proposed tank installation area were investigated. A total of 22 boreholes are monitored on site on a

quarterly basis. Data was obtained from 5 boreholes on site during the site walkover. This includes one baseline borehole and four other boreholes monitoring various areas at the Power Station.

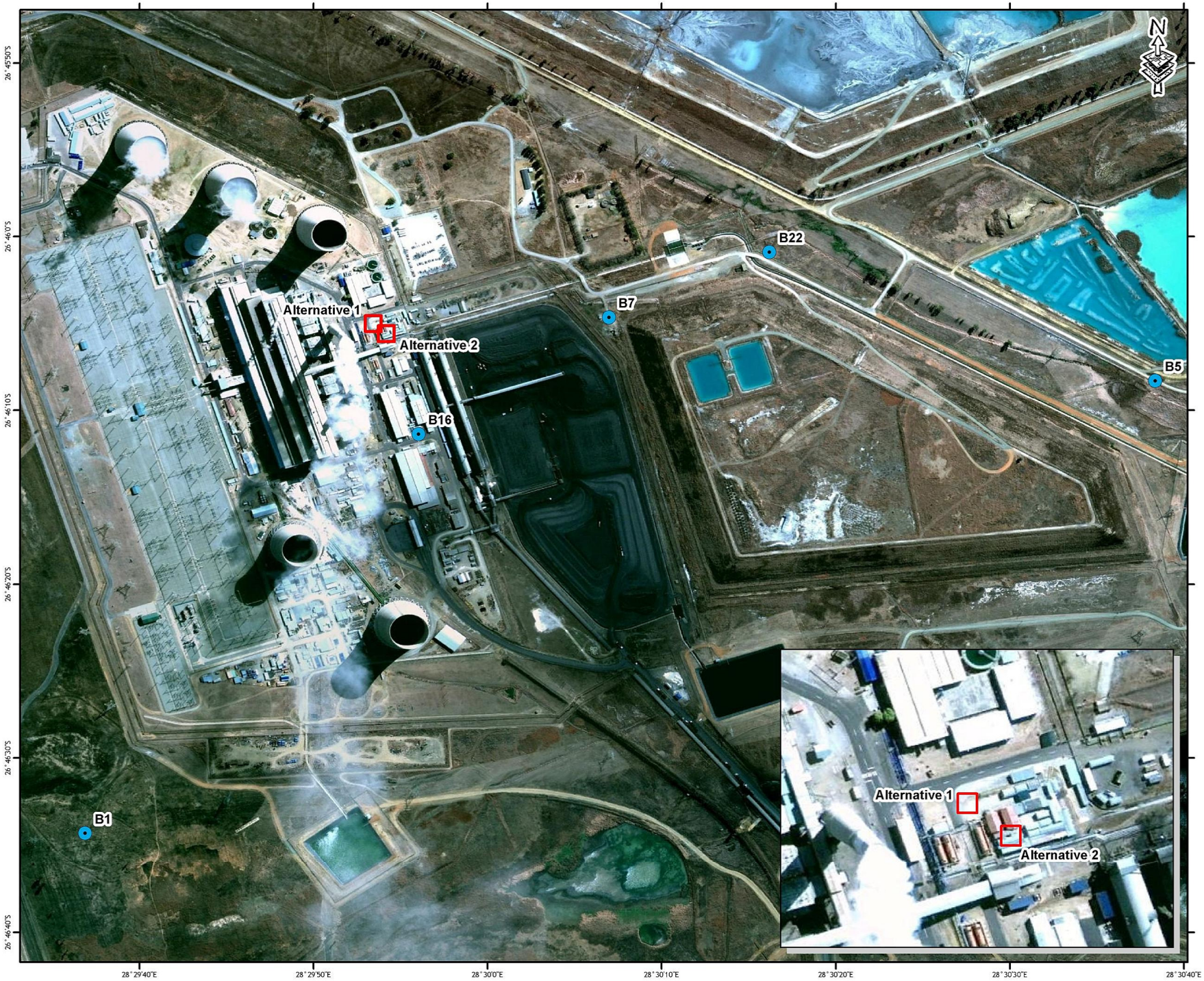
During the visit, details including water levels and coordinates were obtained. The results of the hydrocensus are listed in Table 6-1. The positions of the boreholes are illustrated on Figure 6-1.

The groundwater flow directions were determined using the static water level data. The data was contoured, incorporating the elevations in order to determine the groundwater flow directions across the site. The groundwater flow contours have been depicted in Figure 6-2 and indicates that the predominant flow direction is from west to east across the site.

Table 6-1: Hydrocensus Data

Borehole name	Co-ordinates (Cape Lo29)		Depth (m)	Water level (mbch)	Casing height (m)	Water level (mbgl)	Comments	Area Monitored
	X	Y						
B16	-49806.519	-2961927.299	31	4.78	0.04	4.74	-	Petrol and diesel tank
B1	-50332.825	-2962636.317	27	2.12	0.17	1.95	-	Baseline monitoring point
B7	-49504.975	-2961718.911	34	2.55	0.32	2.23	Brownish	Waste treatment plant
B22	-49250.805	-2961602.682	31	2.47	0.69	1.78	Brownish with suspended solids	Oil separator
B5	-48637.251	-2961827.456	44	2.12	1.07	1.05	-	Ash water return dam

GROOTVLEI POWER STATION: GOOGLE



LEGEND

- Monitoring boreholes
- Location Alternatives

Data Sources: Google Earth™ mapping service: 2011
Imagery Date: 8/22/2009

FIGURE NO.:	6.1
MAP NUMBER:	11-252-20110901-01
DRAWN BY:	L. DU PLESSIS GIS SPECIALIST (PGPT 0071)
REVIEWED BY:	C. BRITES HYDROGEOLOGIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC
DATE:	9 SEPTEMBER 2011
CLIENT:	SIVEST
PROJECT:	GROOTVLEI POWER STATION (11-252)
SCALE:	1:6,500

0 75 150 300 Meters

GCS
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz

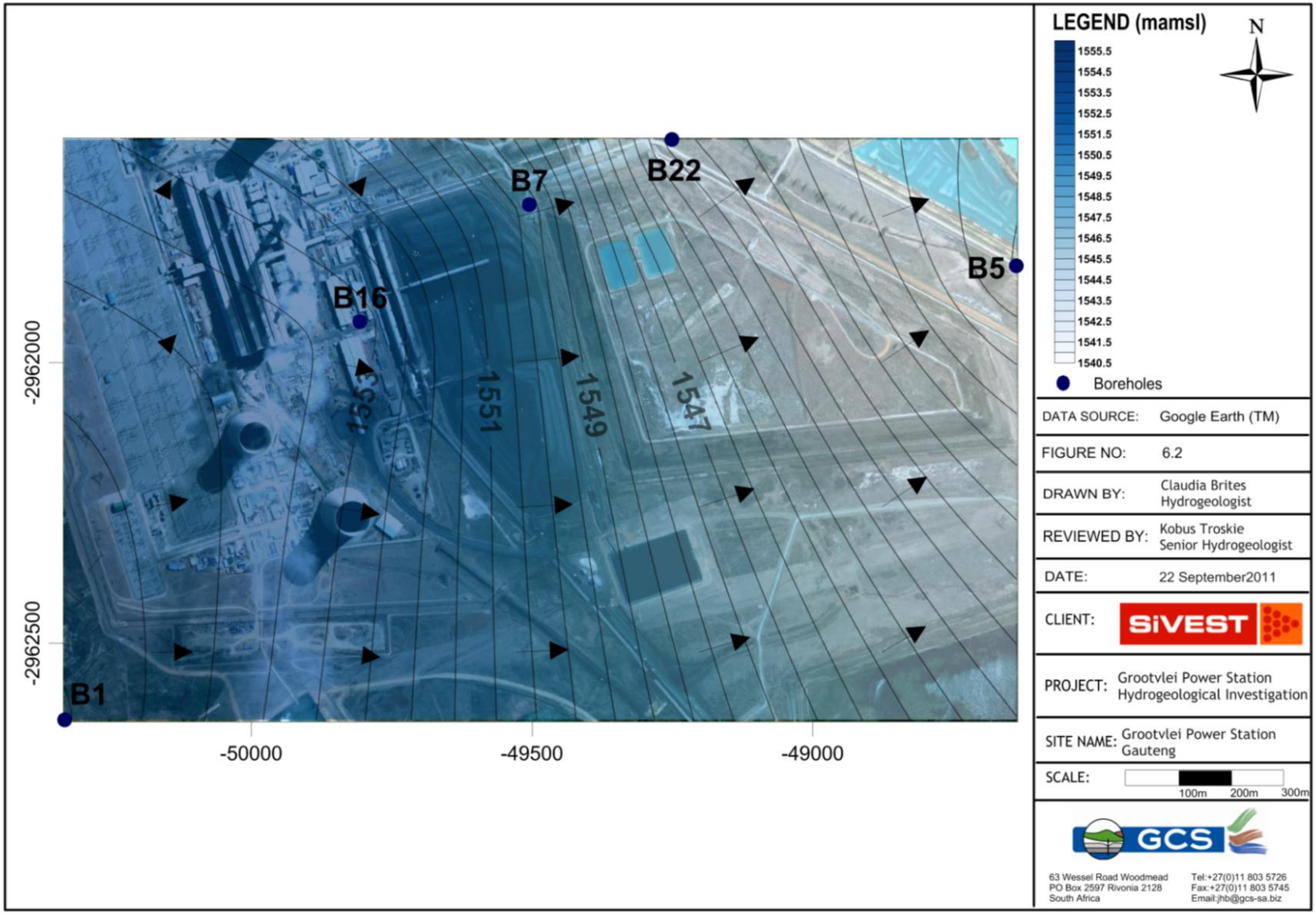


Figure 6-2: Groundwater Flow Directions

6.2 Groundwater Sampling

Three groundwater samples were taken from the hydrocensus boreholes identified during the field investigation to determine the baseline groundwater quality before the installation of the bulk fuel storage tank. The samples were delivered to a South African National Standards (SANS) accredited laboratory, M&L laboratory services based in Johannesburg, South Africa.

The methodology in the collection and preservation of water samples is important for the reliability of the analysis. The samples taken were preserved to ensure a correct version of the on-site conditions at the development area.

Laboratory analyses included TPH (Total Petroleum Hydrocarbons) using the IR method. Analysis was carried out in accordance with methods prescribed by and obtained from the South African Bureau of Standards, in terms of the Standards Act, Act 30 of 1982.

The hydrochemical sampling will be carried out in accordance to the following publications:

- SABS ISO 5667-11:1993 Guidance on sampling of groundwater
- SABS ISO 5667-1:1980 Guidance on the design of sampling programs
- SABS ISO 5667-2:1991 Guidance on sampling techniques
- SABS ISO 5667-3:1994 Guidance on the preservation and handling of samples

Field observations for each sampling point, consisting of the following information, were recorded on field data sheets:

- Date of sampling;
- Coordinates of each borehole;
- General status of the borehole (locked, vandalised, etc.) and depth of water level;
- In-situ measurements for each sampling point, namely pH, electrical conductivity, total dissolved solids and temperature;
- General characteristics of the water samples such as colour, turbidity and smell as well as visual observations of the sample site.

The field parameters measured in the three site boreholes and one hydrocensus borehole sampled are tabulated below in Table 6-2 and includes pH, temperature, electrical conductivity (EC) and TDS (total dissolved solids).

Table 6-2: Field Parameters of Hydrocensus and Site Boreholes

Borehole	pH	EC (µS/cm)	TDS (ppm)	Temperature (°C)
B16	8.94	281	145	20.2
B7	9.29	293	153	19.4
B22	7.68	431	215	18.3

Table 6-3 below contains the laboratory analysis for TPH. TPH methods generate a single number that represents the combined concentrations of all petroleum hydrocarbons in a sample, which are measurable by a particular method. A TPH analysis was conducted in order to determine the total amount of hydrocarbons compounds present within the groundwater on site. The laboratory certificate of analysis is presented in Appendix B. From the analysis it is evident that no hydrocarbon compounds were detected in any of the three boreholes sampled.

Table 6-3: Chemistry Analysis of the Boreholes Sampled

Borehole	Total Petroleum Hydrocarbon (mg/l)
B16	<1
B7	<1
B22	<1

7 IMPACT ASSESSMENT

The following risk assessment methodology was incorporated in order to identify and quantify the risk that the proposed activity poses on the groundwater environment on the site. Firstly, the associated risks were identified and the significance of the impact was taken into consideration by determining the extent and severity of the impact. The impact was determined using the nature, scale and duration of effects on the environment for the operational phase of the project as the risks discussed only apply to the operational phase.

7.1 Determination of Significance of Impacts

Significance is determined through a synthesis of impact characteristics which include context and intensity of an impact. Context refers to the geographical scale i.e. site, local, national or global whereas Intensity is defined by the severity of the impact e.g. the magnitude of deviation from background conditions, the size of the area affected, the

duration of the impact and the overall probability of occurrence. Significance is calculated as shown in Table 7-2.

Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. The total number of points scored for each impact indicates the level of significance of the impact.

7.2 Impact Rating System

Impact assessment must take account of the nature, scale and duration of effects on the environment whether such effects are positive (beneficial) or negative (detrimental). Each issue / impact is also assessed according to the operational project stage.

Where necessary, the proposal for mitigation or optimisation of an impact should be detailed. A brief discussion of the impact and the rationale behind the assessment of its significance has also been included.

7.3 Rating System Used To Classify Impacts

The rating system is applied to the potential impact on the receiving environment and includes an objective evaluation of the mitigation of the impact. Impacts have been consolidated into one rating. In assessing the significance of each issue the following criteria (including an allocated point system) is used:

Table 7-1: Rating System

NATURE		
A brief description of the impact of environmental parameter being assessed in the context of the project. This criterion includes a brief written statement of the environmental aspect being impacted upon by a particular action or activity.		
GEOGRAPHICAL EXTENT		
This is defined as the area over which the impact will be expressed. Typically, the severity and significance of an impact have different scales and as such bracketing ranges are often required. This is often useful during the detailed assessment of a project in terms of further defining the determined.		
1	Site	The impact will only affect the site
2	Local/district	Will affect the local area or district
3	Province/region	Will affect the entire province or region
4	International and National	Will affect the entire country
PROBABILITY		
This describes the chance of occurrence of an impact		
1	Unlikely	The chance of the impact occurring is extremely low (Less than a 25% chance of occurrence).

2	Possible	The impact may occur (Between a 25% to 50% chance of occurrence).
3	Probable	The impact will likely occur (Between a 50% to 75% chance of occurrence).
4	Definite	Impact will certainly occur (Greater than a 75% chance of occurrence).
REVERSIBILITY		
This describes the degree to which an impact on an environmental parameter can be successfully reversed upon completion of the proposed activity.		
1	Completely reversible	The impact is reversible with implementation of minor mitigation measures
2	Partly reversible	The impact is partly reversible but more intense mitigation measures are required.
3	Barely reversible	The impact is unlikely to be reversed even with intense mitigation measures.
4	Irreversible	The impact is irreversible and no mitigation measures exist.
IRREPLACEABLE LOSS OF RESOURCES		
This describes the degree to which resources will be irreplaceably lost as a result of a proposed activity.		
1	No loss of resource.	The impact will not result in the loss of any resources.
2	Marginal loss of resource	The impact will result in marginal loss of resources.
3	Significant loss of resources	The impact will result in significant loss of resources.
4	Complete loss of resources	The impact is result in a complete loss of all resources.
DURATION		
This describes the duration of the impacts on the environmental parameter. Duration indicates the lifetime of the impact as a result of the proposed activity		
1	Short term	The impact and its effects will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 1 years), or the impact and its effects will last for the period of a relatively short construction period and a limited recovery time after construction, thereafter it will be entirely negated (0 – 2 years).
2	Medium term	The impact and its effects will continue or last for some time after the construction phase but will be mitigated by direct human action or by natural processes thereafter (2 – 10 years).
3	Long term	The impact and its effects will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter (10 – 50 years).

4	Permanent	The only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or such a time span that the impact can be considered transient (Indefinite).
CUMULATIVE EFFECT		
This describes the cumulative effect of the impacts on the environmental parameter. A cumulative effect/impact is an effect which in itself may not be significant but may become significant if added to other existing or potential impacts emanating from other similar or diverse activities as a result of the project activity in question.		
1	Negligible Cumulative Impact	The impact would result in negligible to no cumulative effects
2	Low Cumulative Impact	The impact would result in insignificant cumulative effects
3	Medium Cumulative impact	The impact would result in minor cumulative effects
4	High Cumulative Impact	The impact would result in significant cumulative effects
INTENSITY / MAGNITUDE		
Describes the severity of an impact		
1	Low	Impact affects the quality, use and integrity of the system/component in a way that is barely perceptible.
2	Medium	Impact alters the quality, use and integrity of the system/component but system/ component still continues to function in a moderately modified way and maintains general integrity (some impact on integrity).
3	High	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component is severely impaired and may temporarily cease. High costs of rehabilitation and remediation.
4	Very high	Impact affects the continued viability of the system/component and the quality, use, integrity and functionality of the system or component permanently ceases and is irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation.
SIGNIFICANCE		

Significance is determined through a synthesis of impact characteristics. Significance is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required. This describes the significance of the impact on the environmental parameter. The calculation of the significance of an impact uses the following formula:

(Extent + probability + reversibility + irreplaceability + duration + cumulative effect) x magnitude/intensity.

The summation of the different criteria will produce a non weighted value. By multiplying this value with the magnitude/intensity, the resultant value acquires a weighted characteristic which can be measured and assigned a significance rating.

Points	Impact Significance Rating	Description
6 to 28	Negative Low impact	The anticipated impact will have negligible negative effects and will require little to no mitigation.
6 to 28	Positive Low impact	The anticipated impact will have minor positive effects.
29 to 50	Negative Medium impact	The anticipated impact will have moderate negative effects and will require moderate mitigation measures.
29 to 50	Positive Medium impact	The anticipated impact will have moderate positive effects.
51 to 73	Negative High impact	The anticipated impact will have significant effects and will require significant mitigation measures to achieve an acceptable level of impact.
51 to 73	Positive High impact	The anticipated impact will have significant positive effects.
74 to 96	Negative Very high impact	The anticipated impact will have highly significant effects and are unlikely to be able to be mitigated adequately. These impacts could be considered "fatal flaws".
74 to 96	Positive Very high impact	The anticipated impact will have highly significant positive effects.

Table 7-2 below details the impacts associated with the proposed installation of the bulk fuel storage oil tank at the Grootvlei Power Station. The impacts determined apply for both of the alternative sites as there is little difference in terms of aquifer vulnerability between the two different sites. Due to the close proximity of the two sites to each other, both sites will have very similar geological and hydrogeological conditions, similar topography and are associated with the same sensitive receptors.

Table 7-2: Rating of Impacts on the Groundwater System

Environmental Parameter	The proposed installation of the bulk fuel storage oil tank may result in negative impacts on the groundwater present on site. The most significant impact will be a negative effect on the groundwater quality if a spillage was to occur.
Issue/Impact/Environmental Effect/Nature	In terms of spillages on site, the impact on the groundwater system on site will be a negative impact. This is dependent on the nature of the spillage and extent of fuel released. Sensitive receptors (a dam and river) are located 460m to the north east, downgradient of the site. These receptors would be at risk in terms of contamination if spillages were to occur. The shallow groundwater levels on site will result in reduced travel times for contaminants to reach the groundwater level and therefore reduced biodegradation will take place before the contaminant reaches the water level.
Extent	It terms of spillages emanating from the bulk storage fuel tank, the area that will be impacted (post-mitigation) will only be the site, if the area is bunded. If the area is not bunded, spillages may not be confined to the site boundary based on the presence of the shallow groundwater levels acting as a transport medium as well as the sensitive receptors located downgradient of the storage tank and therefore the pre-mitigation impact will affect the local area or district area
Probability	The chances of the impact occurring is highly dependent on the management practices in place. Spillages are likely to occur when refilling the tanks. If the mitigation measures are in place, minimal impacts will be evident, which is not the case if no mitigation measures are in place.
Reversibility	The reversibility of the effects of a spillage depends on the degree of the spillage. A relatively small spillage may not affect the groundwater on and off site and may only affect the soils. In this case, soil remediation may be necessary. If the area is bunded, these will be minimal effects as the spillage will be contained and will not enter the natural environment. A spillage occurring in a nun-bunded area may enter the groundwater system and

	impact on the sensitive receptors. In this case, active treatment might be necessary to remove the contamination followed by monitoring. Active treatment is extremely expensive and sometimes it is impossible to obtain baseline conditions and to remediate to initial site conditions
Irreplaceable loss of resources	If the area is bunded, it is not likely that any resources will be lost if spillages occur. In the case where the area is not bunded, the impact will result in marginal loss of resources as the groundwater quality may be negatively affected.
Duration	The duration of the negative impacts associated with spillages are not likely to last for a period longer than 2 – 10 years, based on the assumption that measures will be taken to remove the contamination and remediate if necessary. With mitigation measures the duration time will be shorter.
Cumulative effect	The cumulative effect of the proposed activity and impacts are considered negligible as only one effect has been identified which is the occurrence of spillages.
Intensity/magnitude	The ability to alter the functionality or quality of a system permanently or temporarily is considered low if the area is bunded (post-mitigation) due to the minimal effects and medium for pre-mitigation if the area is not bunded as there is a possibility of contamination entering the natural environment.
Significance Rating	The significance rating was calculated for both pre- and post-mitigation scenarios. A rating of 22 was calculated for pre-mitigation and 6 for post-mitigation. This indicates that the risk is reduced when the relevant mitigation measures are in place.

	Pre-mitigation impact rating	Post mitigation impact rating
Extent	2	1
Probability	2	1
Reversibility	2	1
Irreplaceable loss	2	1
Duration	2	1
Cumulative effect	1	1

Intensity/magnitude	2	1
Significance rating	-22 (low negative)	-6 (low negative)
Mitigation measures	Although both the impact ratings for pre-mitigation and post-mitigation results in the same rating (both are rated as a low negative rating) there will be differences in the impacts for the scenario where the area is bunded or not. If the area is bunded, it will contain a spillage and prevent contamination of the environment. A spillage within a non-bunded area will results in the possible migration of a spillage which may result in contamination of the soil and groundwater both on the site and the surrounding areas. It is recommended that the volume of the bunded area is 110% of the capacity of the fuel tank. In the event of a spillage, it is recommended that monitoring takes place at the boreholes in close proximity to the spillage area as well as selected boreholes downgradient of the spillage, both on site and off site.	

7.4 Impact Summary

The proposed installation of the bulk fuel storage oil tank may result in negative impacts on the groundwater present on site. The impacts and rating have been summarized in Table 7-3 below with a comparison made between pre- and post-mitigation phases. The most significant impact will be a negative effect on the groundwater quality if a spillage was to occur. The impact rating calculated before any mitigation measures are in place was 22, which results in a low negative impact. The rating calculated after mitigation measures have been included was 6, also resulting in a low negative impact. The mitigation measures includes bunding of the area surrounding the above ground fuel storage tank in order to prevent migration of any fuel spillages on site as well as collection in a sump which is then removed and treated off site.

Table 7-3: Comparison of Summarised Impacts on Environmental Parameters

Environmental parameter	**Issues**	**Rating prior to mitigation**	**Rating**	**Rating post mitigation**	**Rating**
Groundwater system	Fuel spillages	-22	Low Negative Impact	-6	Low Negative Impact

8 CONCLUSION AND RECOMMENDATIONS

GCS conducted a site visit in order to become familiarised with the two (2) proposed site alternatives for the installation of the 500m³ bulk fuel storage oil tank. Based on the outcome of the hydrocensus, the groundwater flow gradients were determined using the data collected. The groundwater flows from west to east across the site with shallow groundwater levels present ranging from 1.05 to 4.74mbgl. The nearest groundwater user is located approximately 2.1km downgradient, from the two alternative site area. Several other groundwater users are also located in this area.

During the hydrocensus, three groundwater samples were collected from boreholes B7, B16 and B22 in order to determine the baseline quality conditions before the installation of the bulk fuel storage tank. The samples were analysed for TPH (Total Petroleum Hydrocarbons) using the IR method. From the analysis it is evident that no hydrocarbon compounds were detected in any of the three boreholes sampled.

A risk assessment methodology was incorporated in order to identify and quantify the risk that the proposed activity poses on the groundwater environment on the site. Firstly, the associated risks were identified and the significance of the impact was taken into consideration by determining the extent and severity of the impact. The impact was determined using the nature, scale and duration of effects on the environment. Due to the close proximity of the two sites to each other, both sites will have very similar geological and hydrogeological conditions, similar topography and are associated with the same sensitive receptors and therefore the impacts determined apply for both of the alternative sites.

The proposed installation of the bulk fuel storage oil tank may result in negative impacts on the groundwater present on site. The most significant impact will be a negative effect on the groundwater quality if a spillage was to occur. The impact rating calculated before any mitigation measures are in place was 22, which results in a low negative impact. The rating calculated after mitigation measures have been included was 6, also resulting in a low negative impact. The mitigation measures includes bunding of the area surrounding the above ground fuel storage tank in order to prevent migration of any fuel spillages on site. It is therefore recommended that the necessary mitigation measures are enforced including the bunding of the areas surrounding the fuel storage tank for safety purposes to act as a barrier to prevent migration of spillages. It is recommended that the volume of the bunded area is 110% of the capacity of the fuel tank. In the event of a spillage, it is recommended that monitoring takes place at the boreholes in close proximity to the spillage area as well

as selected boreholes downgradient of the spillage, both on site and off site. A contractor may be required for removal of the fuel spillage which is to be treated off site.

9 REFERENCES

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Vegter, J. R. (1995), Groundwater Resources of the Republic of South Africa. Water Research Commission, Department of Water Affairs and Forestry. Printpak Transvaal. South Africa

Vermeulen, D and Vermaak, K. (2009), Hydrocensus for Grootvlei Power Station. Institute of Groundwater Studies.

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APPENDIX A

PHOTO LOG

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
1	08/09/11

Direction Photo Taken:
East to west

Description:
Site Alternative 1

Photo No.	Date:
2	08/09/11

Direction Photo Taken:
South west to north east

Description:
Site Alternative 1

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
3	08/09/11

Direction Photo Taken:
North east to south west

Description:
Site Alternative 2

Photo No.	Date:
4	08/09/11

Direction Photo Taken:
South west to North east

Description:
Site Alternative 2

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
5	08/09/11

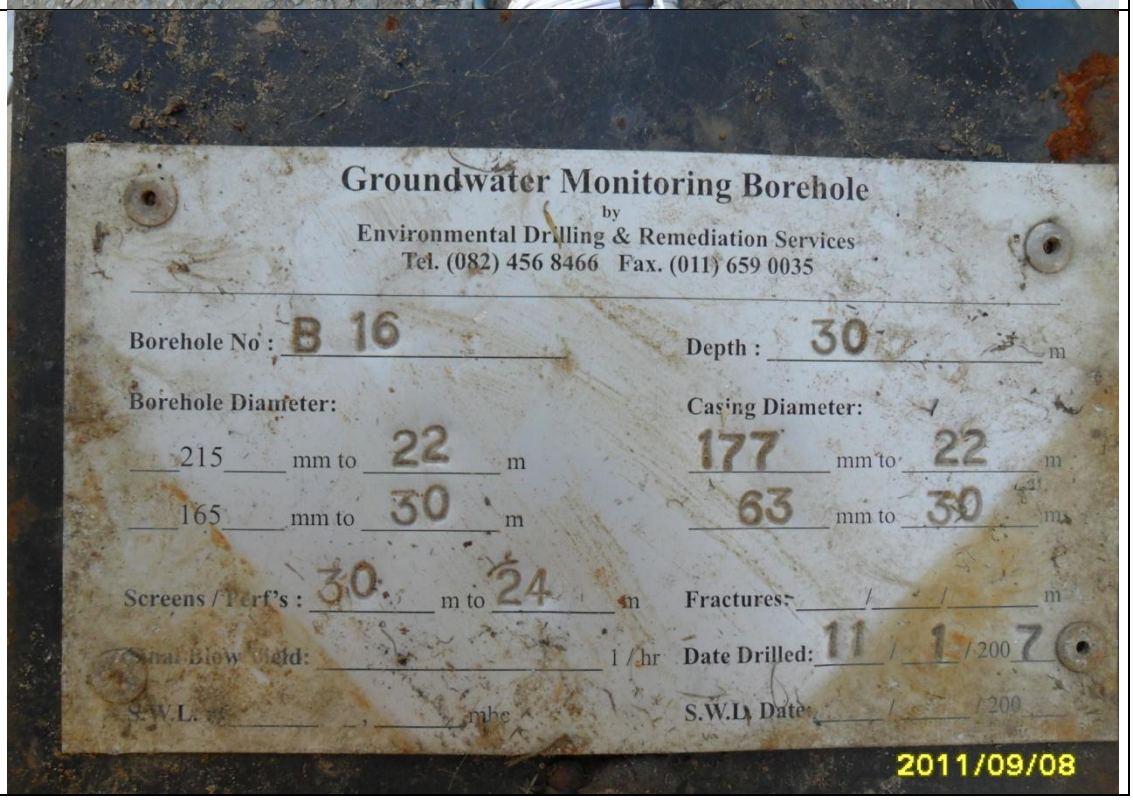
Direction Photo Taken:
N/A

Description:
Borehole B16

Photo No.	Date:
6	08/09/11

Direction Photo Taken:
N/A

Description:
Borehole B16 details



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
7	08/09/11

Direction Photo Taken:
North east to south west

Description:
Diesel pump monitored by borehole B16

Photo No.	Date:
8	08/09/11

Direction Photo Taken:
South east to north west

Description:
Borehole B1

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
9	08/09/11

Direction Photo Taken:
N/A

Description:
Borehole B7

Photo No.	Date:
10	08/09/11

Direction Photo Taken:
South west to north east

Description:
Borehole B22

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
SASOL	Grootvlei Power Station	11-247

Photo No.	Date:
11	08/09/11

Direction Photo Taken:
N/A

Description:
Borehole B22 details

Photo No.	Date:
12	08/09/11

Direction Photo Taken:
South west to north east

Description:
Borehole B5

APPENDIX B

LABORATORY RESULTS

P.O. Box 82124,
Southdale, 2135,
South Africa.
TEL. (011) 496-2228
FAX (011) 496-2239

Registration Number 1974/001476/07 Vat Number 4780103505

M and L Laboratory Services (Pty) Ltd

Consulting Industrial Chemists, Analysts & Samplers
CONFIDENTIAL

Ref No. : 11/03107/L

Issued at : Johannesburg

Date : 27.09.2011

COMPANY NAME	:	GROUNDWATER CONSULTING SERVICES
ADDRESS	:	P.O. BOX 2597, RIVONIA, 2128
SUBJECT	:	ANALYSIS OF 3 SAMPLES OF WATER
MARKED	:	GROOTVLEI POWER STATION
INSTRUCTED BY	:	CLAUDIA BRITES
ORDER NO	:	11-491
RECEIVED ON	:	09.09.2011
LAB NO(S)	:	H00604- H00606
DATE ANALYSED	:	13.09.2011

Analysis on as received basis:

Test: TPH IR

Test Ref:: Based on EPA 418.1. (Using Florisil and Sodium Sulphate clean up for extract)

SAMPLE MARKS	TOTAL PETROLEUM HYDROCARBONS (mg/l)
B7	<1
B16	<1
B22	<1

1. All samples were analyzed and results reported by a subcontracted laboratory