environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEAT/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 718, 2009

PROJECT TITLE

Proposed 30-year Ash Disposal Facility at Kendal Power Station, Mpumalanga

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4.2 The specialist appointed in terms of the Regulations_

I, Gerhard van der Linde, declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

[signature]

Signature of the specialist:

Golder Associates Africa (Pty)

Name of company (if applicable):

20/5/2016

Date:

July 2016

ZITHOLELE CONSULTING (PTY) LTD

Groundwater Specialist Study - Kendal 30 Year Extension - Ash Disposal Facility

Submitted to:
Zitholele Consulting (Pty) Ltd

Report Number. 13615285-12420-1

Distribution:

2 x Zitholele Consulting (Pty) Ltd
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REPORT

Golder Associates

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Africa (Golder) has been appointed by Zitholele Consulting (Pty) Ltd to provide specialist groundwater inputs in support of the Environmental Impact Assessment process for the 30 year ash disposal facility at Kendal Power tation. This process involves an Environmental Impact Assessment (EIA), Environmental Management Programme (EMPr), Waste Management License Application and the Integrated Water Use License (IWUL) Application.

As part of the EIA process four (4) potential dry ash waste sites were identified within a 7km radius of Kendal Power Utility.

This document reports on the baseline groundwater situation at the three feasible alternatives, namely Site B, Site C and Site F and apart from ranking and rating, includes an initial conceptual understanding of the hydrogeology and an initial Qualitative Impact Assessment.

Site H (previously excluded) for detailed assessment is also included in this report after a separate appointment by Zitholele Consulting (Pty).

2.0 BACKGROUND

In order for the power station to have adequate space for its ashing activities, the new site should have a ground footprint of 404.7 Hahectare (ha).

The new ash disposal facility will receive ash through the use of a conveyor belt system.

The new ash disposal facility will be lined and continuously rehabilitated using topsoil covering and vegetation.

3.0 KEY PROJECT OBJECTIVES

The main objectives of the groundwater study are summarised as:

- Hydrocensus;
- Characterise the prevailing groundwater situation;
- Define the water bearing strata in the area;
- Determine current groundwater level distribution and flow directions;
- Determine baseline groundwater quality;
- Rating and ranking of the 4 feasible sites identified;
- Conceptual Hydrogeological Model,
- Qualitative Impact Assessment and Environmental Management).

4.0 SCOPE OF WORK

The following scope of work was followed to adhere to the objectives mentioned above:

- Hydrocensus;
- Groundwater sampling x 10 samples;
- Baseline reporting on 4 proposed sites;
- Conceptual Hydrogeological Model (Ste H); and
- Qualitative Impact Assessment (Site H).

5.0 GROUNDWATER BASELINE

5.1 Desk Study and Information Reviewed

The following information and data was utilised during the desk study and information review task:

- 1:250 000 geological map series;
- 1:2 500 000 Groundwater Resources map of RSA –Sheet 1 (WRC.DWAF 1995);
- 1:4 000 000 Groundwater Resources map of RSA – Sheet 2 (WRC.DWAF 1995);
- 1: 500 000 Hydrogeological Map Series of RSA (1996);
- Homeland Energy Group Ltd's Independent Technical Report (SRK, 2007);
- Resources and Reserves Statement for WesCoal Holdings Limited as at 31 March 2013 (D.S. Coetzee, 2013);
- Continental Coal's Independent Technical Report (SRK, 2011), and internet research;
- Kendal Power Station Routine Monitoring Phase 58 Report No. RVN 601.11/1286, GHT Consulting Scientists, April 2012.

5.2 Locality

Kendal Power Station is situated in Mpumalanga Province 40km south west of Witbank and 6km west of Ogies in the Nkangala District Municipality as indicated on Figure 1.

5.2.1 Site B Locality

Site B (1137.77ha) is located some 3.6km to 9.5km west-northwest of Kendal 'E-House' off the N12, immediately south of the R555, which links the towns of Delmas and Ogies, and the Arbor railway siding. The site lies within Portions 3 and 4 as well as the Remainder of the farm Van Dyksput 214 IR, Portions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13 and 16 of the farm Vlakvarkfontein 213 IR and Portions 36, 38, 52 and 92 of the farm Heuwelfontein 215 IR (Figure 2).

5.2.2 Site C Locality

Site C (950.58ha) is located some 4.8km to 9.8km west of Kendal 'E-House' south of Site B on the opposite side of the Leeuwfonteinspruit. The site lies within Portions 4, 5, 7, 8, 9, 11, 12, 14, 15 and 16 of the farm Vlakvarkfontein 213 IR (Figure 2).

5.2.3 Site F Locality

Site F (1200.91ha) is located some 3km to 8km north-northeast of Kendal 'E-House' between the N12 and the R555 to the west of the Kendal / Balmoral road opposite the Kendal Forest Holdings. The site lies within Portions 9, 18, 33, 34, 40, 41, 42, 80, 84, 96, 97, 99 and the Remainder of the farm Heuwelfontein 215 IR, Henma 291 IR and Portions 7, 10, 11 and 17 of the farm Bankfontein 216 IR (Figure 3).

5.2.4 Site H Locality

Site H (706.40ha) is located some 750m to 3.5km west-northwest of Kendal 'E-House' south of the R555 and east of the Kendal / Balmoral tar road. The Site Lies within Portions 20, 38, 74, 78 and 79 of the farm Heuwelfontein 215 IR and Portions 24, 25, 27, 38 and 39 of the farm Schoongezicht 218 IR Figure 4.

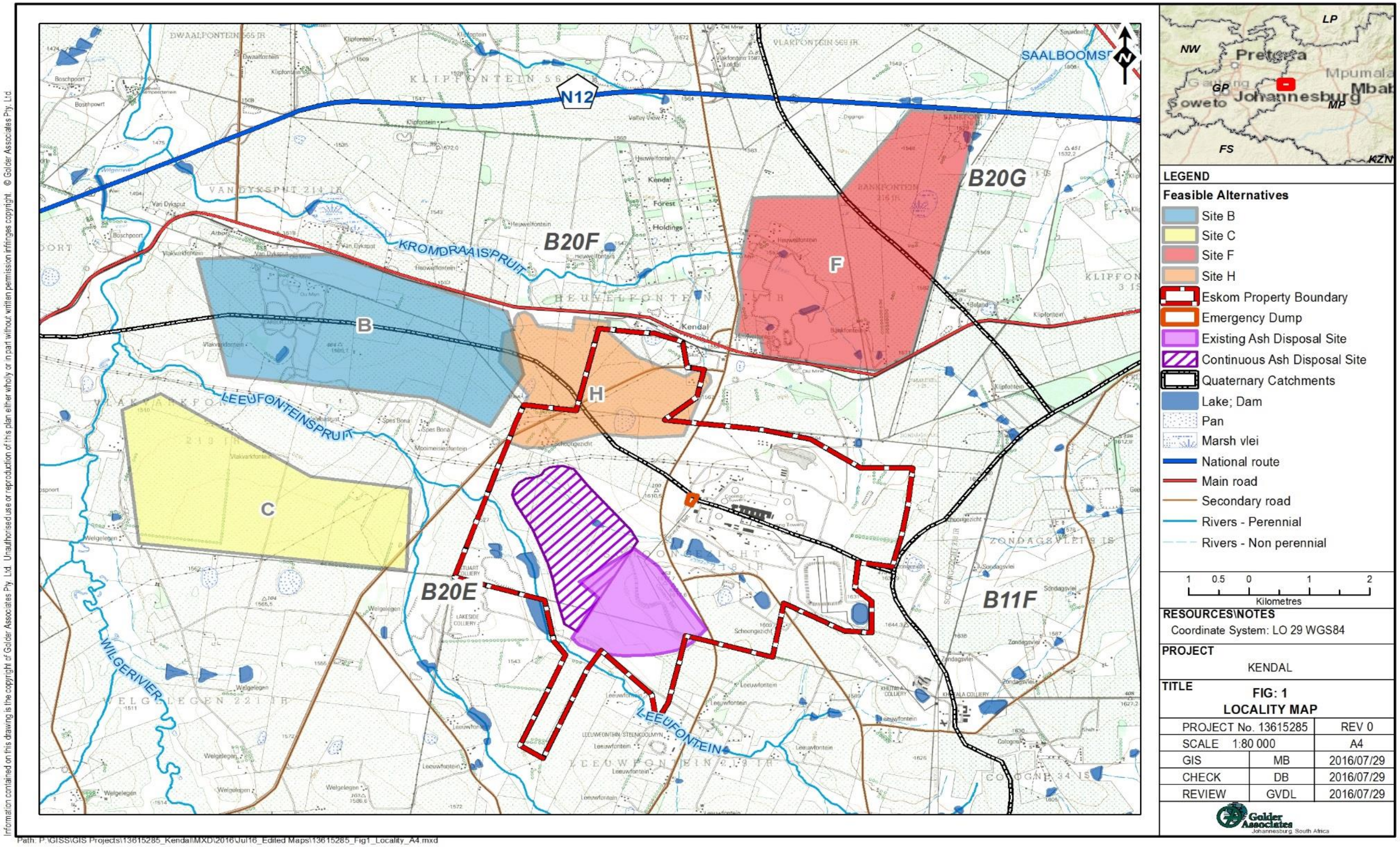

Figure 1: Locality Map

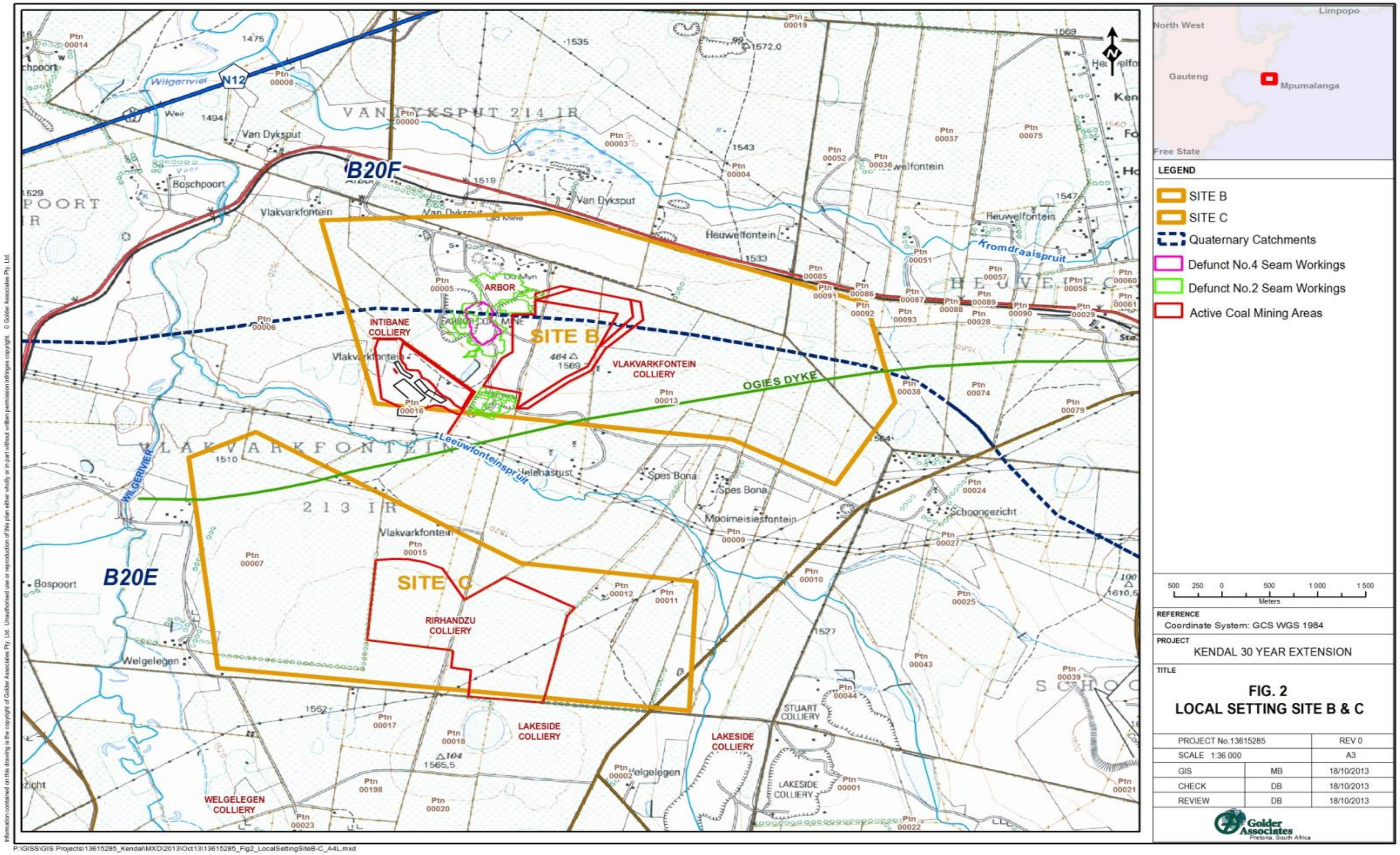

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Figure 2: Local Setting and Topography Site B & Site C

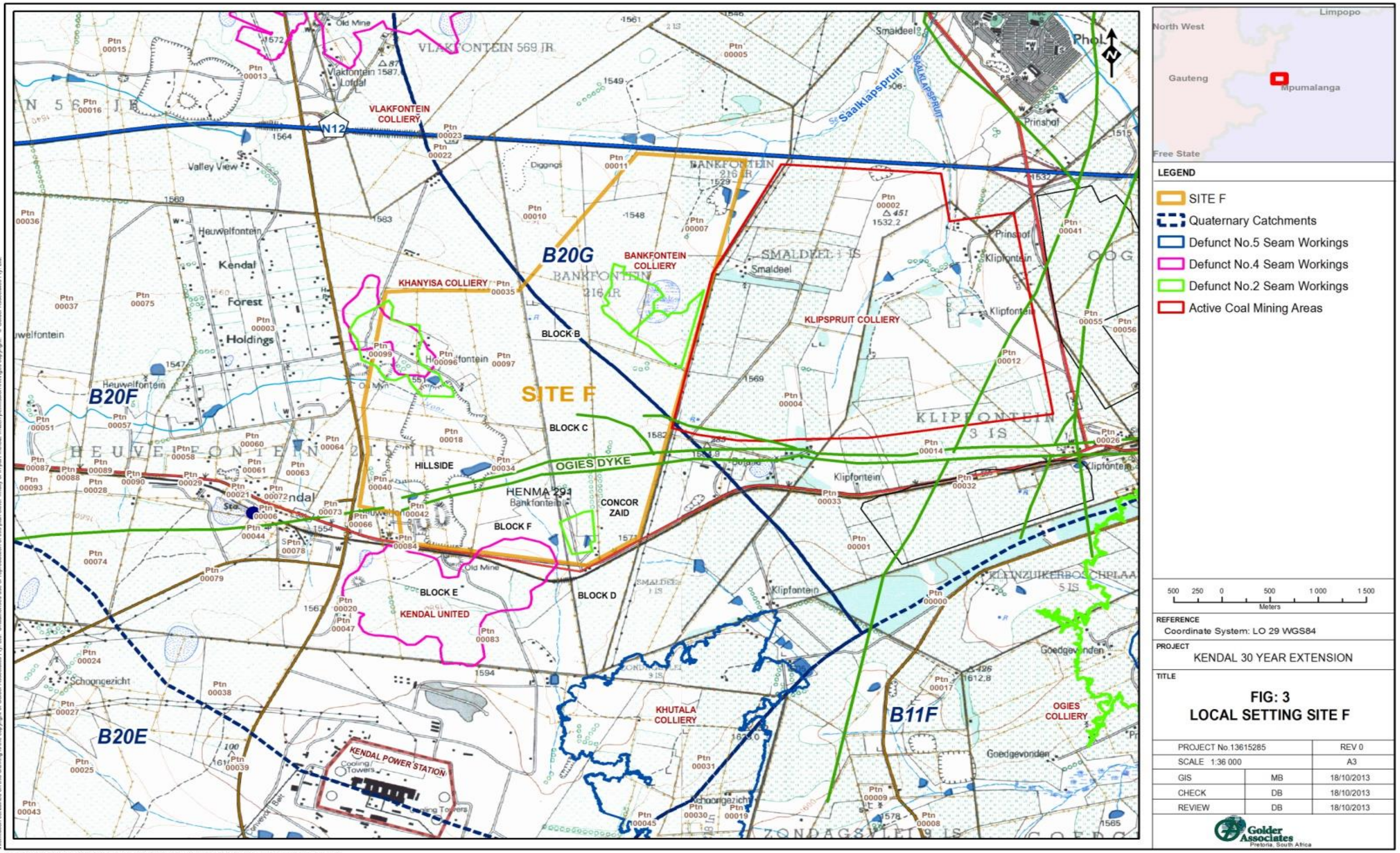

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Figure 3: Local Setting and Topography Site F

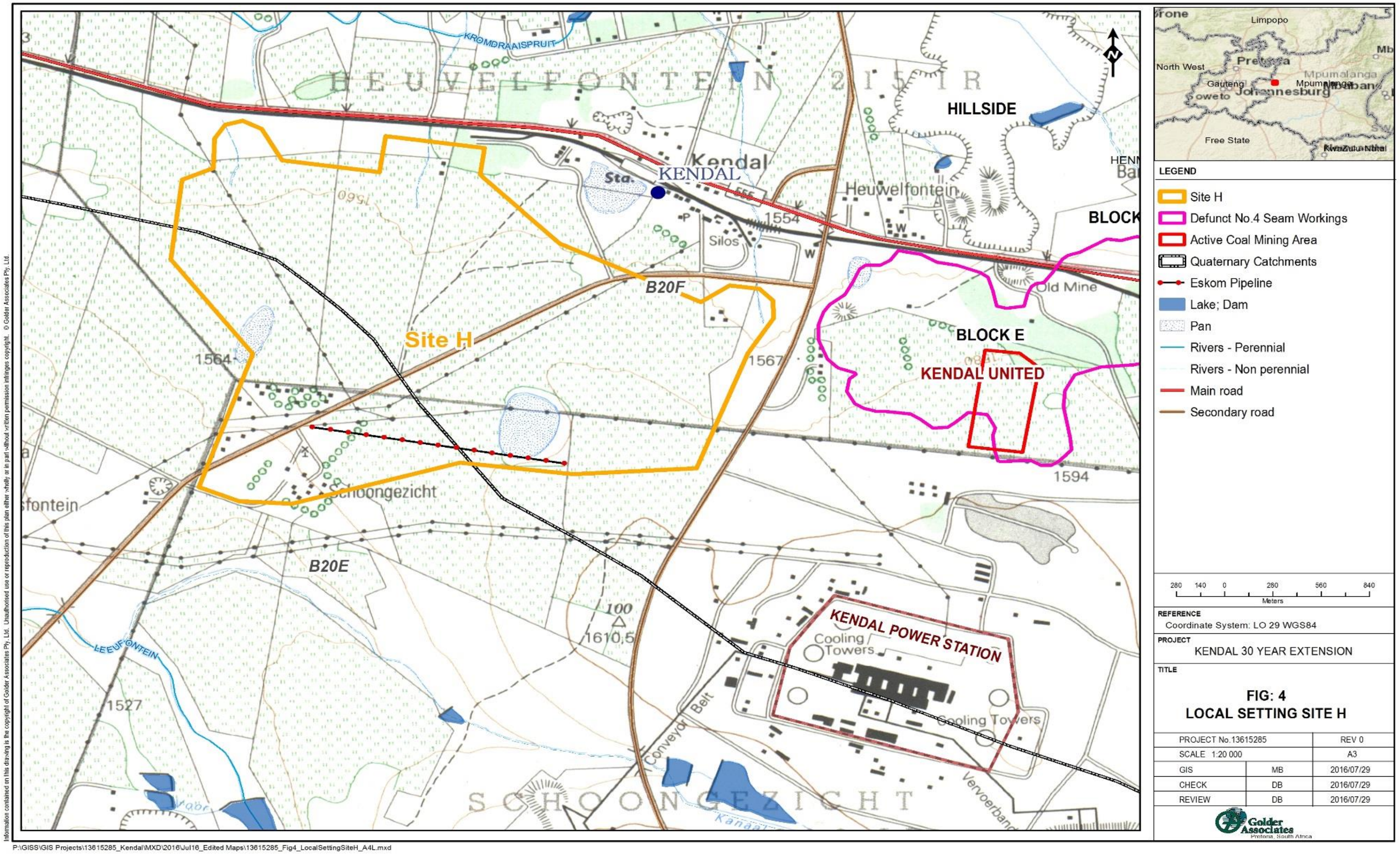


Figure 4: Local Setting and Topography Site H

5.3 Hydrological Setting

5.3.1 Site B Hydrological Setting

Site B is intersected by the surface water divide between quaternary catchment areas B20E and B20F with recorded mean annual precipitations (MAP) of 657.25mm/a and 666.79mm/a respectively. The mean annual evaporation (MAR) across catchment area B20E and the southern half's of catchment areas B20F and B20G is indicated as ranging between 1600mm/a and 1700mm/a (Midgley et al, 1994). Drainage is affected by the Wilge River to the west and two of its tributaries to the north and south of the site. The total length of the main drainage lines bounding the site is approximately 21.5km.

5.3.2 Site C Hydrological Setting

Site C is contained within quaternary catchment area B20E. Drainage is affected by the Wilge River in the west, the Leeuwfonteinspruit in the north and a tributary of the Leeuwfonteinspruit that originates on Zondagsfontein 253 IR to the east of the site. The total length of the main drainage lines bounding the site is approximately 13km.

5.3.3 Site F Hydrological Setting

Site F is intersected by the surface water divide between quaternary catchment areas B20F and B20G. Catchment area B20G has a recorded MAP of 669.29mm/a. Drainage across catchment area B20F is affected by a tributary of the Wilge River that originates on Schoongezicht 218 IR to the east of Kendal 'E-House'. This tributary cuts across Henma 291 IR, the Remainder and Portions 18, 96 and 99 of the farm Heuwelfontein 215 IR over a distance of roughly 3.3km. To the north across catchment area B20G drainage is affected by a number of tributaries of the Saalklapspruit. The total length of the drainage lines bounding the northern most portion of the site is approximately 3.4km.

5.3.4 Site H Hydrological Setting

Site H is intersected by the surface water divide between quaternary catchment areas B20E and B20F with recorded mean annual precipitations (MAP) of 657.25mm/a and 666.79mm/a respectively. Drainage across catchment area B20E is affected by a tributary of the Leeuwfonteinspruit that originates on Schoongezicht 218 IR to the south of Kendal 'E-House' (Schoongezichtspruit Drainage System). To the north across catchment area B20F drainage is affected by a number of tributaries of the Kromdraaispruit of which one originates within the site's north-eastern corner on Portion 20 of the farm Heuwelfontein 215 IR. The total length of the drainage line bounding the southernmost portion of the site is approximately 2.9km. The Kromdraaispruit is located some 1.28km to 2.31km to the north of the site. Centrally the site also features a perennial pan that is intersected by the boundary between Heuwelfontein 215 IR and Schoongezicht 218 IR.

5.4 Topographical Setting

5.4.1 Site B Topography

The topography slopes to the west, the north and the south from an elongated high coinciding with the water divide between quaternary catchment areas B20E and B20F (Figure 2). The maximum elevation along the central part of the site is indicated as 1569.7 meter above mean sea level (mamsl). The slope to the west is roughly 2% and towards the Wilge River, while the slope to the south is towards the Leeuwfonteinspruit, ranging roughly between 4% and 6%, to just more than 3% in the east, with the steepest slope along the central portion of the site. The slope to the north is towards another tributary of the Wilge River that originates on Schoongezicht 218 IR to the east of Kendal 'E-House', and roughly 3%. The fall from east to west along this northern tributary is in excess of 40m, while the fall along the Leeuwfonteinspruit to the south of the site is some 20m, between an upstream elevation of approximately 1517mamsl and 1497mamsl at the confluence with the Wilge River. The lowest point (roughly 1473mamsl) is the confluence between the Wilge River and the northern tributary that binds the site.

5.4.2 Site C Topography

Site C features a topographic high (1560mamsl) along the central portion of its southern boundary from where it slopes radially to the north, from west to east towards the Wilge River, the Leeuwfonteinspruit and a tributary of the Leeuwfonteinspruit that originates on Zondagsfontein 253 IR (Figure 2). The lowest point is the confluence of the Leeuwfonteinspruit with the Wilge River (roughly 1497mamsl). Slopes range between 1.6% and 4.3 averaging roughly at 2.7%.

5.4.3 Site F Topography

The topography slopes from an elongated high (1583mamsl - 1585mamsl) coinciding with the water divide between quaternary catchment areas B20F and B20G towards the northeast with an elevation of approximately 1520mamsl along the north-eastern extent of the site as well as the southwest and the tributary intersecting the south-western extent of the site (Figure 3). This tributary has a fall of approximately 20m across the site ranging between approximately 1540mamsl upon entering the site and 1520mamsl upon leaving the site. The average slope on both sides of the water divide is roughly 2%.

5.4.4 Site H Topography

The topography slopes from an elongated high (1574mamsl - 1613mamsl in the southeast) coinciding with the water divide between quaternary catchment areas B20F and B20E towards the tributary of the Leeuwfonteinspruit and an elevation of approximately 1539mamsl along the south-western extent of the site as well as the north towards the Kromdraaispruit and its tributaries and a minimum elevation of 1561mamsl along the north-eastern extent of the site Figure 4. Centrally drainage around the perennial pan that is intersected by the boundary between Heuwelfontein 215 IR and Schoongezicht 218 IR Figure 5 is towards the pan and an elevation of approximately 1580mamsl. North of the water divide the average slope is in the region of 2.8% while south of the divide the average slope is approximately 4.4%.

Figure 5: South-Westernly view of pan (KEN30-P3)

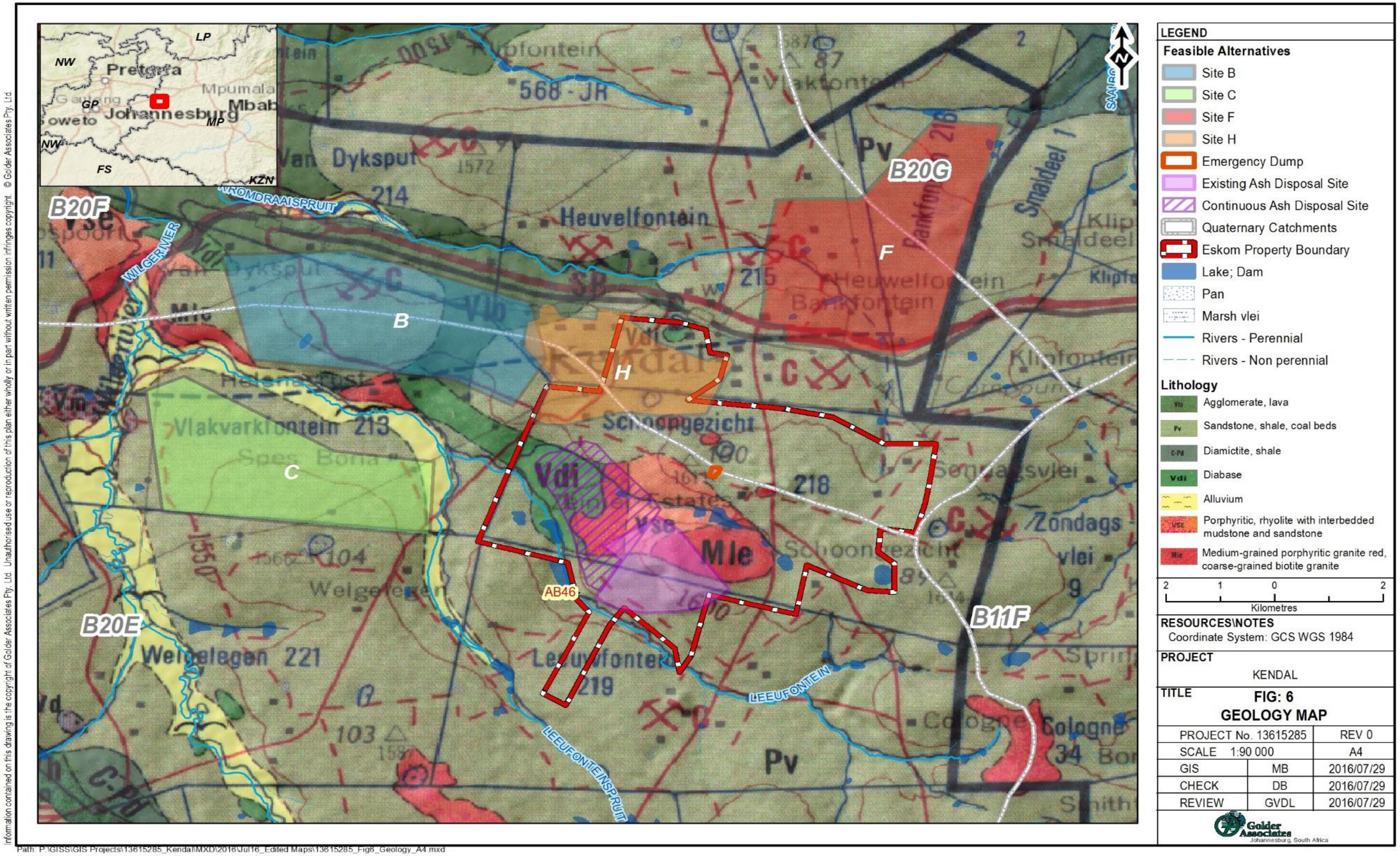


Figure 6: Geology Map

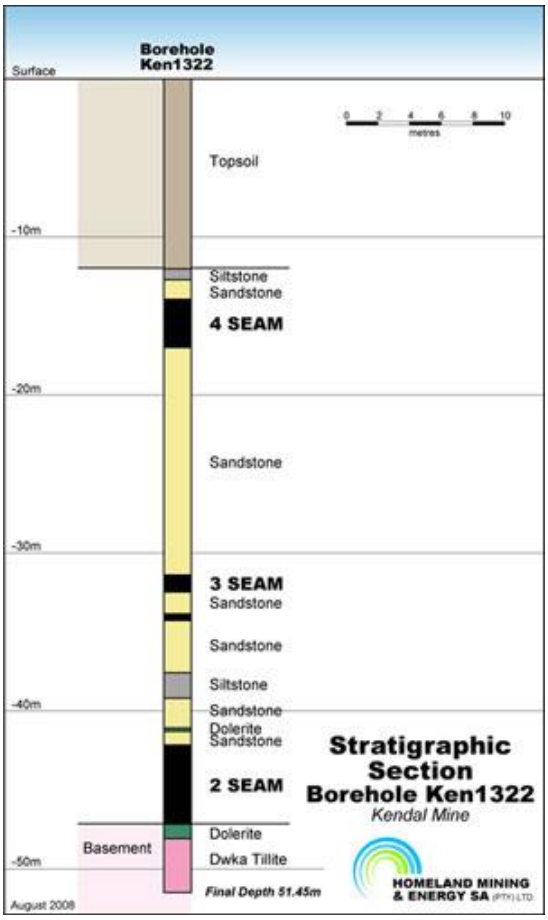


Figure 7: Typical Stratigraphic Section at Kendal Power Station (Homeland Mining & Energy SA, 2008)

5.5 Geological Setting

Based on the published 1:250 000 geology map series (2628 East Rand), the area of investigation is mainly underlain by Karoo Sequence sediments Figure 7. The Karoo Sequence consists of the older Dwyka formation at the base, followed by the Ecca, Beaufort and Lebombo groups. The sediments in the areas of investigation comprise of shale, carbonaceous shale, sandstone and coal of the Vryheid formation of the Ecca Group.

Basement rocks consist mainly of strata of the Selons River Formation (Vse) and the overlying Loskop Formation (Vlo - regarded as the last phase of sedimentation associated with the Transvaal sequence) hosting Nebo Granite (the main part of the Bushveld Granite) and diabase sill intrusions.

Transecting the area of investigation is the west-east striking, post deposition, Ogies dyke, which attains a thickness of approximately 15 m. Local aeromagnetic data in the vicinity of Ogies, is indicative of the Ogies dyke dipping roughly between 73 and 79 degrees to the south. The dyke is also known to feature smaller off-shoots to both the north and south. Sediments up to 20m either side of the dyke have been subjected to folding and jointing.

To the west ‘Quaternary Tertiary’ alluvial deposition is indicated along the Wilge River and two of its tributaries on either side of the R555.

A typical stratigraphic section at Kendal power station is illustrated in Figure 7.

5.5.1 Site B Geology

The western and also largest portion of Site B consists of an almost isolated basin surrounded and underlain by basement rocks, overlain by Dwyka Group tillites and the coal bearing Vryheid Formation. The coal seams attenuate and pinch out against the elevated basement rocks along the basin margins except were they are intersected by present day topography around the central southern part adjacent to the Leeuwfonteinspruit. Within this basin the Karoo succession attains a maximum thickness of approximately 55m to 60m.

This basin, apart from the old Arbor Coal Mine where both the No.2 and No.4 Coal Seams were historically mined underground by board-and-pillar extraction, as well as by opencast mining, also hosts:

- Continental Coal Limited's Vlakvarkfontein Colliery within Portions 3, 5 and 13 of the farm Vlakvarkfontein 213 IR;
- WesCoal' Intibane Colliery within Portion 16 of the farm Vlakvarkfontein 213 IR;
- A historic mine drainage decant seepage zone along the slope to the Leeuwfonteinspruit west of the Dwyka outcrop and north of the Ogies dyke.

As far as Vlakvarkfontein Colliery is concerned, the following:

- The opencast resource is estimated at some 15.6Mt which amounts to more than a 10 years Life of Mine (LoM) at 1.2Mtpa (SRK, August 2011);
- Coal production commenced on the 27th of May 2010.

As far as Intibane Colliery is concerned, the following:

- The opencast resource is estimated at some 2Mt which amounts to 20-26 months (WesCoal, 2012);
- Operations commenced end 2012;
- The far south-eastern part of the Intibane pit intersects historic underground mining.

The central part of the basin host in excess of 31ha historic board-and-pillar underground mining on the No.2 Coal Seam horizon.

The eastern part of Site B is constituted by the eastern rim of the basin featuring a sizeable outcrop of strata from the Loskop Formation (rocky in parts) covered to the east by sediments of the Vryheid Formation. This area can be seen to be intersected by the Ogies dyke.

5.5.2 Site C Geology

This area on Vlakvarkfontein 213 IR is largely underlain by sediments of the Vryheid Formation bounded by substantial 'Quaternary Tertiary' alluvial deposits along the Wilge River to the west, as well as the Leeuwfonteinspruit to the north and east. A basal outcrop of Magaliesburg quartzite (Vm) located to the west of the site is intersected by the Wilge River. Additionally the Ogies dyke can be seen to intersect the north-western corner of the site. Around the central south the Vryheid Formation succession attains a maximum thickness of approximately 50m.

Site C hosts the Mbuyelo Group's Rirhandzu Colliery within Portions 4, 12, 14 and 15 of the farm Vlakvarkfontein 213 IR.

As far as Rirhandzu Colliery is concerned, the following (Mbuyelo Group, 2013):

- LoM is estimated as 6 to 8 years with a confirmed resource of 8Mt;
- Operations commenced on the 5th of July 2013.

Post deposition sills appear to be more prominent south of the Ogies dyke. A transgressive dolerite sill is known to be intersected by present day topography across the southern part of Portion 4 of the farm Vlakvarkfontein 213 IR.

5.5.3 Site F Geology

This area on parts of Heuwelfontein 215 IR, Bankfontein 216 IR and Henma 291 IR is solely underlain by sediments of the Vryheid Formation and does not feature any basal outcrops. The Ogies dyke intersects the southernmost portion of the site containing the historic Hillside opencast mine.

Homeland Energy Group Ltd's Independent Technical Report (SRK, 2007) states the following:

- Sedimentary rocks ranging from coarse grained sandstones to very fine grained mudstones occur both interlaminated and interbedded above and below the target coal seams;
- The lowermost target coal seam, the No. 2 Seam, often occurs directly over the glacial Dwyka tillite, and occasionally in direct contact with the pre-Karoo dolomites of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup);
- Dwyka tillite overlying the pre-Karoo basement lithology of the Malmani dolomites may not always be present;
- The maximum depth drilled on the property is some 70m.

The site, apart from the historic Hillside opencast workings (within Portions 9, 18, 40, 41 & 42 of the farm Heuwelfontein 215 IR (Portions R/E, 40, 41(R/E) and 42 listed as belonging to Shanduka Coal, Synergistic 2010), also hosts:

- WesCoal's Khanyisa Colliery within Portions 96, 97 and 99 of the farm Heuwelfontein 215 IR;
- Homeland Energy Group Ltd's Kendal Colliery (previously named Zaid Colliery (Pty) Ltd) within the farm Henma 291 IR and Portion 83 of the farm Heuwelfontein 215 IR located to the immediate south of Site F, covering some 587ha;
- Shanduka Coal's Bankfontein Colliery within Portions 7 and 10 and 11 of the farm Bankfontein 216 IR (listed as belonging to Trutor Boedery, Synergistic 2010);

As far as Khanyisa Colliery is concerned, the following (WESCOAL, 2013):

- WesCoal acquired portions 96, 97 and 99 of Heuwelfontein 215 IR effective 5 October 2009, under the name of Khanyisa Mine with a remaining, estimated reserve of 2.7 million tons. They also acquired Portion 10 of the farm Bankfontein 216 IR with an inferred resource of 5.1 million tons of high grade thermal coal;
- During July 2012 the Khanyisa reserve was estimated at 1Mt with a life of 10 to 12 months;
- The mine which previously was limited to open cast mining only, due to an extension of the mining plan, now includes underground mining. The extension into underground mining (including pillar extraction at historic Sarie Marais) will add an additional 12 to 18 months to the life of mine at Khanyisa;
- Currently some 45,000 tons per month are produced from the underground workings;
- A PetroNet Pipeline traverses the Khanyisa property.

As far as Kendal Colliery is concerned, the following (Homeland Energy Group Ltd. 2013):

- The Colliery opened October 2008. The resource base, largely opencast was estimated at 34Mt. The mineralized deposit includes the No.4, upper and lower, No.3 and No.2 coal seams;
- Following numerous operational setbacks, including flooding in the mine, the significant incidence of dykes and sills in the coal seams and the discovery that the underground workings in the E Block (Portion 83) had been mined to a more significant extent than had previously been indicated (underground production occurred in the Block E No. 4 Seam between the 1910s and the 1950s – old Kendal United Colliery), Homeland announced on the 28th of March 2013 that they had entered into an agreement with the Joe Singh Group of Companies (Pty) (Ltd.), who are to acquire a 100% interest in the Kendal Colliery through the purchase of all of the issued and outstanding common shares of Ferret Coal (Kendal)(Pty)(Ltd.). In terms of the head of agreement the Purchaser has been retained to commence mining operations at Kendal effective April 1, 2013;
- Open cast mining (including pillar extraction on the historically mined No.4 seam) at Block E by Just Coal is currently taking place.

As far as Bankfontein Colliery is concerned, the following:

- Upon commissioning it was announced that Bankfontein should produce one million tons of coal a year, of which half will target Eskom and half export or non-Eskom domestic markets;
- Mining, opencast only, commenced around 1998 and ceased during 2009;
- The mine footprint is some 178ha contained in a lease area of 419ha;
- Rehabilitation is almost complete. A void with a softs stockpile for final rehabilitation is left. Drainage across the rehabilitated opencast section is towards the northeast. The site also features a partially covered dry slimes dam, a discard dump (60 000m^3) with a small slimes dam to the immediate north of it, as well as a mini-pit previously used as water supply/reservoir to the wash plant.

5.5.4 Site H Geology

Site H is almost entirely underlain by sediments of the Vryheid Formation featuring two small Nebo Granite inliers on Schoongezicht 218 IR as well as a small diabase sill outcrop along the central northern boundary of the site.

The Karoo sediments can be seen to pinch out against basal outcrops of the Loskop Formation some 500m to 1.4km to the north and west as well as diabase sill, Nebo Granite and rocks of the Selons River Formation to the south. The south-western corner of the site transects a minor portion of the sill outcrop while the south-eastern corner of the site intersects a portion of the mentioned Selons River Formation.

Site H is transected to the north by the west-east striking, post deposition, Ogies dyke.

Although Site H does not feature any current or known historical coal mining activities, it is bounded in the northeast by the historic Kendal United No.4 seam underground workings. Open cast mining (including pillar extraction on the historically mined No.4 seam) at Block E by Just Coal is currently taking place.

5.6 Regional Hydrogeology – Aquifer Classification

The published hydrogeological map series (DWAF 1996) was used to define the mean annual groundwater recharge for the three alternative sites (Figure 7).

The published hydrogeological map series by DWAF (1996) was used to define the regional aquifer classification (Figure 7).

Groundwater vulnerability gives an indication of how susceptible an aquifer is to contamination. Aquifer vulnerability is used to represent the intrinsic characteristics that determine the sensitivity of various parts of an aquifer to being adversely affected by an imposed contaminant load.

The national scale groundwater vulnerability map of South Africa prepared by the WRC (Water Research Commission) was used to define the aquifer vulnerability for the three alternative sites (Figure 7). The map incorporates the DRASTIC methodology that includes the following components:

- **D**epth to groundwater, **R**echarge due to rainfall, **A**quifer media, **S**oil media, **T**opography, **I**mpact on the vadose zone and Hydraulic **C**onductivity.

5.6.1 Site B Hydrogeological Setting

- The average recharge for Site B is indicated as ranging between 50mm to 75mm per annum.
- The aquifer is classified as a minor aquifer system.
- The aquifer type is indicated as intergranular and fractured.
- The average borehole yield in the area is indicated as ranging between 0.5l/s and 2.0l/s.
- Groundwater vulnerability is indicated as **medium to low**.

5.6.2 Site C Hydrogeological Setting

- The average recharge for Site C is indicated as ranging between 50mm to 75mm per annum.
- The aquifer is classified as a minor aquifer system.

- The aquifer type is indicated as intergranular and fractured.
- The average borehole yield in the area is indicated as ranging between 0.5l/s and 2.0l/s.
- Groundwater vulnerability is indicated as **low to medium**.

5.6.3 Site F Hydrogeological Setting

- The average recharge for Site F is indicated as ranging between 50mm to 75mm per annum.
- The aquifer is classified as a minor aquifer system.
- The aquifer type is indicated as intergranular and fractured.
- The average borehole yield in the area is indicated as ranging between 0.5l/s and 2.0l/s.
- Groundwater vulnerability is indicated as **low**.

5.6.4 Site H Hydrogeological Setting

- The average recharge for Site H is indicated as ranging between 50mm to 75mm per annum.
- The aquifer is classified as a minor aquifer system.
- The aquifer type is indicated as intergranular and fractured.
- The average borehole yield in the area is indicated as ranging between 0.5l/s and 2.0l/s.
- Groundwater vulnerability is indicated as **low to medium**.

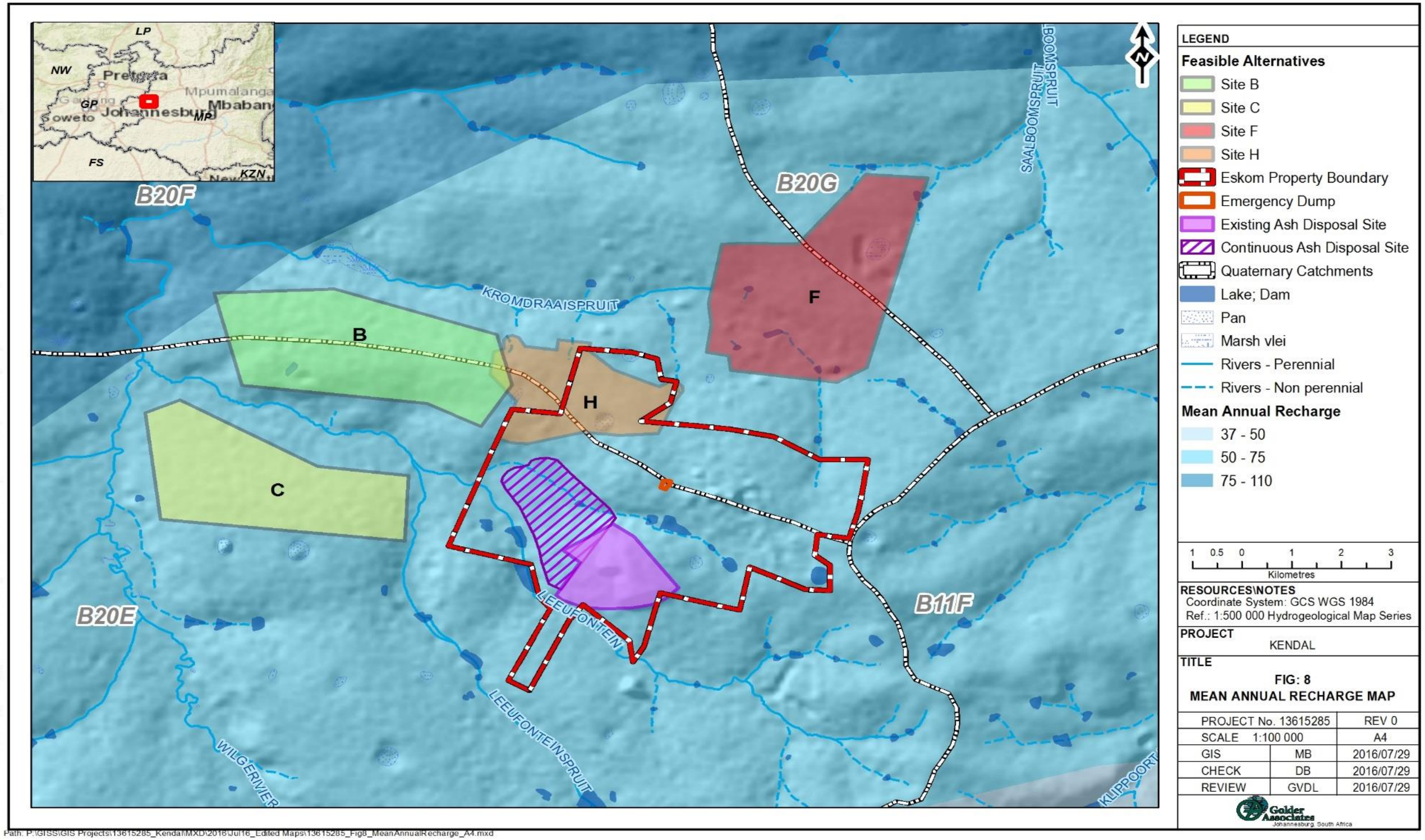


Figure 8: Mean Annual Groundwater Recharge

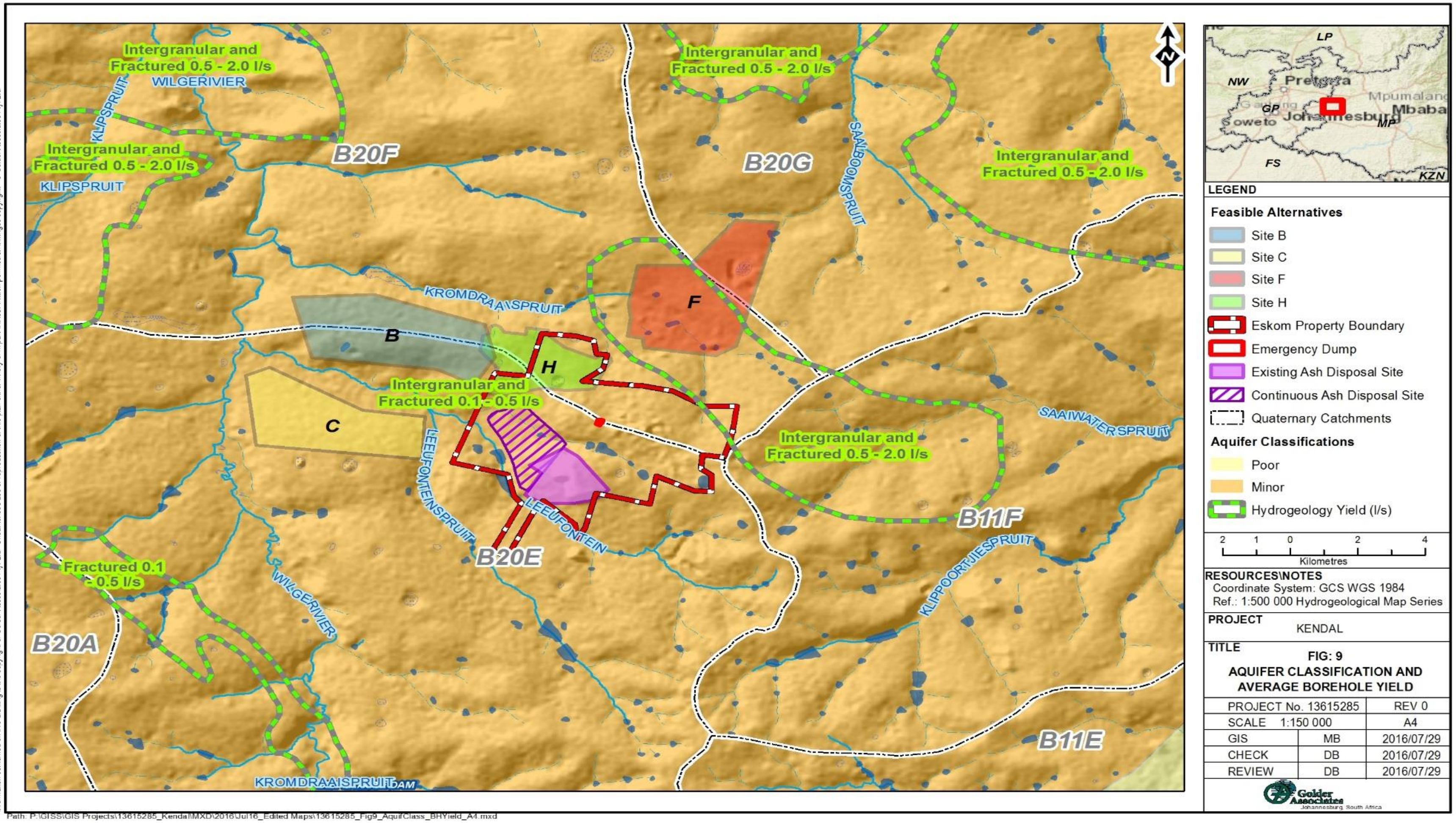


Figure 9: Aquifer Classification and Average Borehole Yield

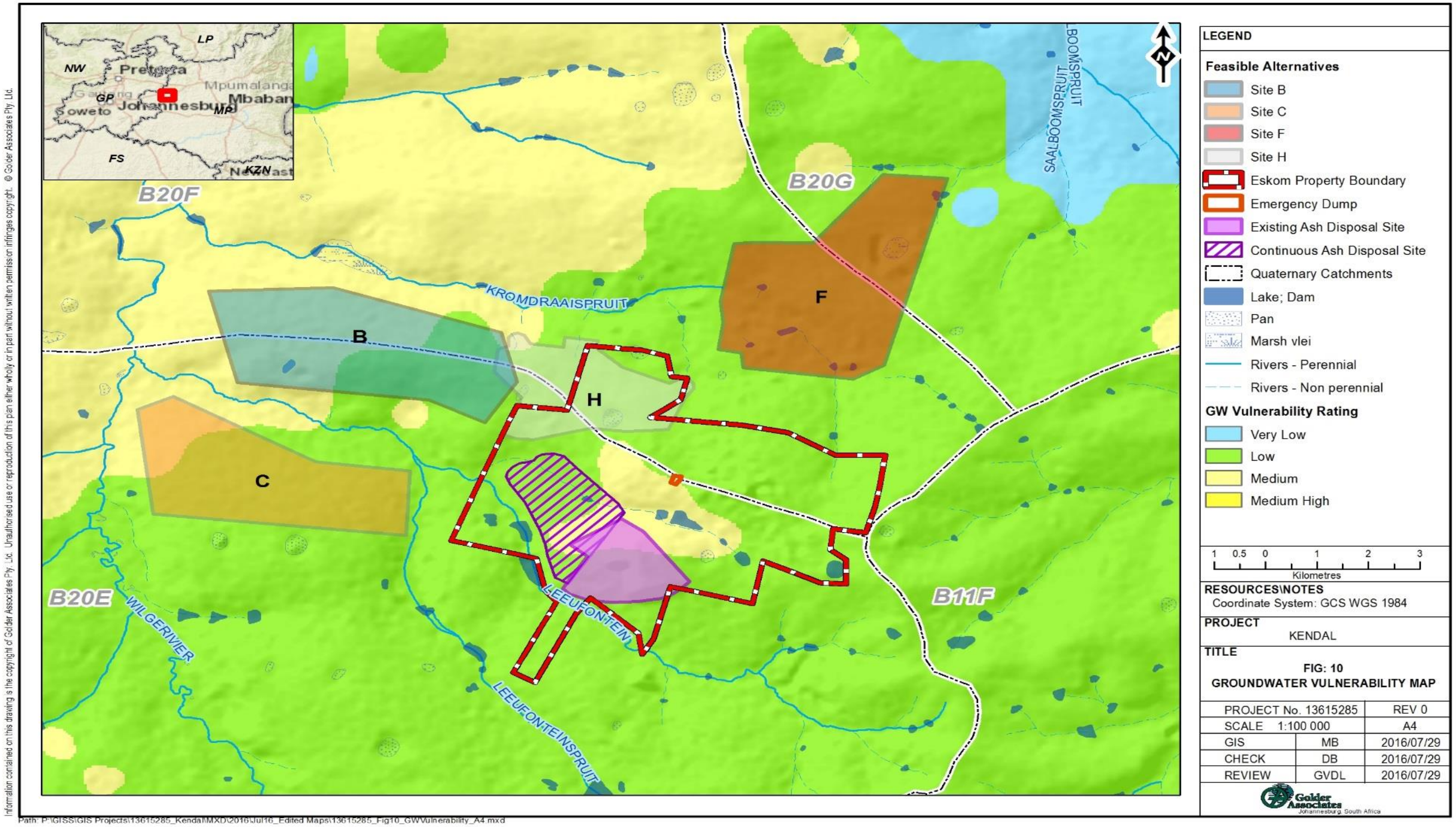


Figure 10: Groundwater Vulnerability Map

Hydrocensus

During September 2013 Golder conducted a hydrocensus to locate private owned boreholes, springs and other related water use infrastructure within a 1km radius of the 3 alternative sites selected for possible continuous ash disposal. The census was updated during February 2014 to include Site H. The localities of the surveyed boreholes and springs are indicated on Figure 11 through to Figure 13.

All coordinates were measured with a hand held GPS using the WGS 84 reference datum. The hydrocensus information are summarised in Table 1 through to Table 6 with a photo record attached in Appendix A.

A total of 47 sites were surveyed within a 1 km radius of Sites B and C which are located close to each other on opposite sides of the Leeuwfonteinspruit. These include 30 boreholes, 3 dug wells, 2 pans, 10 fountains, including an irrigation abstraction point in the 'Schoongezicht Drainage System' as well as a historic decant point associated with the old Arbor Colliery. Five boreholes were recorded as being destroyed and another 3 as unused. Six of the boreholes south of the Leeuwfonteinspruit are monitoring boreholes used for observation. Another two mine boreholes, of which one has recently been destroyed were used for pumping water to underground sections.

A total of 52 sites, 46 boreholes and 6 reservoirs were surveyed within a 1km radius of Site F. Thirty of the boreholes were recorded as in use. Six of these are observation boreholes used for monitoring purposes.

Apart from the 3 boreholes Site H has in common with Site B, as well as 8 boreholes and 4 reservoirs it has in common with Site F, another three points, including a pan with a pump station, a fountain as well as a dam with a pump station in the 'Leeuwfonteinspruit Drainage System', were surveyed within a 1km radius of Site H. This site also features several monitoring points belonging to the Kendal Power Station Monitoring System with existing information.

Ten water samples were taken during the census, 3 at Site B, 3 at Site C and 4 at Site F. Additionally another 3 water samples were taken at Site H.

5.6.5 Site B Hydrocensus

The Department of Water Affairs (DWA), Directorate Water Services Macro Planning and Information Systems, December 2010 demographics for the Victor Khanye Water Services Authority (WSA) indicates the Arbor informal settlement (Settlement Id. 08B20F001) to consist of 45 households with a population of 200 people. It is however obvious that the settlement has grown much larger than this. The Village and the Arbor Primary School (238 pupils – recorded 2009) is supplied with potable drinking water from borehole KEN30-B6. This borehole is equipped with a submersible pump and a chlorinator. The water is pumped to a raised reservoir at the borehole and another raised reservoir at the primary school. The water is also distributed to a number of taps around the village from the raised reservoir at the borehole. A pumping water level of 28.24 meter below the collar (mbc) was observed in this borehole. The only other water supply point observed to be in use is a dug well at the village shop (KEN30-D1).

The Trutor Boerdery Trust boreholes on Van Dyksput 214 IR (KEN30-B1 to B5 & B9) are located between the northern site boundary and the tributary of the Wilge River that originates on Schoongezicht 218 IR. The surface lithology pertaining to these boreholes is predominantly pyroclastic rocks (tuff, agglomerate & breccia) of the Loskop Formation (Vlo). All six boreholes are in use for domestic purposes, supplying 4 houses, 4 gardens, 1 office complex, 2 workshops and 3 employee housing complexes consisting of 10-12 units incorporating some 160 people. Approximately 200 hectares wheat and soy (2 cycles per annum) are irrigated under an existing water use from the mentioned tributary. Some 1200 large stock units and 100 small stock units are also watered from this stream.

In the south, within the Intibani Colliery reserve area, on the slope between the site boundary and the Leeuwfonteinspruit, some 500m to the west of the historical mine water decant seepage area (KEN30-O1) that was dry during the time of the census, is a fountain (KEN30-F4) and a dug well (KEN30-D2). The dug well is situated on rocks of the Lebowa Granite Suite (Mle). A water level of 1.65mbc was observed in this well. The fountain which constitutes a kidney shaped wet area of roughly 20x8m along the bank of the Leeuwfonteinspruit, below the Lebowa Granite Suite (Mle) outcrop, was noted as dry. The well provides some 8 people with water.

Some 500m plus, to the east of the decant seepage zone, contained within Vlakvarkfontein Colliery's surface rights area, are two more fountains (KEN30-F5 & F6) flowing towards the Leeuwfonteinspruit. A flow of roughly 0.3l/s was observed for KEN30-F5, while the flow at KEN30-F6 annually ranges approximately between 0.25l/s and 1.00l/s. Close by, the property also features a broken windmill (KEN30-B20) and a borehole that is equipped with a submersible pump (KEN30-B19). These points are located on rocks of the Lebowa Granite Suite (Mle) immediately south of the Ogies Dyke.

Located further to the east are 5 more boreholes (3 different owners), all equipped with submersible pumps, supplying some 114 people, 425 large stock units and 150 small stock units with water (KEN30-B21 to B25). The stock units however, mostly drink from the Leeuwfonteinspruit.

In the far southeast at KEN30-F11, some 230ha is irrigated intermittently from a dam within the 'Schoongezichtspruit Drainage System' originating on Ptn.21 of the farm Schoongezicht 218 IR. However, irrigation water is currently sourced from the 'Leeufonteinspruit Drainage System' (P11) on Portion 44 of the farm Schoongezicht 218 IR (see Figure 5; Figure 7 and Figure 4).

The number of groundwater production points in use within a 1km radius of Site B to the north of the Leeuwfonteinspruit is 12 boreholes and two dug wells.

5.6.6 Site C Hydrocensus

Site C only features two external user's boreholes. Borehole KEN30-B10 located on Ptn.2 of the farm Welgelegen 221 IR is used for agricultural and domestic purposed and supply 7 people and some 270 large stock units with potable water.

The other, KEN30-B18 (Welgelegen 221 IR Ptn.1) discharges into a nearby pan (KEN30-P2), some 380m to the south, and is used for agricultural irrigation purposes, currently some 39ha of wheat. The discharge rate of this borehole was estimated at 2.0l/s. Some 900m due east, bordering Lakeside Colliery's western opencast workings, is another pan (KEN30-P2) also used for irrigation purposes. Both pans are used as reservoirs, with the bulk of the water being pumped from the Wilge River and one of its tributaries to the south.

To the far south on Welgelegen 221 and in close proximity to Welgelegen Colliery, located in the mentioned Wilge River tributary, are 3 dams (KEN30-F9) with associated baseflow contributions that are also used for agricultural irrigation purposes.

To the southeast, Portion 7 of the farm Vlakvarkfontein 213 IR features 2 dams with associated baseflow contributions (KEN30-F7 & F8) in close proximity to the Wilge River. Both are used for agricultural irrigation purposes with the bulk water being pumped from the Wilge River.

Locally Trutor Boerdery Trust's agricultural activities are supported by infrastructure with a well-developed pipe network.A dug well KEN30-D3 on Ptn.5 of the farm Vlakvarkfontein 213 IR supplies two people with potable drinking water.

A fountain KEN30-F2 on Ptn.5 of the farm Vlakvarkfontein 213 IR with a discharge rate of some 1.25l/s supplies 1 person with drinking water. Flow is towards the Wilge River.

Wetland conditions associated with alluvial deposition occur across large tracks of land along the Wilge River and the Leeuwfonteinspruit, as well as some of their tributaries.

North of KEN30-F8 and in close proximity to the Ogies dyke, at KEN30-F1, is a wetland area that pinches out against an outcrop of Magaliesburg quartzite (Vm). Discharge to the Wilge River was estimated at 2.5l/s.

Along the central northern part of the area at KEN30-F10 is a wetland area with baseflow seepage/ponding along the side of the farm road.

Apart from 6 monitoring boreholes surveyed across the area the number of water production points in use within a 1km radius of Site C to the south of the Leeuwfonteinspruit is 2 boreholes, one dug well and 4 fountains.

5.6.7 Site F Hydrocensus

The area is bounded to the west by the Kendal Forest Holdings. Eight small holdings were visited during the census. Eleven boreholes on Plots 4, 9, 12, 32, 35 & 37 (one unknown) were found to be in use supplying some 317 people, 110 large stock units, a workshop, a vehicle wash bay, and truck wash with water. Another borehole KEN30-B46 on Plot 32 is used for gardening purposes only due to its poor potability. Total usage is estimated at 97.5m^3/day. Borehole KEN30-B43's yielding capacity (Plot 32) was reported as decreasing. A 90m deep water supply borehole KEN30-B44 was drilled by the mine, presumably Khanyisa Colliery, on this property (Plot 32) for future use.

South of the small holdings on Portion 27 of the farm Heuwelfontein 215 IR, water supply is from two boreholes (KEN30-B34 & B36), supplying some 35 houses on and around the property as well as 60 large stock units with water.

A small informal settlement of some 30 houses is located in the northwest on Portion 11 of the farm Heuwelfontein 215 IR. Water supply is from a hand pump KEN30-B53. The potability is reported as poor. Bulk water supply is from a 10m^3 reservoir KEN30-X5 with water being carted by the local authority.

Some 900m to the south on Portion 13 of the farm Heuwelfontein 215 IR is another small informal settlement consisting of 12 houses. Water supply is from a hand pump KEN30-B54. This borehole is reported as being nearly dry and the water is dirty. Bulk water supply is from a 10m^3 reservoir KEN30-X6 with water being carted by the local authority.

Further south at Khanyisa Colliery, on Portions 99 and 96 of the farm Heuwelfontein 215 IR are two boreholes, KEN30-B62 & B63, supplying a small primary school and the farmstead with water. The latter is reported to have been drilled by the mine and supplies 6 people and approximately 150 large stock units with water.

Along the south-western extent of Site F, just outside the boundary delineation in close proximity to the Ogies dyke, on Portions 66, 40 & 41 of the farm Heuwelfontein 215 IR, adjacent to the old Hillside opencast workings, is an informal settlement of some 95 houses. Bulk water supply is from four 5m^3 (KEN30-X1) and one 2.5m^3 (KEN30-X2) reservoirs with water being carted weekly by the local authority. The settlement also features a play pump (KEN30-B29) as well as a hand pump (KEN30-B30). Both are recorded as not being in use.

Further west, north of the Afgri Silos (who together with the settlement to their immediate west are supplied with water from Eskom), and south of the R555 on Portion 31 of the farm Heuwelfontein 215 IR, is a settlement of roughly 25 houses. Water supply is from a hand pump KEN30-B31. The settlement also has a reservoir (KEN30-X3) consisting of two 5m^3 tanks which are filled weekly by local authority. North of the R555 on Portion 72 of the farm Heuwelfontein 215 IR, borehole KEN30-B32 supplies 6 people and a shop with water. Usage is estimated at 2m^3 per day. On the same Portion a 5m^3 reservoir (KEN30-X4), also being filled weekly by local authority, supplies a settlement consisting of some 25 dwellings with water.

To the far southwest on Portion 47 of the farm Heuwelfontein 215 IR, west of the mining operations on Portion 83 (current and historic), a windmill (KEN30-B37) supplies Kayalethu Village, consisting of some 15 houses with water.

In the southeast on Klipfontein 3 IS borehole KEN30-B60 is used to spray herbicide. Usage is estimated at 1750m^3/annum. Borehole KEN30-B61 supplies 40 people, two gardens and some 400 large stock units with water. The usage is estimated at 20m^3 per day.

A total of 7 monitoring boreholes were also surveyed across the northern part of the area. The number of water production points (groundwater) in use within a km radius of Site F is 24 boreholes.

5.6.8 Site H Hydrocensus

Centrally Site C features a perennial pan (KEN30-P3) that is intersected by the boundary between Heuwelfontein 215 IR and Schoongezicht 218 IR. The pan forms part of the local agricultural irrigation system totalling some 230ha (maize & soya). Infrastructure allows for water to be pumped from the 'Schoongezictspruit Drainage System' at KEN30-F11 between Kendal Power Station's surface water monitoring points R04 and PP05 as well as from the dam in the 'Leeuwfonteinspruit Drainage System' located between the current ashing activities and Lakeside Colliery's infrastructure (Kendal Power Station's surface water monitoring point P11). The latter is currently in use as the former's pipeline is leaky. The pump station in the 'Leeuwfonteinspruit Drainage System' apart from pumping to the pan also drives two centre pivots situated between these two 'Drainage Systems'. The pump station at the pan drives 3 centre pivots located to the southwest, north and northeast of the pan. Water pumped from the 'Leeuwfonteinspruit Drainage System' has a strong hydrogen sulphide smell. According to the farm manager this has been the case since the beginning of the current rainfall season.

The Kendal Power Station Routine Monitoring Phase 58 Report No. RVN 601.11/1286 by GHT Consulting Scientists indicates that:

- There are a sulphate, sodium, calcium and potassium impact on the 'Schoongezictspruit Drainage System' associated with the ash transfer system in the Power Station Area, the Ash Stack and its associated operation just north of the stack;
- There is a mining impact (elevated sulphate concentrations) on the 'Leeuwfonteinspruit Drainage System'.

Also, in close proximity to the pan is an unfinished Eskom substation/pump house with an associated, recently commissioned pipeline (water) that cuts across Schoongezicht 218 IR to the west and transects the north-eastern corner of Site B (Figure 11; Figure 12 and Figure 13).

The external users points shared with Site F (KEN30-B26 to B33 as well as KEN30-B37 and KEN30-X1 to X4) have already been described in the previous section and won't be detailed here again, apart from stating that only 5 of the 8 boreholes are in use; and apart from supplying 36 people with some 17m^3/day, another 40 households are supplied from two of these boreholes.

Site H has three previously surveyed external users boreholes in common with Site B (KEN30-B22, B24 & B25), as well as the irrigation abstraction point in the 'Schoongezicht Drainage System' namely KEN30-F11. All three of these boreholes are in use supplying some 97 people, 25 large stock units and 130 small stock units with water.

During the recent update only one unused fountain (KEN30-F12) was surveyed on Portion 78 of the farm Heuvelfontein 215 IR. A flow of 0.4l/s was estimated towards the tributary of the Kromdraaispruit that originates on Portion 20 of the same farm.

The number of groundwater production points observed to be in use within a km radius of Site H is 8 boreholes.

As previously stated Site H features several monitoring points with existing information belonging to the Kendal Power Station Monitoring System. A number of relevant groundwater monitoring boreholes selected for evaluation are presented in Table 1 below.

Table 1: Site H – Kendal Power Station Groundwater Monitoring Boreholes

Borehole Number	Latitude	Longitude	SWL (mbgl)	SWL_2013 (mamsl)	SWL Date measured	Depth (m)	Yield (l/s)	Aquifer Monitoring Zone
AB07	26.09261229	28.95222	4.4	1574	2013/03/13	40	0.2	Deep
AB21	26.0915123	28.94692	3.47	-	2009/11/12	30	0.01	Deep
AB52	26.0900023	28.94366	3.53	-	2012/10/24	31	0.015	Deep
AB53	26.0899623	28.94363	1.63	-	2012/10/24	6	-	Shallow
PB06	26.09021228	28.95492	2.22	1600	2013/03/12	40	0.1	Deep
PB23	26.09141228	28.95522	1.06	1598	2013/03/12	21	0.1	Deep
PB58	26.08473225	28.95796	17.16	1591	2013/03/13	31	-	Deep
PB59	26.08244224	28.96010	3.19	1603	2013/03/13	31	-	Deep

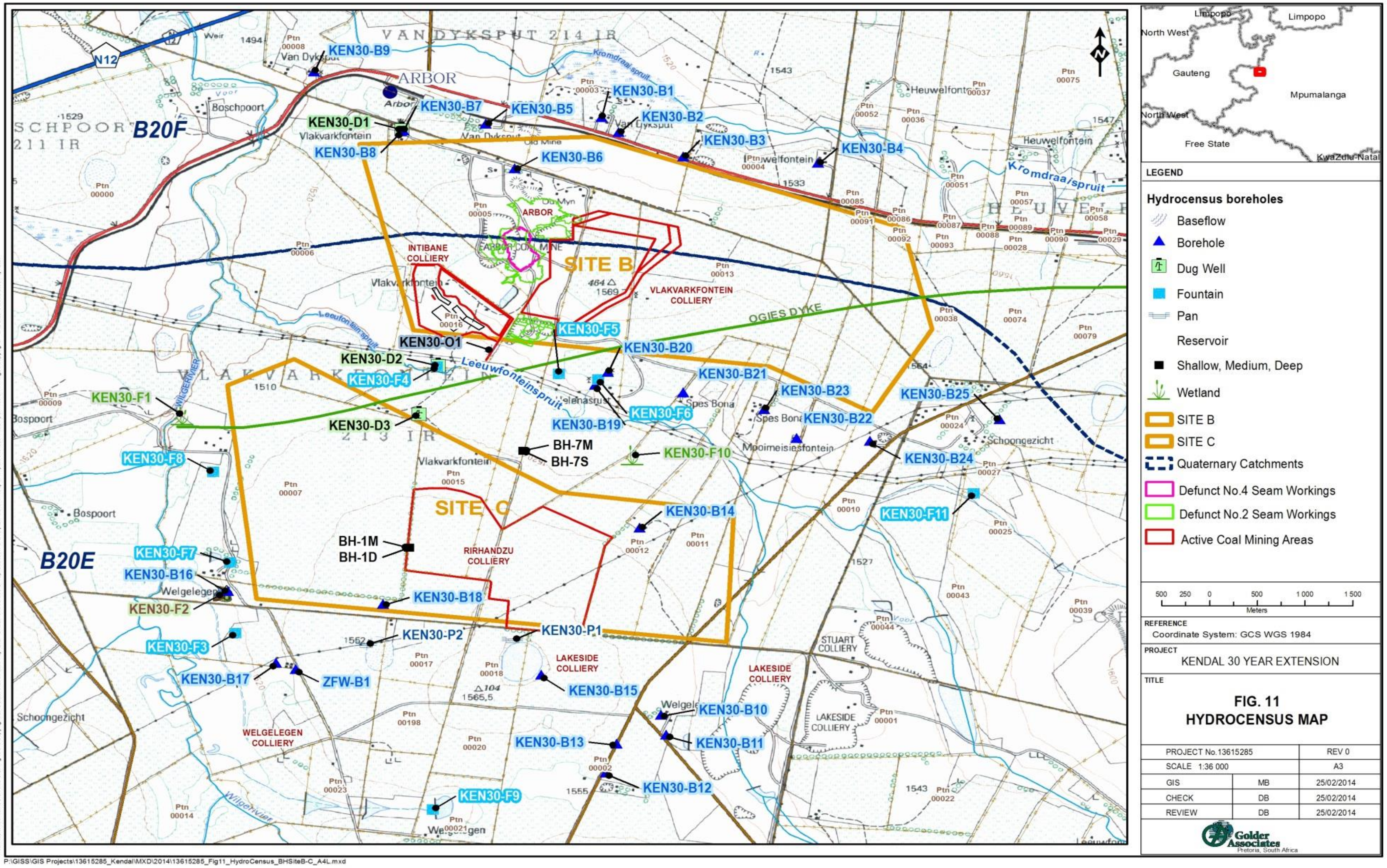


Figure 11: Hydrocensus Map Site B and Site C

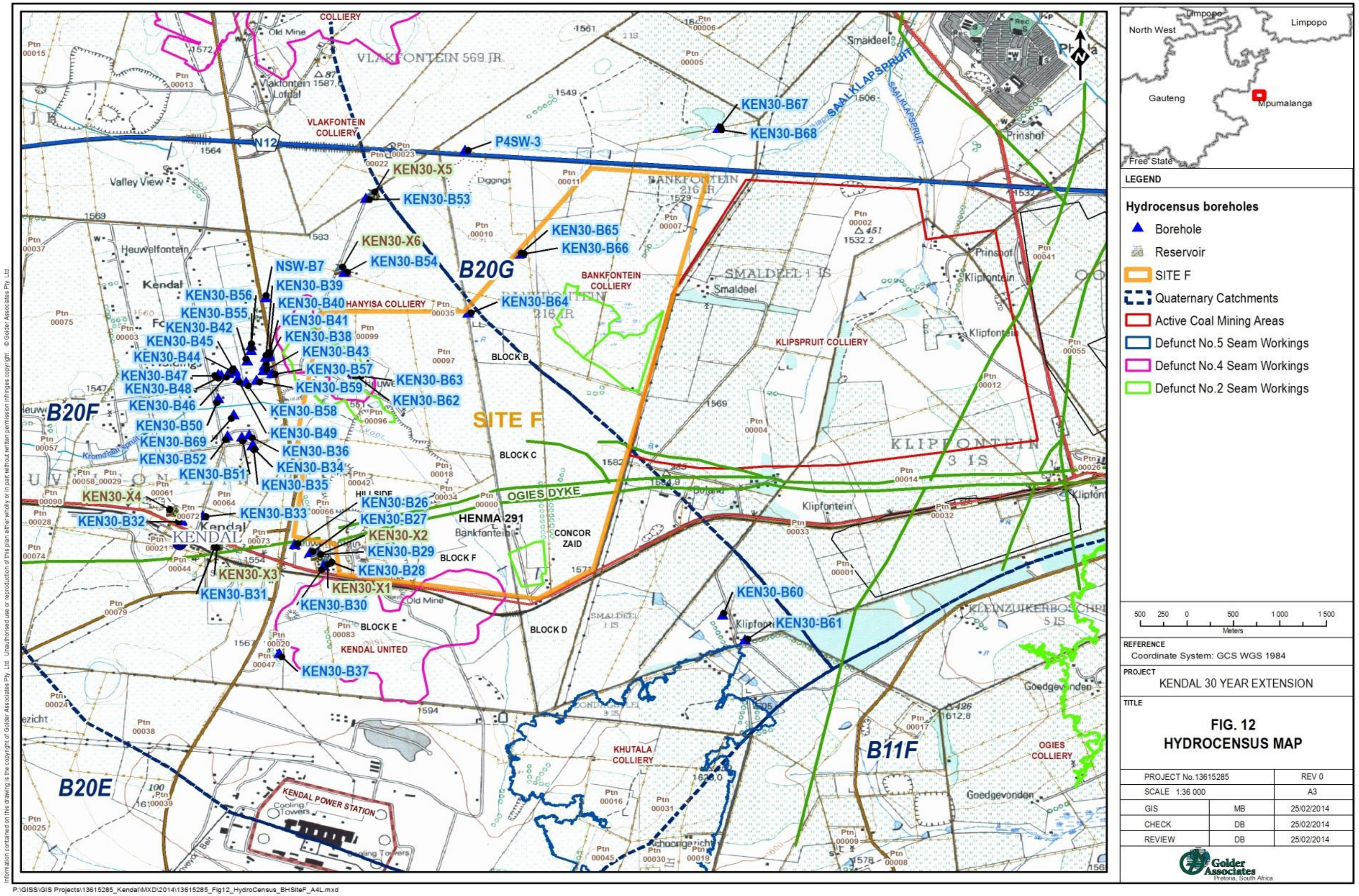


Figure 12: Hydrocensus Map Site F

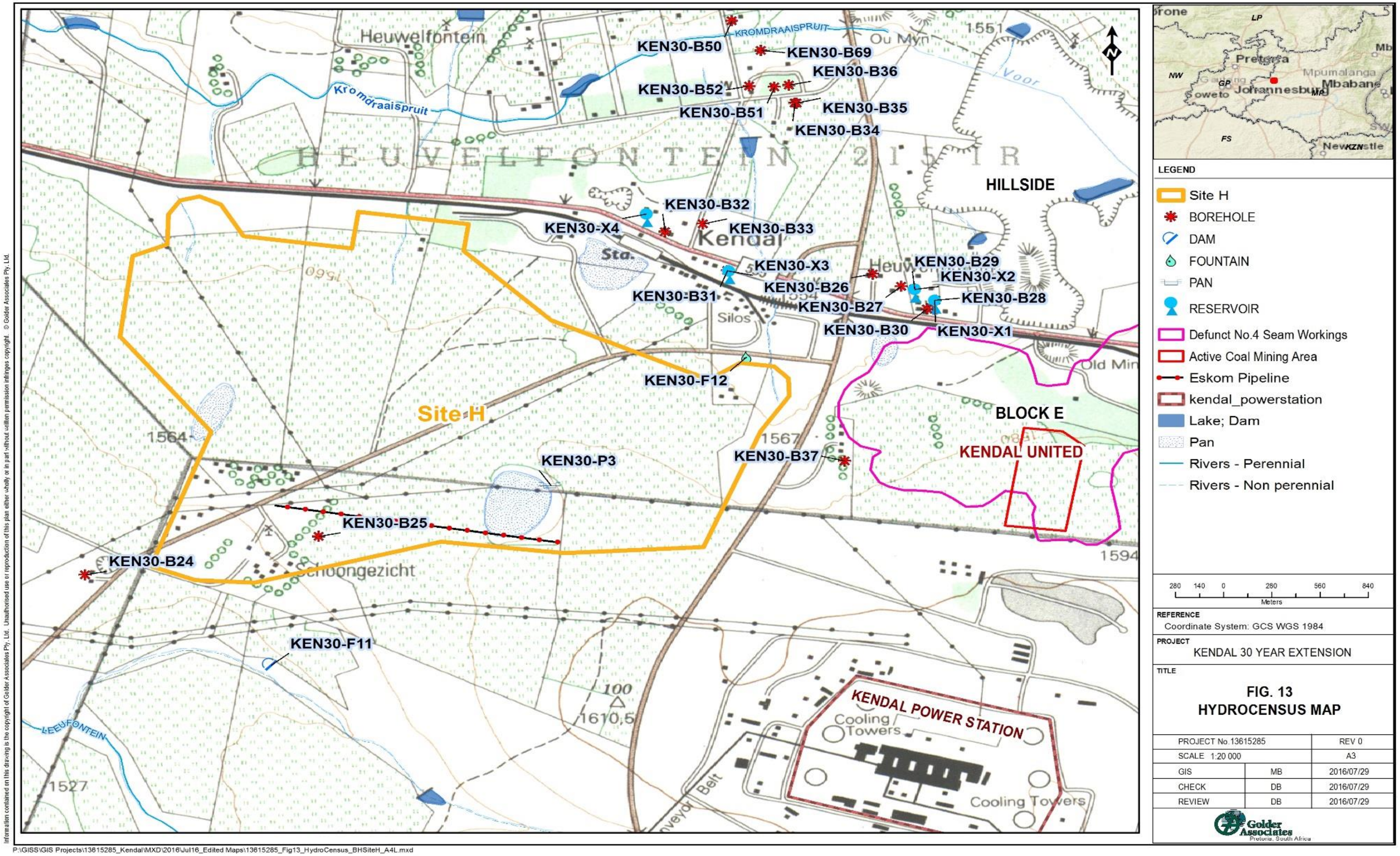


Figure 13: Hydrocensus Map Site H

Table 2: Hydrocensus Site B, C & H: Number on map, Sampled, Owner, Farm Number, Coordinates, Site Type, Equipment, Status & Application

Number on map	Sampled	Owner	Farm Number	Latitude (WGS84)	Longitude (WGS84)	Elevation (mamsl)	Type	Equipment	Status	User Application
KEN30-B1	NO	TRUTOR BOERDERY TRUST	214 IR/3	26.04266	28.89988	1520.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B2	NO	TRUTOR BOERDERY TRUST	214 IR/3	26.04425	28.90154	1528.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B3	NO	TRUTOR BOERDERY TRUST	214 IR/3	26.04686	28.90762	1533.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B4	YES	TRUTOR BOERDERY TRUST	214 IR/4	26.04759	28.92035	1534.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B5	NO	TRUTOR BOERDERY TRUST	214 IR/RE	26.04339	28.88901	1514.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B6	YES	ARBOR VILLAGE	213 IR/5	26.04815	28.89166	1545.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-D1	NO	ARBOR VILLAGE	213 IR/5	26.04395	28.88113	1526.00	DUG WELL	NONE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B7	NO	ARBOR VILLAGE	213 IR/5	26.04408	28.88115	1526.00	BOREHOLE	NONE	DESTROYED	
KEN30-B8	NO	ARBOR VILLAGE	213 IR/5	26.04424	28.88103	1529.00	BOREHOLE	NONE	DESTROYED	
KEN30-B9	NO	TRUTOR BOERDERY TRUST	214 IR/8	26.03779	28.87283	1502.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B10	NO	SL DUVENHAGE	221 IR/2	26.10676	28.90551	1557.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B11	NO	SL DUVENHAGE	221 IR/2	26.10889	28.90596	1552.00	BOREHOLE	SUBMERSIBLE	UNUSED	
KEN30-B12	NO	SL DUVENHAGE	221 IR/2	26.11299	28.90026	1562.00	BOREHOLE	NONE	DESTROYED	
KEN30-B13	NO	LAKESIDE COLLIERY	221 IR/2	26.10992	28.90132	1564.00	BOREHOLE	NONE	IN USE	MINING
KEN30-B14	NO	SL DUVENHAGE	213 IR/12	26.08669	28.90353	1538.00	BOREHOLE	NONE	UNUSED	
KEN30-B15	NO	TRUTOR BOERDERY TRUST	221 IR/2	26.10248	28.89416	1565.00	BOREHOLE	NONE	IN USE	
KEN30-P1	NO	TRUTOR BOERDERY TRUST	221 IR/18	26.09860	28.89164	1565.00	PAN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-P2	NO	TRUTOR BOERDERY TRUST	221 IR/16	26.09907	28.87779	1558.00	PAN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-F1	YES	TRUTOR BOERDERY TRUST	213 IR/7	26.07450	28.86038	1504.00	WETLAND	NONE	UNUSED	
KEN30-F2	NO	TRUTOR BOERDERY TRUST	213 IR/8	26.09363	28.86420	1522.00	FOUNTAIN	NONE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B16	NO	TRUTOR BOERDERY TRUST	213 IR/8	26.09348	28.86468	1527.00	BOREHOLE	NONE	DESTROYED	
KEN30-F3	NO	TRUTOR BOERDERY TRUST	221 IR/9	26.09792	28.86538	1517.00	FOUNTAIN	NONE	UNUSED	
KEN30-B17	NO	TRUTOR BOERDERY TRUST	221 IR/9	26.10121	28.86919	1538.00	BOREHOLE	HAND PUMP	DESTROYED	
ZFW-B1	NO	WELGELEGEN COLLIERY	221 IR/1	26.10189	28.87106	1547.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B18	YES	TRUTOR BOERDERY TRUST	213 IR/8	26.09494	28.87935	1554.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL IRRIGATION
KEN30-F7	NO	TRUTOR BOERDERY TRUST	213 IR/7	26.09032	28.86494	1525.00	FOUNTAIN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-F8	NO	TRUTOR BOERDERY TRUST	213 IR/7	26.08059	28.86334	1513.00	FOUNTAIN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-F9	NO	TRUTOR BOERDERY TRUST	221 IR/21	26.09029	28.86490	1538.00	FOUNTAIN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
BH-1D	NO	RIRHANDZU COLLIERY	213 IR/7/15	26.08872	28.88175	1556.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
BH-1M	NO	RIRHANDZU COLLIERY	213 IR/7/15	26.08874	28.88174	1557.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
BH-7M	NO	RIRHANDZU COLLIERY	213 IR/14	26.07834	28.89250	1525.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
BH-7S	NO	RIRHANDZU COLLIERY	213 IR/14	26.07831	28.89251	1525.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-F10	NO	RIRHANDZU COLLIERY	213 IR/4	26.07876	28.90284	1523.00	WETLAND	NONE	UNUSED	
KEN30-D2	NO	WESTCOAL VLAKVARKFONTEIN COLLIERY	213 IR/16	26.06924	28.88449	1511.00	DUG WELL	NONE	IN USE	DOMESTIC ALL PURPOSES
KEN30-F4	NO	WESTCOAL VLAKVARKFONTEIN COLLIERY	213 IR/16	26.06933	28.88442	1511.00	FOUNTAIN	NONE	UNUSED	
KEN30-O1	NO	WESTCOAL VLAKVARKFONTEIN COLLIERY	213 IR/16	26.06762	28.88961	1522.00	BASEFLOW	NONE	UNUSED	MINING
KEN30-D3	YES	CONTICOAL VLAKVARKFONTEIN COLLIERY	213 IR/5	26.07442	28.88269	1522.00	DUG WELL	NONE	IN USE	DOMESTIC ALL PURPOSES

Number on map	Sampled	Owner	Farm Number	Latitude (WGS84)	Longitude (WGS84)	Elevation (mamsl)	Type	Equipment	Status	User Application
KEN30-B19	NO	CONTICOAL VLAKVARKFONTEIN COLLIERY	213 IR/3	26.07137	28.89926	1529.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-F6	YES	CONTICOAL VLAKVARKFONTEIN COLLIERY	213 IR/3	26.07071	28.89957	1531.00	FOUNTAIN	NONE	UNUSED	
KEN30-F5	NO	CONTICOAL VLAKVARKFONTEIN COLLIERY	213 IR/3	26.07006	28.89594	1527.00	FOUNTAIN	NONE	UNUSED	
KEN30-B20	NO	CONTICOAL VLAKVARKFONTEIN COLLIERY	213 IR/3	26.07000	28.90054	1535.00	BOREHOLE	WIND MILL	UNUSED	
KEN30-B21	NO	RIRHANDZU COLLIERY	213 IR/4	26.07220	28.90762	1537.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B22	NO	AM SWANEPOEL	213 IR/9	26.07711	28.91831	1545.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B23	NO	J.G. PRINSLOO	213 IR/11	26.07398	28.91515	1537.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B24	NO	J.G. PRINSLOO	213 IR/10	26.07741	28.92525	1558.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B25	NO	J.G. PRINSLOO	218 IR/24	26.07509	28.93745	1575.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-F11	NO	J.G. PRINSLOO	218 IR/27	26.08287	28.93497	1543.00	FOUNTAIN	SUBMERSIBLE	IN USE	AGRICULTURAL IRRIGATION
P11	NO	J.G. PRINSLOO / SHANDUKA COAL	218 IR/44	26.09508	28.93121	1533.00	DAM	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-P3	NO	J.G. PRINSLOO / ESKOM HOLDINGS LTD	218 IR/24,38	26.07200	28.94957	1579.00	PAN	CENTRIFUGAL	IN USE	AGRICULTURAL IRRIGATION
KEN30-F12	NO	AFGRI SILOS	215 IR/78	26.06427	28.95979	1560.00	FOUNTAIN	NONE	UNUSED	

Table 3: Hydrocensus Site B, C & H: Number on Map, Diameter (m), Collar Height (m), Depth (m), Date, Time, Water Level (mbc) & Comment

Number on map	Farm Number	Type	BH Diam (m)	Collar Height (m)	Depth (m)	Date	Time	Water Level (mbc)	Comment: P=People; LSU=Large Stock; SSU=Small Stock; D=Dairy; G=Garden; N=Nursery
KEN30-B1	214 IR/3	BOREHOLE	165.00	0.13		20130917	1300	10.63	THREE HOUSES, OFFICE, WORKSHOP, 10 STAFF HOUSES, P=40, G=3
KEN30-B2	214 IR/3	BOREHOLE	165.00	0.35		20130917	1315		THREE HOUSES, OFFICE, WORKSHOP, 10 STAFF HOUSES, P=40, G=3
KEN30-B3	214 IR/3	BOREHOLE	165.00	0.10		20130917	1325	11.51	12 STAFF HOUSES, P=60
KEN30-B4	214 IR/4	BOREHOLE	165.00	0.24		20130917	1335		P=12, G=1
KEN30-B5	214 IR/RE	BOREHOLE	165.00			20130917			UOPA MASILELEA RENTING, CANNOT FIND
KEN30-B6	213 IR/5	BOREHOLE	165.00	0.20		20130917	1135	28.24	WATER SUPPLY TO ARBOR VILLAGE (LARGE SETTLEMENY), CHLORINATION, + ARBOR PRIMART SCHOOL = 235 PUPILS
KEN30-D1	213 IR/5	DUG WELL	2.00	0.39	6.00	20130917	1150	2.78	DUG WELL AT ARBOR VILLAGE SHOP
KEN30-B7	213 IR/5	BOREHOLE	165.00			20130917	1155		OPEN HOLE, BLOCKED
KEN30-B8	213 IR/5	BOREHOLE	165.00			20130917	1200		BOREHOLE DESTROYED
KEN30-B9	214 IR/8	BOREHOLE	165.00	0.17		20130917	1245	8.27	10 STAFF HOUSES
KEN30-B10	221 IR/2	BOREHOLE	165			20130916	0950		1.1KW 32MM SUBMERSIBLE, P=7, LSU=270, 10 000L JO-JO TANK
KEN30-B11	221 IR/2	BOREHOLE	214		49.73	20130916	1050	6.51	NO POWER BOX, 80MM SUBMERSIBLE, PUMP FELL DOWN HOLE
KEN30-B12	221 IR/2	BOREHOLE	214			20130916			4" UPVC PIPE INTO UNDERGROUND WORKINGS
KEN30-B13	221 IR/2	BOREHOLE		0.00		20130916	1020	33.21	6' PIPE TO UNDERGROUND WORKINGS, WATER FROM OPENCAST WAS PUMPED TO UNDERGROUND
KEN30-B14	213 IR/12	BOREHOLE	165			20130916			OLD POWER HEAD, BLOCKED AT 3M, PIPES STILL IN HOLE, OLD ABANDONED FARMSTEAD
KEN30-B15	221 IR/2	BOREHOLE	165	0.42	59.74	20130916	1210	4.30	LAKESIDE COLLIERY MONITORING BOREHOLE
KEN30-P1	221 IR/18	PAN				20130916			WATER FROM WILGE RIVER TO PAN @ APPROXIMATELY 25L/S FOR AGRICULTURAL IRRIGATION
KEN30-P2	221 IR/16	PAN				20130916			WATER FROM WILGE RIVER TO PAN @ APPROXIMATELY 25L/S FOR AGRICULTURAL IRRIGATION
KEN30-F1	213 IR/7	WETLAND				20130916	1415	0.00	FLOW INTO WILGE RIVER ESTIMATED AT 2.5L/S
KEN30-F2	213 IR/8	FOUNTAIN		0.00		20130916	0930	0.00	FLOW TO WILGE RIVER ESTIMATED AT 1.25L/S
KEN30-B16	213 IR/8	BOREHOLE	214	0.16	9.3	20130916		8.54	CASING DAMAGED, COLLAPSED JUST BELOW WATER LEVEL
KEN30-F3	221 IR/9	FOUNTAIN				20130916		0.00	WET AREA 30X15M, NO RUNOFF
KEN30-B17	221 IR/9	BOREHOLE	165			20130916			OLD HAND PUMP OUT OF ORDER
ZFW-B1	221 IR/1	BOREHOLE	165	0.35	30	20130916	1220	7.72	SCREENED 16-18M, SAMPLED AT 18M, MONITORING BOREHOLE
KEN30-B18	213 IR/8	BOREHOLE	214	0.21		20130916	1230	22.95	PUMPING, DISCHARGE INTO PAN2, ROUGHLY 2.0L/S,
KEN30-F7	213 IR/7	FOUNTAIN				20130916		0.00	BASEFLOW INTERACTION UPGRADIENT, DAMED FOUNTAIN, STORAGE WILGE RIVER WATER
KEN30-F8	213 IR/7	FOUNTAIN			1.6	20130916		0.00	BASEFLOW INTERACTION UPGRADIENT, DAMED FOUNTAIN, STORAGE WILGE RIVER WATER
KEN30-F9	221 IR/21	FOUNTAIN				20130916		0.00	BASEFLOW INTERACTION UPGRADIENT, DAMED FOUNTAIN, WILGE TRIBUTARY
BH-1D	213 IR/7/15	BOREHOLE	165	0.44	72	20130916	1235	13.67	MONITORING BOREHOLE, 30M SOLID CASING
BH-1M	213 IR/7/15	BOREHOLE	110	0.59	30	20130916	1240	7.46	MONITORING BOREHOLE
BH-7M	213 IR/14	BOREHOLE	165	0.43	30	20130916	1255	2.87	MONITORING BOREHOLE, 5L/S BLOW YIELD, DIABASE CHIPPINGS
BH-7S	213 IR/14	BOREHOLE	165	0.37	6	20130916	1300	2.72	MONITORING BOREHOLE
KEN30-F10	213 IR/4	WETLAND				20130916		0.00	BASEFLOW (WETLAND) SEEPAGE ALONG ROAD
KEN30-D2	213 IR/16	DUG WELL	2000			20130917	1225	1.65	ONE HOUSE, P=8
KEN30-F4	213 IR/16	FOUNTAIN		0.00		20130717	1235		20x8M KIDNEY SHAPED SEASONAL WET AREA, NO FLOW , NOW DRY
KEN30-O1	213 IR/16	BASEFLOW				20130717	1250		OLD ARBOR MINE HISTORIC DECANT POINT, DRY, SEASONAL

Number on map	Farm Number	Type	BH Diam (m)	Collar Height (m)	Depth (m)	Date	Time	Water Level (mbc)	Comment: P=People; LSU=Large Stock; SSU=Small Stock; D=Dairy; G=Garden; N=Nursery
KEN30-D3	213 IR/5	DUG WELL	1500	0.00	4.12	20130916	1244	3.20	DUG WELL, P=2
KEN30-B19	213 IR/3	BOREHOLE	165	1.05	18	20130717	1100		0.75KW SUBMERSIBLE
KEN30-F6	213 IR/3	FOUNTAIN				20130916	1415	0.00	FLOW TO LEEUWFONTUIN SPRUIT ESTIMATED AT 0.25 to 1L/S SEASONAL
KEN30-F5	213 IR/3	FOUNTAIN				20130717	1125	0.00	FLOW TOWARDS LEEUWFONTUIN SPRUIT ESTIMATED AT 0.3L/S
KEN30-B20	213 IR/3	BOREHOLE	165			20130717	1050		BROKEN WINDMILL
KEN30-B21	213 IR/4	BOREHOLE	165	0.07		20130717	1440	14.16	PUMPING, G=2, P=10, LSU=100, SSU=20 PUMP 1 HOUR/DAY, MINE BOUGHT PROPERTY, CAN STAY ONOTHER 2 YEARS
KEN30-B22	213 IR/9	BOREHOLE	165	0.08		20130717	0935	11.68	P=4, LSU=25, SSU=130, 1X2 500L + 2X5 000L TANKS
KEN30-B23	213 IR/11	BOREHOLE	165	0.21		20130717	0950	9.97	0.75KW SUBMERSIBLE, P=7, LSU=300, 2X10 000L TANKS
KEN30-B24	213 IR/10	BOREHOLE	165	0.00		20130717	1030		P=84, 32MM SUBMERSIBLE, 1X5 000L TANK
KEN30-B25	218 IR/24	BOREHOLE	165			20130717	1015		P=9, 40MM SUBMERSIBLE, 2X5 000L TANKS, SEALED
KEN30-F11	218 IR/27	FOUNTAIN				20130717	1020		IRRIGATE 230HA FROM SCHOONGEZICHTSPRUIT DRAINAGE SYSTEM - INTERMIITTENT
P11	218 IR/44	DAM				20140204			IRRIGATE 230HA FROM LEEUWFONTEINSPRUIT DRAINAGE SYSTEM – CURRENT – WATER ALSO TO KEN30-P3
KEN30-P3	218 IR/24,38	PAN				20140204			IRRIGATE 2 CENTRE PIVOTS TO THE SOUTHWEST, NORTH AND NORTHEAST FROM THE PAN
KEN30-F12	215 IR/78	FOUNTAIN		0.00		20140204		0.00	NEXT TO DIRT ROAD, FLOW APPROXIMATELY 0.40L/S

Table 4: Hydrocensus Site B, C & H: Number on map, Farm Number, Owner, Address, Contact Person, Telephone Number

Number on map	Farm Number	Owner	Address	Contact Person	Telephone Number
KEN30-B1	214 IR/3	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	079 877 5942
KEN30-B2	214 IR/3	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	079 877 5942
KEN30-B3	214 IR/3	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	079 877 5942
KEN30-B4	214 IR/4	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	079 877 5942
KEN30-B5	214 IR/RE	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	OUPA MASILELA	079 877 5942
KEN30-B6	213 IR/5	ARBOR VILLAGE		R.P. MOLALATHOKO	083 330 8893
KEN30-D1	213 IR/5	ARBOR VILLAGE		R.P. MOLALATHOKO	083 330 8893
KEN30-B7	213 IR/5	ARBOR VILLAGE		R.P. MOLALATHOKO	083 330 8893
KEN30-B8	213 IR/5	ARBOR VILLAGE		R.P. MOLALATHOKO	083 330 8893
KEN30-B9	214 IR/8	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	079 877 5942
KEN30-B10	221 IR/2	SL DUVENHAGE		JAG DUVENHAGE	082 492 6963
KEN30-B11	221 IR/2	SL DUVENHAGE		JAG DUVENHAGE	082 492 6963
KEN30-B12	221 IR/2	SL DUVENHAGE		JAG DUVENHAGE	082 492 6963
KEN30-B13	221 IR/2	LAKESIDE COLLIERY		HENNIE BRINK	082 708 6891
KEN30-B14	213 IR/12	SL DUVENHAGE		JAG DUVENHAGE	082 492 6963
KEN30-B15	221 IR/2	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-P1	221 IR/18	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-P2	221 IR/16	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F1	213 IR/7	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F2	213 IR/8	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B16	213 IR/8	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F3	221 IR/9	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B17	221 IR/9	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
ZFW-B1	221 IR/1	WELGELEGEN COLLIERY	PO BOX 551, DELMAS, 2210	CHRIS RAUTENBACH	083 276 4111
KEN30-B18	213 IR/8	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F7	213 IR/7	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F8	213 IR/7	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-F9	221 IR/21	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
BH-1D	213 IR/7/15	RIRHANDZU COLLIERY		NICK RADEMAN	083 744 8222
BH-1M	213 IR/7/15	RIRHANDZU COLLIERY		NICK RADEMAN	083 744 8222
BH-7M	213 IR/14	RIRHANDZU COLLIERY		NICK RADEMAN	083 744 8222
BH-7S	213 IR/14	RIRHANDZU COLLIERY		NICK RADEMAN	083 744 8222
KEN30-F10	213 IR/4	RIRHANDZU COLLIERY		NICK RADEMAN	083 744 8222
KEN30-D2	213 IR/16	WESTCOAL VLAKVARKFONTEIN COLLIERY		RIKA VOSLOO	079 887 6997
KEN30-F4	213 IR/16	WESTCOAL VLAKVARKFONTEIN COLLIERY		RIKA VOSLOO	079 887 6997
KEN30-O1	213 IR/16	WESTCOAL VLAKVARKFONTEIN COLLIERY		RIKA VOSLOO	079 887 6997
KEN30-D3	213 IR/5	CONTICOAL VLAKVARKFONTEIN COLLIERY		SAGRYS	076 402 0108

Number on map	Farm Number	Owner	Address	Contact Person	Telephone Number
KEN30-B19	213 IR/3	CONTICOAL VLAKVARKFONTEIN COLLIERY		SAGRYS	076 402 0108
KEN30-F6	213 IR/3	CONTICOAL VLAKVARKFONTEIN COLLIERY		SAGRYS	076 402 0108
KEN30-F5	213 IR/3	CONTICOAL VLAKVARKFONTEIN COLLIERY		SAGRYS	076 402 0108
KEN30-B20	213 IR/3	CONTICOAL VLAKVARKFONTEIN COLLIERY		SAGRYS	076 402 0108
KEN30-B21	213 IR/4	RIRHANDZU COLLIERY	PO BOX 127, KENDAL, 2225	JAG DUVENAGE	082 640 2830
KEN30-B22	213 IR/9	AM SWANEPOEL	PO BOX 2123, DELMAS, 2210	AM SWANEPOEL	082 711 7600
KEN30-B23	213 IR/11	J.G. PRINSLOO	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
KEN30-B24	213 IR/10	J.G. PRINSLOO	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
KEN30-B25	218 IR/24	J.G. PRINSLOO	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
KEN30-F11	218 IR/27	J.G. PRINSLOO	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
P11	218 IR/44	J.G. PRINSLOO / SHANDUKA COAL	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
KEN30-P3	218 IR/24,38	J.G. PRINSLOO / ESKOM HOLDINGS LTD	PO BOX 149, DELMAS, 2210	J.G. PRINSLOO	082 785 4865
KEN30-F12	215 IR/78	AFGRI SILOS	PO BOX 11054, CENTURION, 0046		+27 11 063 2347

Table 5: Hydrocensus Site F & H: Number on map, Sampled, Owner, Farm Number, Coordinates, Site Type, Equipment, Status & Application

Number on map	Sampled	Owner	Farm Number	Latitude (WGS84)	Longitude (WGS84)	Elevation (mamsl)	Type	Equipment	Status	User Application
KEN30-B26	YES	DELTA CRANE & PLANT HIRE	215 IR PLOT4	26.05925	28.96639	1571.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B27	NO	DELTA CRANE & PLANT HIRE	215 IR PLOT 4	26.05999	28.96788	1569.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B28	NO	SHANDUKA COAL	215 IR/41	26.06082	28.96966	1574.00	BOREHOLE	HAND PUMP	UNUSED	
KEN30-X1	NO	SHANDUKA COAL	215 IR/41	26.06084	28.96961	1573.00	RESERVOIR		IN USE	DOMESTIC ALL PURPOSES
KEN30-B29	NO	SHANDUKA COAL	215 IR/40	26.06014	28.96856	1573.00	BOREHOLE	PLAY PUMP	UNUSED	
KEN30-X2	NO	SHANDUKA COAL	215 IR/40	26.06018	28.96855	1572.00	RESERVOIR		IN USE	
KEN30-B30	NO	SHANDUKA COAL	215 IR/40	26.06137	28.96923	1570.00	BOREHOLE	HAND PUMP	UNUSED	
KEN30-B31	NO		215 IR/31	26.05904	28.9588	1563.00	BOREHOLE	HAND PUMP	IN USE	DOMESTIC ALL PURPOSES
KEN30-X3	NO		215 IR/31	26.05908	28.95885	1560.00	RESERVOIR		IN USE	
KEN30-X4	NO		215 IR/72	26.05563	28.95455	1568.00	RESERVOIR		IN USE	
KEN30-B32	NO	ISMAIL GRIM	215 IR/72	26.0567	28.95553	1567.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B33	NO		215 IR/72	26.05623	28.95752	1563.00	BOREHOLE	NONE	DESTROYED	
KEN30-B34	NO	R DLADLA	215 IR/27	26.04894	28.96232	1553.00	BOREHOLE	HAND PUMP	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B35	NO	R DLADLA	215 IR/27	26.04894	28.96241	1552.00	BOREHOLE	MONO TYPE	UNUSED	
KEN30-B36	NO	R DLADLA	215 IR	26.04784	28.96201	1552.00	BOREHOLE	HAND PUMP	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B37	NO	KAYALETHU VILLAGE	215 IR/47	26.07054	28.96493	1568.00	BOREHOLE	WIND MILL	IN USE	
KEN30-B38	NO	JH DUVENAGE	215 IR PLOT 12	26.04059	28.96347	1558.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B39	NO	JH DUVENAGE	215 IR PLOT 12	26.03967	28.96357	1557.00	BOREHOLE	NONE	DESTROYED	
KEN30-B40	NO	JH DUVENAGE	215 IR PLOT 12	26.03961	28.96386	1554.00	BOREHOLE	NONE	DESTROYED	
KEN30-B41	NO	JH DUVENAGE	215 IR PLOT 12	26.0394	28.96385	1554.00	BOREHOLE	NONE	DESTROYED	
KEN30-B42	NO	JH DUVENAGE	215 IR PLOT 13	26.04014	28.96177	1553.00	BOREHOLE	NONE	DESTROYED	
KEN30-B43	NO	DJE DUVENAGE	215 IR PLOT 32	26.04115	28.96342	1557.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B44	NO	DJE DUVENAGE	215 IR PLOT 32	26.04118	28.96064	1554.00	BOREHOLE	NONE	UNUSED	
KEN30-B45	NO	DJE DUVENAGE	215 IR PLOT 32	26.04115	28.96064	1554.00	BOREHOLE	NONE	UNUSED	
KEN30-B46	NO	DJE DUVENAGE	215 IR PLOT 32	26.04139	28.95996	1552.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B47	YES	DJE DUVENAGE	215 IR PLOT 32	26.04149	28.95902	1541.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B48	NO	DJE DUVENAGE	215 IR PLOT 32	26.04161	28.9593	1547.00	BOREHOLE	NONE	DESTROYED	
KEN30-B49	NO	DJE DUVENAGE	215 IR PLOT 32	26.04193	28.96091	1560.00	BOREHOLE	NONE	UNUSED	
KEN30-B50	NO		215 IR PLOT 34	26.04397	28.95903	1549.00	BOREHOLE	PISTON	UNUSED	
KEN30-B51	NO	DAN SWART	215 IR PLOT 37	26.04797	28.96125	1556.00	BOREHOLE	NONE	UNUSED	
KEN30-B52	NO	DAN SWART	215 IR PLOT 37	26.04791	28.95993	1545.00	BOREHOLE		IN USE	
KEN30-X5	NO	TRUTOR BOERDERY TRUST	215 IR/11	26.02275	28.974	1575.00	RESERVOIR	SUBMERSIBLE	IN USE	
KEN30-B53	YES	TRUTOR BOERDERY TRUST	215 IR/11	26.02318	28.97333	1579.00	BOREHOLE	HAND PUMP	IN USE	
KEN30-X6	NO	TRUTOR BOERDERY TRUST	215 IR/13	26.03053	28.9709	1592.00	RESERVOIR		IN USE	
KEN30-B54	NO	TRUTOR BOERDERY TRUST	215 IR/13	26.03091	28.97119	1595.00	BOREHOLE	HAND PUMP	IN USE	
KEN30-B55	NO	AVENG GRINAKER SITE	215 IR	26.03902	28.96218	1557.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B56	NO	AVENG GRINAKER SITE	215 IR	26.03851	28.96218	1561.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES

Number on map	Sampled	Owner	Farm Number	Latitude (WGS84)	Longitude (WGS84)	Elevation (mamsl)	Type	Equipment	Status	User Application
KEN30-B57	NO	DJE DUVENAGE	215 IR PLOT 32	26.04144	28.96416	1560.00	BOREHOLE		UNUSED	
KEN30-B58	NO		215 IR PLOT 9	26.04231	28.96169	1550.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B59	NO		215 IR PLOT 9	26.04213	28.96265	1558.00	BOREHOLE	SUBMERSIBLE	IN USE	
KEN30-B60	NO	R P ENSLIN	3 IS REM	26.06653	29.00782	1596.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL IRRIGATION
KEN30-B61	NO	R P ENSLIN	3 IS REM	26.06907	29.01004	1606.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC
KEN30-B62	NO	WESTCOAL KHANYISA MINE	215 IR/99	26.04128	28.97203	1544.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
KEN30-B63	NO	WESTCOAL KHANYISA MINE	215 IR/96	26.04152	28.97251	1559.00	BOREHOLE	SUBMERSIBLE	IN USE	DOMESTIC ALL PURPOSES
NSW-B7	NO	TRUTOR BOERDERY TRUST	215 IR/13	26.03352	28.96355	1573.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B64	NO	JOE SINGH GROUP OF COMPANIES	291 IR	26.03507	28.98320	1575.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B65	NO	TRUTOR BOERDERY TRUST	216 IR/10	26.02901	28.98815	1564.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B66	NO	TRUTOR BOERDERY TRUST	216 IR/10	26.02893	28.98829	1563.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B67	NO	TRUTOR BOERDERY TRUST	216 IR/7	26.01588	29.00742	1527.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B68	NO	TRUTOR BOERDERY TRUST	216 IR/7	26.01586	29.00741	1527.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
P4SW-3	NO	TRUTOR BOERDERY TRUST	216 IR/11	26.01824	28.98288	1523.00	BOREHOLE	NONE	IN USE	MINING OBSERVATION
KEN30-B69	YES	JAMES PAUL	215 IR PLOT 36	26.04576	28.96055	1544.00	BOREHOLE	SUBMERSIBLE	IN USE	AGRICULTURAL & DOMSETIC

Table 6: Hydrocensus Site F & H: Number on Map, Diameter (m), Collar Height (m), Depth (m), Date, Time, Water Level (mbc) & Comment

Number on map	Farm Number	Type	BH Diam. (m)	Collar Height (m)	Depth (m)	Date	Time	Water Level (mbc)	Comment: P=People; LSU=Large Stock; SSU=Small Stock; D=Dairy; G=Garden; N=Nursery
KEN30-B26	215 IR PLOT4	BOREHOLE	165	0.18	50	20130918	0910	11.54	40MM SUBMERSIBLE, 0.75KW, P=8, 1 HOUSE + 2 FLATS, USE 5 000L/DAY
KEN30-B27	215 IR PLOT 4	BOREHOLE	165	0.26	76	20130918	0925	12.61	40MM SUBMERSIBLE, 0.75KW, P=22, WORSKOP + WASHBAY, USE 10 000L/DAY, 2X5 000L TANKS
KEN30-B28	215 IR/41	BOREHOLE				20130918	0935		INFORMAL SETTLEMENT
KEN30-X1	215 IR/41	RESERVOIR				20130918	0940		INFORMAL SETTLEMENT, 4X5 000L TANKS, FILLED BY MUNISIPALITY ONCE A WEEK, SUPPLY WITH KEN30-X2 TO ROUGHLY 95 HOUSES
KEN30-B29	215 IR/40	BOREHOLE				20130918	0945		INFORMAL SETTLEMENT, PLAY PUMP
KEN30-X2	215 IR/40	RESERVOIR				20130918	0950		INFORMAL SETTLEMENT, 1X2 500L TANK
KEN30-B30	215 IR/40	BOREHOLE				20130918	1000		
KEN30-B31	215 IR/31	BOREHOLE				20130918			SUPPLY TO 25 HOUSES
KEN30-X3	215 IR/31	RESERVOIR				20130918			2X5 000L TANKS FILLED ONCE A WEEK BY MUNICIPALITY
KEN30-X4	215 IR/72	RESERVOIR				20130918			1X5 000L TANK FILLED ONCE A WEEK BY MUNICIPALITY, SUPPLY ROUGHLT 25 HOUSES
KEN30-B32	215 IR/72	BOREHOLE	165	0.14		20130918	1010	13.45	P=6 + SHOP, USE 2 000L/DAY, 1X2 500L TANK
KEN30-B33	215 IR/72	BOREHOLE				20130918			OLD DESTROYED BOREHOLE
KEN30-B34	215 IR/27	BOREHOLE				20130918	1040		SUPPLY WATER TO 35 HOUSES ON AND AROUND PROPERTY, ALSO 60 LSU TOGETHER WITH WATER FROM KEN30-B36
KEN30-B35	215 IR/27	BOREHOLE	165	0.16		20130918	1045	7.69	50MM MONO, NOT IN USE FOR 4 YEARS, ELECTRICAL CABLES STOLEN
KEN30-B36	215 IR	BOREHOLE				20130918	1055		SUPPLY WATER TO 35 HOUSES ON AND AROUND PROPERTY, ALSO 60 LSU TOGETHER WITH WATER FROM KEN30-B34
KEN30-B37	215 IR/47	BOREHOLE				20130918	1240		SUPPLY WATER TO 15 HOUSES, KAYALETHU VILLAGE, 4X5 000L TANKS
KEN30-B38	215 IR PLOT 12	BOREHOLE	165	0.72		20130919	0850	11.51	40MM SUBMERSIBLE, 1X5 000L TANK, P=6, LSU=15, USE 5 000L/DAY
KEN30-B39	215 IR PLOT 12	BOREHOLE				20130919	0855		BLOCKED AT 7.10M
KEN30-B40	215 IR PLOT 12	BOREHOLE				20130919	0905		BLOCKED AT 1.610M
KEN30-B41	215 IR PLOT 12	BOREHOLE				20130919	0910		BLOCKED AT 4.56M
KEN30-B42	215 IR PLOT 13	BOREHOLE				20130919	0915		BLOCKED AT 11.43M, NO CASING
KEN30-B43	215 IR PLOT 32	BOREHOLE	165	0.35	60	20130919	0925	9.65	50MM SUBMERSIBLE, P=4, USE 2 500L/DAY, BOREHOLE YIELD DECREASING
KEN30-B44	215 IR PLOT 32	BOREHOLE	165	0.67	90	20130919	0935	6.65	DRILLED BY MINE FOR FUTURE USE
KEN30-B45	215 IR PLOT 32	BOREHOLE	165	0.63		20130919	0945	7.25	DRILLED BY MINE, PROBLEM WITH CASING INSTALLATION, REPLACE WITH KEN30-B44
KEN30-B46	215 IR PLOT 32	BOREHOLE	165	0.24		20130919	1000	20.25	40MM SUBMERSIBLE, USE FOR GARDEN ONLY, POOR POTABILITY, USE 2 500L/DAY
KEN30-B47	215 IR PLOT 32	BOREHOLE	165	0.00		20130919	1005	4.62	40MM SUBMERSIBLE, 4 HOUSES, P=20, LSU=35, USE 20 000L/DAY
KEN30-B48	215 IR PLOT 32	BOREHOLE				20130919	1015		BLOCKED
KEN30-B49	215 IR PLOT 32	BOREHOLE	165	0.21	60	20130919	1025	5.02	FOR FUTURE USE
KEN30-B50	215 IR PLOT 34	BOREHOLE	150	0.00		20130919	1145	9.45	NO ELECTRICITY, WATER CARTED TO PROPERTY, 1X4 500L TANK
KEN30-B51	215 IR PLOT 37	BOREHOLE				20130919	1150		SEALED
KEN30-B52	215 IR PLOT 37	BOREHOLE				20130919	1155		32MM SUBMERSIBLE, 0.75KW, P=4 + TRUCK WASH, USE 20 000L/DAY
KEN30-X5	215 IR/11	RESERVOIR				20130919	1225		SUPPLY 30 HOUSES WITH WATER
KEN30-B53	215 IR/11	BOREHOLE				20130919	1235		POOR POTABILITY
KEN30-X6	215 IR/13	RESERVOIR				20130919	1250		SUPPLY 12 HOUSES WITH WATER
KEN30-B54	215 IR/13	BOREHOLE				20130919	1255		WATER DIRTY, HOLE NEARLY DRY

Number on map	Farm Number	Type	BH Diam. (m)	Collar Height (m)	Depth (m)	Date	Time	Water Level (mbc)	Comment: P=People; LSU=Large Stock; SSU=Small Stock; D=Dairy; G=Garden; N=Nursery
KEN30-B55	215 IR	BOREHOLE				20130919	1315		50MM SUBMERSIBLE, PUMP HOUSE LOCKED, P=200
KEN30-B56	215 IR	BOREHOLE				20130919	1320		50MM SUBMERSIBLE, PUMP HOUSE LOCKED, P=200, 6X5 000L TANKS, USE 20 000L/DAY (KEN30-B55 & B56)
KEN30-B57	215 IR PLOT 32	BOREHOLE				20130920	0833		CLOSED, PUMP BROKE OFF IN HOLE
KEN30-B58	215 IR PLOT 9	BOREHOLE		0.00	10.62	20130920	0915		50MM SUBMERSIBLE, PUMP HOUSE LOCKED, P=50
KEN30-B59	215 IR PLOT 9	BOREHOLE				20130920	0920		50MM SUBMERSIBLE, PUMP HOUSE LOCKED, P=50, USAGE FROM BOTH BOREHOLE TOTALS 10 000L/DAY, 3X5 000L TANKS
KEN30-B60	3 IS REM	BOREHOLE	165		123	20130920	1020		SPRAY 1400HA 5XYEAR 250L/HA WITH HERBICIDE MIX; SEALED; USE 1750M3/ANNUM; WATER SRIKE = 107M, YIELD = 3L/s
KEN30-B61	3 IS REM	BOREHOLE	165	0.21	129	20130920	1025	26.46	P = 40; LSU = 400; G = 2; PUMPING WATER LEVEL; USE 20 000L/DAY
KEN30-B62	215 IR/99	BOREHOLE				20130920	1155		SUPPLY TO SCHOOL BY MINE OFFICES
KEN30-B63	215 IR/96	BOREHOLE				20130920			DRILLED BY MINE, P=6, LSU=150
NSW-B7	215 IR/13	BOREHOLE	165	0.29	29.76	20130925	1530	11.14	MONITORING BOREHOLE
KEN30-B64	291 IR	BOREHOLE	165	1.31	36.69	20130925	1130	32.76	MONITORING BOREHOLE
KEN30-B65	216 IR/10	BOREHOLE	165			20130925	1140		MONITORING BOREHOLE, SHANDUKA, BANKFONTEIN COLLIERY, SIPHO MAKHATSHWA, 082 337 1880, CASING DAMAGED
KEN30-B66	216 IR/10	BOREHOLE	165	0.65	30.33	20130925	1145	18.44	MONITORING BOREHOLE, SHANDUKA, BANKFONTEIN COLLIERY, SIPHO MAKHATSHWA, 082 337 1880
KEN30-B67	216 IR/7	BOREHOLE	176	0.58	5.96	20130925	1215	2.53	MONITORING BOREHOLE
KEN30-B68	216 IR/7	BOREHOLE	176	0.77	30.38	20130925	1220	2.67	MONITORING BOREHOLE
P4SW-3	216 IR/11	BOREHOLE	165	0.56	29.75	20130925		1.21	MONITORING BOREHOLE
KEN30-B69	215 IR PLOT 36	BOREHOLE	165	0.29		20130925	1510	9.21	50MM SUBMERSIBLE, PUMPING, P=3, LSU=60, 1X5 000L TANK

Table 7: Hydrocensus Site F & H: Number on map, Farm Number, Owner, Address, Contact Person, Telephone Number

Number on map	Farm Number	Owner	Address	Contact Person	Telephone Number
KEN30-B26	215 IR PLOT4	DELTA CRANE & PLANT HIRE	PO BOX 2552, SASOLBURG, 1947	JENNY VAN DAM	083 259 3302
KEN30-B27	215 IR PLOT 4	DELTA CRANE & PLANT HIRE	PO BOX 2552, SASOLBURG, 1947	JENNY VAN DAM	083 259 3302
KEN30-B28	215 IR/41	SHANDUKA COAL		SIPHO MAKHATSHWA	082 337 1880
KEN30-X1	215 IR/41	SHANDUKA COAL		SIPHO MAKHATSHWA	082 337 1880
KEN30-B29	215 IR/40	SHANDUKA COAL		SIPHO MAKHATSHWA	082 337 1880
KEN30-X2	215 IR/40	SHANDUKA COAL		SIPHO MAKHATSHWA	082 337 1880
KEN30-B30	215 IR/40	SHANDUKA COAL		SIPHO MAKHATSHWA	082 337 1880
KEN30-B31	215 IR/31				
KEN30-X3	215 IR/31				
KEN30-X4	215 IR/72				
KEN30-B32	215 IR/72	ISMAIL GRIM			072 152 0654
KEN30-B33	215 IR/72				
KEN30-B34	215 IR/27	R DLADLA			079 908 9368
KEN30-B35	215 IR/27	R DLADLA			079 908 9368
KEN30-B36	215 IR	R DLADLA			079 908 9368
KEN30-B37	215 IR/47	KAYALETHU VILLAGE			079 908 9368
KEN30-B38	215 IR PLOT 12	JH DUVENAGE	PO BOX 330, KENDAL, 2225		082 490 2981
KEN30-B39	215 IR PLOT 12	JH DUVENAGE	PO BOX 330, KENDAL, 2225		082 490 2981
KEN30-B40	215 IR PLOT 12	JH DUVENAGE	PO BOX 330, KENDAL, 2225		082 490 2981
KEN30-B41	215 IR PLOT 12	JH DUVENAGE	PO BOX 330, KENDAL, 2225		082 490 2981
KEN30-B42	215 IR PLOT 13	JH DUVENAGE	PO BOX 330, KENDAL, 2225		082 490 2981
KEN30-B43	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B44	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B45	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B46	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B47	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B48	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B49	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B50	215 IR PLOT 34				
KEN30-B51	215 IR PLOT 37	DAN SWART	PO BOX 132, KENDAL, 2225		072 690 7112
KEN30-B52	215 IR PLOT 37	DAN SWART	PO BOX 132, KENDAL, 2225		072 690 7112
KEN30-X5	215 IR/11	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B53	215 IR/11	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-X6	215 IR/13	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B54	215 IR/13	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B55	215 IR	AVENG GRINAKER SITE		SHAUN ERASMUS	076 016 0047
KEN30-B56	215 IR	AVENG GRINAKER SITE		SHAUN ERASMUS	076 016 0047

Number on map	Farm Number	Owner	Address	Contact Person	Telephone Number
KEN30-B57	215 IR PLOT 32	DJE DUVENAGE	PO BOX 132, KENDAL, 2225		082 490 3476
KEN30-B58	215 IR PLOT 9				
KEN30-B59	215 IR PLOT 9				
KEN30-B60	3 IS REM	R P ENSLIN	PO BOX 544, OGIES. 2230	R P ENSLIN	(013) 6432326
KEN30-B61	3 IS REM	R P ENSLIN	PO BOX 544, OGIES. 2230	R P ENSLIN	(013) 6432326
KEN30-B62	215 IR/99	WESTCOAL KHANYISA MINE			
KEN30-B63	215 IR/96	WESTCOAL KHANYISA MINE	PO BOX 128, KENDAL, 2225	CLAUDE	082 278 0836
NSW-B7	215 IR/13	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B64	291 IR	JOE SINGH GROUP OF COMPANIES			
KEN30-B65	216 IR/10	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B66	216 IR/10	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B67	216 IR/7	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B68	216 IR/7	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
P4SW-3	216 IR/11	TRUTOR BOERDERY TRUST	PO BOX 621, OGIES, 2230	BERTIE TRUTOR	082 554 8695
KEN30-B69	215 IR PLOT 36	JAMES PAUL			072 999 8171

5.7 Aquifer Yielding Potential

5.7.1 Site B Aquifer Yielding Potential

The hydrocensus did not yield any specific borehole yielding information. Generally the equipment installed in the boreholes gives a fair indication of yielding capacity, e.g.:

- Submersibles pumps with electrical motors of 0.75kW;
- Raising columns ranging between 32mm and 40mm in diameter.

Discharge rates were recorded for the two fountains, KEN30-F5 and KEN30-F6 surveyed during the hydrocensus. KEN30-F5 recorded an estimated discharge of 0.30l/s, while the discharge rate at KEN30-F6 is reported as seasonally varying between 0.25l/s and 1.00l/s.

The yielding potential observations are in line with the published hydrogeological maps (DWAF 1996) indicating the average borehole yield in the area to range between 0.5l/s and 2.0l/s.

5.7.2 Site C Aquifer Yielding Potential

Two external user's boreholes were observed to be equipped with submersibles pumps; the one KEN30-B10 has a 1.1kW electrical motor and a 32mm raising column, whilst the other KEN30-B18 recorded an estimated discharge rate of 2.0l/s.

Fountains KEN30-F1 and KEN30-F2 recoded estimated discharge rates of respectively 2.50l/s and 1.25l/s during the recent hydrocensus.

5.7.3 Site F Aquifer Yielding Potential

The hydrocensus yielded very little specific borehole yielding information. Generally the equipment installed in the boreholes gives a fair indication of yielding capacity, e.g.:

- Submersibles pumps with electrical motors of 0.75kW;
- Raising columns ranging between 32mm and 50mm in diameter;
- Borehole depths recorded (7 in total) for the water supply boreholes ranged between 50 meter below surface (mbs) and 129mbs, averaging at 84mbs, indicative of the basal aquifers being utilized.

Borehole KEN30-B60 on Klipfontein 3 IS has a reported yield of 3l/s. The main water strike in this borehole is reported to have been intersected at a depth of 107mbs.

With reference to Section 5.5.3 and the statements pertaining to the base of the Karoo overlying pre-Karoo dolomites of the Malmani Subgroup with the Dwyka Formation occasionally discontinuous (Homeland Energy Group Ltd's Independent Technical Report - SRK, 2007) the following:

- Unlike in the Delmas and Bapsfontein areas, locally there is no evidence of depressions and sinkholes associated with major karst aquifers and large scale groundwater abstraction;
- The observed water uses, borehole construction and equipment installed in the water supply boreholes are not indicative of a major basal karts aquifer;
- Chert poor dolomites are generally less productive with a borehole yielding class < 5l/s (median).

5.7.4 Site H Aquifer Yielding Potential

The hydrocensus did not yield any specific borehole yielding information. Generally the equipment installed in the boreholes gives a fair indication of yielding capacity, e.g.:

- Submersibles pumps with electrical motors of 0.75kW (x3);
- Raising columns ranging between 32mm and 40mm in diameter (2).

With reference to Table 7 and the selection of Kendal Power Station groundwater monitoring boreholes, the following:

- Five of the seven holes selected, recorded water makes;
- The recorded yields ranged between 0.01l/s and 0.20l/s, averaging at 0.085l/s.

The discharge rate recorded for fountain KEN30-F12 during the hydrocensus update was estimated at 0.4l/s.

Although the yields observed for the monitoring boreholes are all less than 0.5l.s, the yielding potential observations are generally in line with the published hydrogeological maps (DWAF 1996) indicating the average borehole yield in the area to range between 0.5l/s and 2.0l/s.

5.8 Lateral Extent of Groundwater Zone

The major hydraulic and physical aquifer boundaries defining the lateral extent of the groundwater zones pertaining to the 4 alternative sites are discussed blow. Surface infiltration sources such as unlined water ponds heaps and dumps, although not individually dealt with due to the lack of information, will most likely represent constant head (hydraulic) influx boundaries causing induced lateral migration through the shallow weathered zone aquifer and any perched aquifers present.

5.9.1 Site B Aquifer Boundaries

The site is intersected by the water divide between quaternary catchment areas B20E and B20F, constituting a no-flow boundary that separates the area in two distinct flow regimes bounded in the west by the Wilge River, as well as by two perennial tributaries, namely the Leeuwfonteinspruit in the south and an unnamed tributary, also referred to as the 'Kromdraaispruit' in the north. The river and streams represent accurately definable groundwater discharge boundaries.

The eastern boundary is definable by arbitrary lines parallel with the groundwater flow directions on both sides of the water divide.

The site's flow regime is however much more complicated than this. The largest part of the area consists of Karoo sediments almost entirely surrounded and underlain by basement rocks on both sides of the surface water divide. In certain parts some of the intrusive geological discontinuities are anticipated to represent physical impermeable boundaries that might affect flow directions and velocities. Fountains KEN30-F5 & F6 are both located along the southern margins of this basin were the Karoo sediments pinch out against an outcrop of Lebowa granite.

The western rim of this Karoo basin is defined by strata of the Loskop Formation (rocky outcrops present) that runs parallel to the anticipated groundwater flow directions on both sides of the surface water divide, thus separating the basin from the adjacent Karoo strata to the east. This outcrop, although it might well be considered as a no flow boundary in terms of separating the Karoo aquifers across the site, does not necessarily constitute an aquiclude. Attesting to this is the presence of a wetland area located in close proximity to the contact between an intrusive diabase sill and the southern extent of the mentioned Loskop Formation outcrop.

The side slope along the southern part of the basin not rimmed by basal outcrops, roughly 1.5km in length, features a historical mine water decant seepage area to the west of a Dwyka Group tillite outcrop. Although seasonality does affect the discharge from the seepage zone, observed to be dry during the hydrocensus, the active opencast pit at Vlakvarkfontein probably also currently might have an influence as groundwater flow directions are bound to change towards the pit.

The eastern 'Karoo' flow regime to the west of the Loskop Formation outcrop, south of the water divide, is further intersected by the Ogies dyke striking to the east. The dyke is also more likely to represent a preferential flow zone than a physical impermeable boundary as far as the weathered and any perched aquifers are concerned.

The larger flow regime includes the historic Arbor underground and opencast workings as well as the current opencast workings of Vlakvarkfontein Colliery and Intibane Colliery.

5.9.2 Site C Aquifer Boundaries

Site C is bounded in the west by the Wilge River, the north by the Leeuwfonteinspruit and the east by a perennial tributary of the Leeuwfonteinspruit that originates around the western part of the farm

Zondagsfontein 253 IR and that is diverted around one of Lakeside Colliery's rehabilitated opencast pits located on Potion 2 of the farm Welgelegen 221IR. These all represent accurately definable groundwater discharge boundaries. The flow regime can further be divided by the watershed (no-flow boundary) between the catchment areas of the Wilge River and the Leeuwfonteinspruit.

The southern boundary is constituted by arbitrary lines parallel to the groundwater flow directions around the central area of 2 pans located just south of the boundary between the farms Vlakvarkfontein 213 IR and Welgelegen 221 IR. Included in the southern part of the eastern groundwater flow regime (Leeuwfonteinspruit catchment area) is an un-rehabilitated opencast pit belonging to Lakeside Colliery. The same flow regime also largely includes the Mbuyelo Group's Rirhandzu Colliery.

The north-eastern extent of the footprint area pertaining to the Wilge River catchment area can be seen to be intersected by the Ogies Dyke.

5.9.3 Site F Aquifer Boundaries

The site is intersected by the water divide between quaternary catchment areas B20F and B20G, constituting a no-flow boundary that separates the area in two distinct flow regimes bounded in the northeast by two non-perennial tributaries of the Saalklapspruit and drained in the southeast by the "Kromdraaispruit" across the old rehabilitated Hillside Colliery opencast pit. The streams all represent accurately definable groundwater discharge boundaries.

The groundwater flow regime to the northeast of the surface water divide contains the almost rehabilitated Bankfontein Colliery's opencast workings, as well as part of the Block B workings previously owned by Homeland Energy and a small part of the north-eastern corner of the Khanyisa Colliery property.

The site's footprint area located within quaternary catchment area B20F hosts Khanyisa Colliery as well as the workings pertaining to of part of Block B as well as Block C and Block F, the latter all until recently belonged to Homeland Energy. The area also includes the historic Hillside Colliery's rehabilitated opencast workings. This area is also intersected by the Ogies dyke cutting across the southern part of mentioned rehabilitated opencast workings.

5.8.1 Site H Aquifer Boundaries

Site H is intersected by the water divide between quaternary catchment areas B20F and B20E, constituting a no-flow boundary that separates the area in two distinct flow regimes bounded in the south by a tributary of the Leeuwfonteinspruit that originates on Schoongezicht 218 IR to the south of Kendal 'E-House' (Schoongezichtspruit Drainage System); and to the far north the Kromdraaispruit. The streams including a number of basically south-north orientated tributaries of the Kromdraaispruit to the north of the site all represent accurately definable groundwater discharge boundaries. No spring discharges were observed around the perimeter of the pan that is intersected by the boundary between Heuwelfontein 215 IR and Schoongezicht 218 IR. As the pan is used as a reservoir for irrigation purposes (3 x centre pivots), it most likely represent an intermittent constant head (hydraulic) influx boundary.

5.10 Groundwater Levels and Flow Direction

5.10.1 Site B Groundwater Levels and Flow Directions

The depth to water table observed in the external users' boreholes during the hydrocensus ranged between 8.27mbc 28.24mbc. Taking the outliers (pumping water levels) out of the equation the average depth to water table observed, calculates to 11.04mbc. A good correlation exits between the depth to groundwater rest level and the surface elevation ($r^2 = 0.9903$ – Figure 14). The saturated interstices pertaining to these boreholes are of the surrounding basal rocks, mostly the Loskop Formation.

Adding to the analyses, the dug wells and fountains surveyed, mostly related to rocky outcrop areas of basal rocks, the correlation deteriorates ($r^2 = 0.8274$), possible suggestive of no-flow boundaries and perched aquifer conditions. Analyses of the shallow dug wells and fountains on their own obviously results in a good correlation ($r^2 = 0.9827$).

The correlation deterioration is however not enough to caution against the application of the Bayes interpolation technique to simulate a groundwater elevation contour pattern using surface topography as a reference level. The site's groundwater flow regime is however fairly complicated. Groundwater flow where not impacted by mining is away from the high lying areas on either side of the surface water divide towards the river and streams (Figure 18 - snapshot in time). Geological discontinuities, discharges at surface and shallow perched water table conditions as well as possible preferential flow along the Ogies dyke have already been discussed in in Section 5.9.1.

Although not necessarily distinguishable in Figure 19 due to data restraints, the dynamics related to mining impacts manifest in a reversal of the water level gradient towards the active open pit operations (below the water table) within a maximum anticipated zone of 200m around the pits, while increased recharge across abandoned and rehabilitated opencast workings, shallow underground workings as well as heaps and dumps, results in enhanced lateral migration.

5.10.2 Site C Groundwater Levels and Flow Directions

The depth to water table associated with the shallow weather zone Karoo aquifer ranged between 2.87mbc 13.67mbc. Taking the outliers (pumping water levels) out of the equation, the average depth to water table observed, calculates to 6.62mbc. A good correlation exits between the depth to groundwater rest level and the surface elevation (r^2 = 0.9826). Including the observed shallow water table conditions and discharges at surface the correlation improves to (r^2 = 0.991 – Figure 15). In general it is safe to assume that the groundwater level elevation distribution within the shallow weathered zone aquifer, unaffected by mining, will mimic the surface topography (Figure 18)

Groundwater flow in all three aquifer types is essentially horizontal but interconnection between the aquifer types can introduce non-horizontal flow components. The perched aquifer usually displays unconfined conditions; the shallow weathered zone aquifer displays unconfined to semi-unconfined conditions whilst the deep aquifer predominantly displays confined conditions.

Difference in hydraulic head between the shallow weathered zone Karoo aquifers and the deep fractured aquifer was observed in one monitoring borehole pairing namely BH-1M and BH-1D drilled some 3 meters apart to respective depths of 30m and 72m below surface. A depth to water level of 7.46mbc was observed in the shallow borehole, while a depth to water level of 13.67mbc was observed in the deep borehole.

In another observation borehole pairing, BH-7S (6m deep) and BH-7M (30m deep), also roughly drilled 3m apart, respective water level measurements of 2.72mbc and 2.87mbc were obtained

5.10.3 Site F Groundwater Levels and Flow Directions

The depth to water table associated with the external users' boreholes as well as the monitoring boreholes surveyed ranged between 1.21mbc and 32.76mbc. Taking the outliers (pumping water levels and water levels affected by mining) out of the equation, the average depth to water table observed, calculates to 7.89mbc. A good correlation exits between the depth to groundwater rest level and the surface elevation (r^2 = 0.9772 - Figure 16). Borehole depths were recorded for 9 out of the 16 water levels analysed for correlation. The depths ranged between 5.96mbc and 90mbs, averaging at 47.98mbs. In general it is safe to assume that the groundwater level elevation distribution within the shallow weathered zone aquifer, unaffected by mining, will mimic the surface topography(Figure 19 – snapshot in time). The area is however disturbed to a large extent by current and historic mining activities and apart from data restraints; the dynamism of the water table in terms of mining and external users' abstractions is evident from the contoured groundwater level elevations presented in Figure 19.

The water levels measured in monitoring boreholes KEN30-B64 (borehole depth = 36.69mbs) and KEN30-B66 (borehole depth = 30.33mbs), respectively at 32.76mbc and 18.44mbc can be attributed to mining impacts. These two boreholes are located on the farm Henma 291 IR and Portion 10 of the farm Bankfontein 216 IR in close proximity to both the Shanduka and Homeland Energy (now the Joe Singh Group of Companies) opencast workings.

5.10.4 Site H Groundwater Levels and Flow Directions

Depth to water table ranges between 1.06mbc and 17.16mbc, averaging at 6.66mbc (outliers excluded).

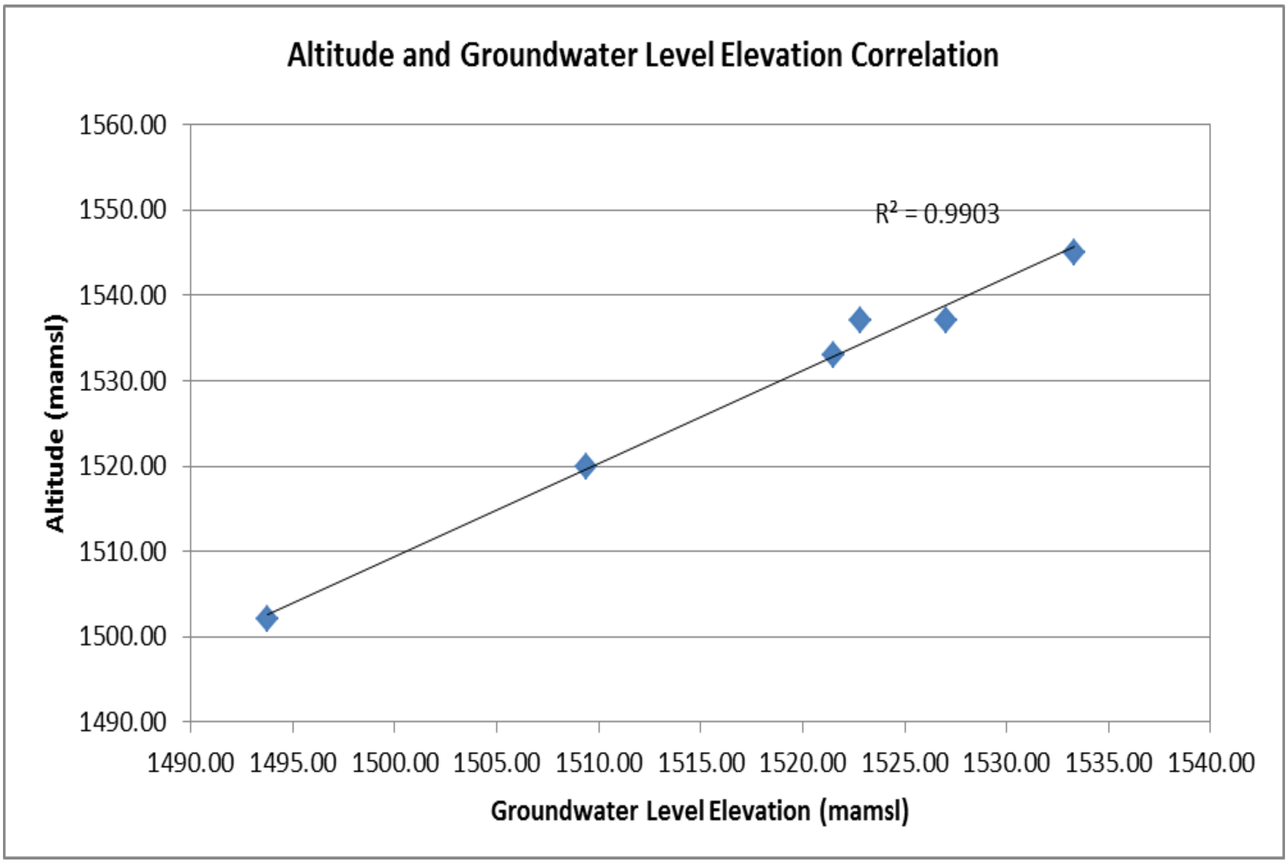


Figure 14: Correlation between Altitude and Groundwater levels observed at Site B

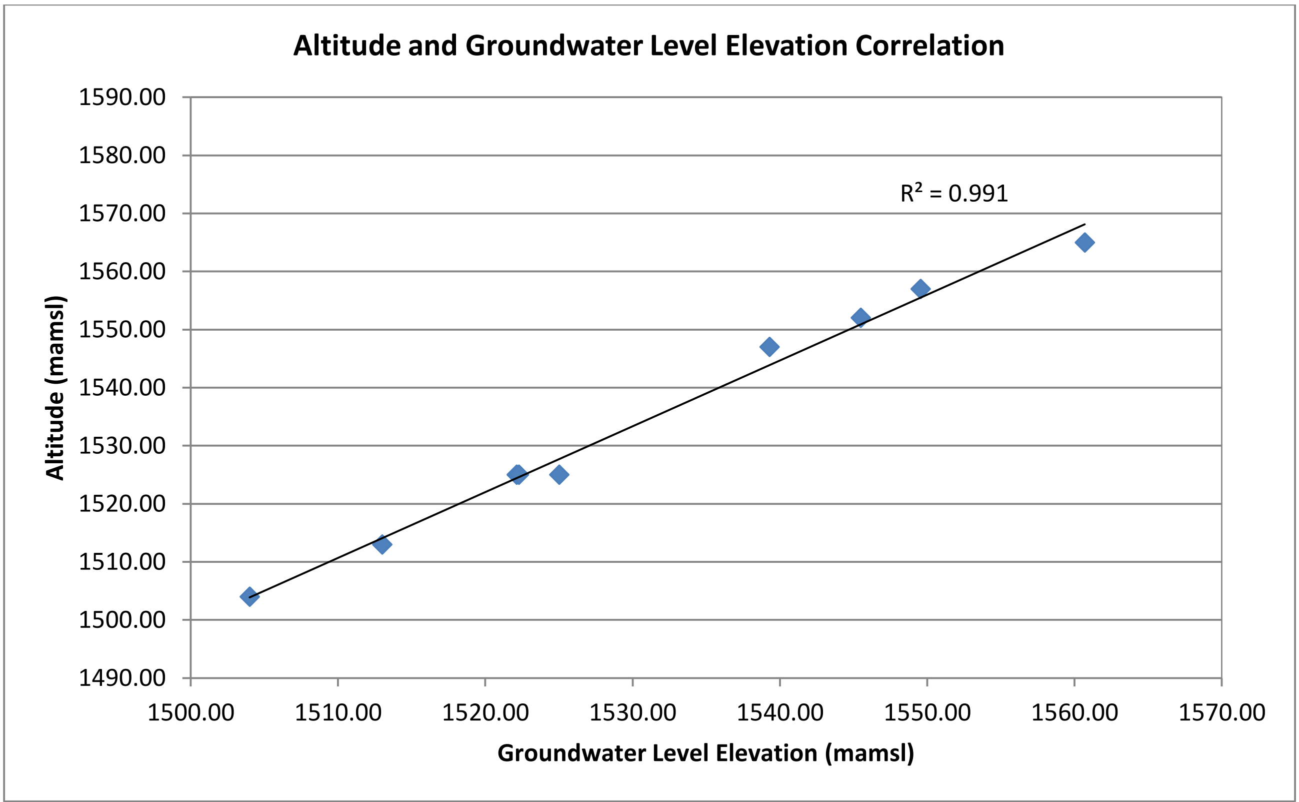


Figure 15: Correlation between Altitude and Groundwater levels observed at Site C

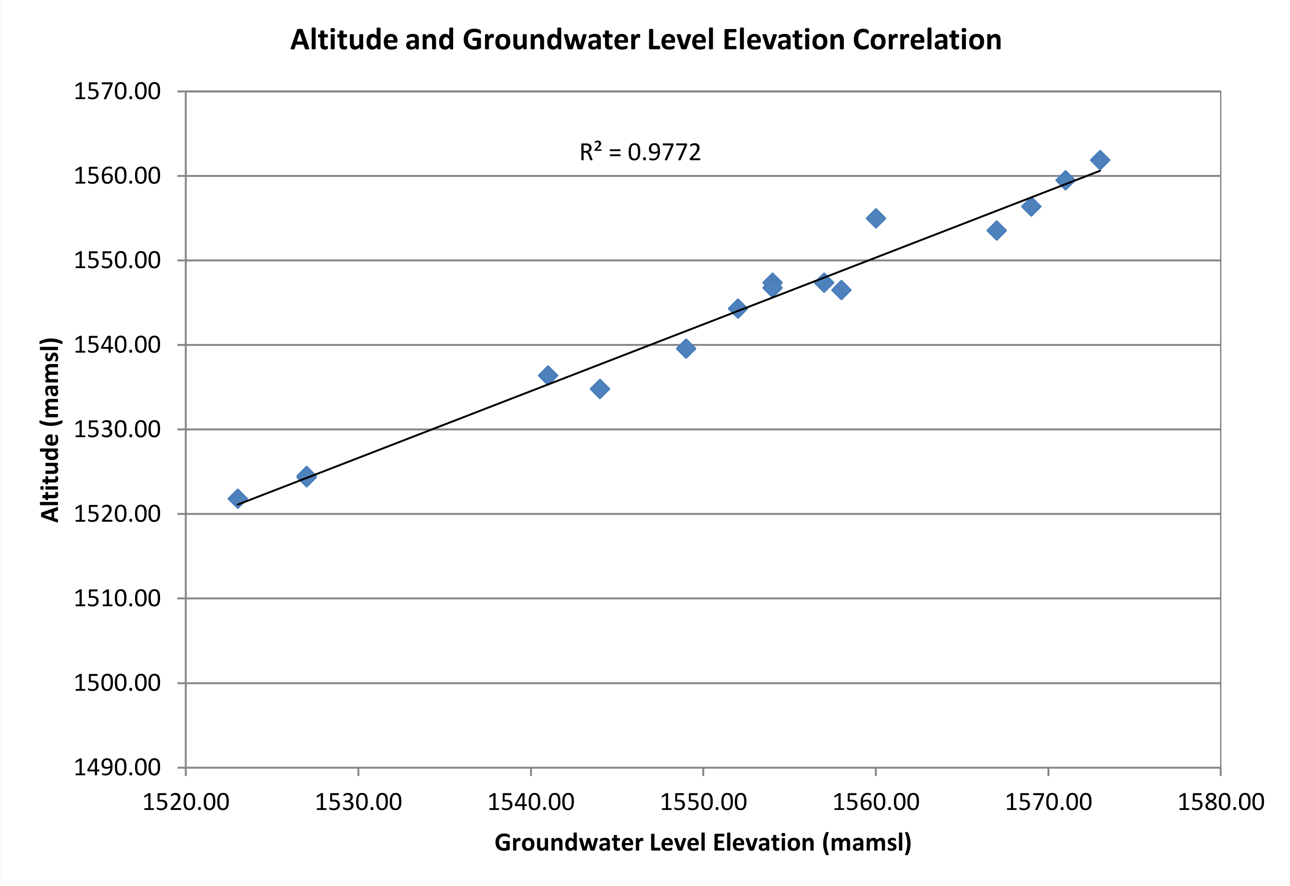


Figure 16: Correlation between Altitude and Groundwater levels observed at Site F

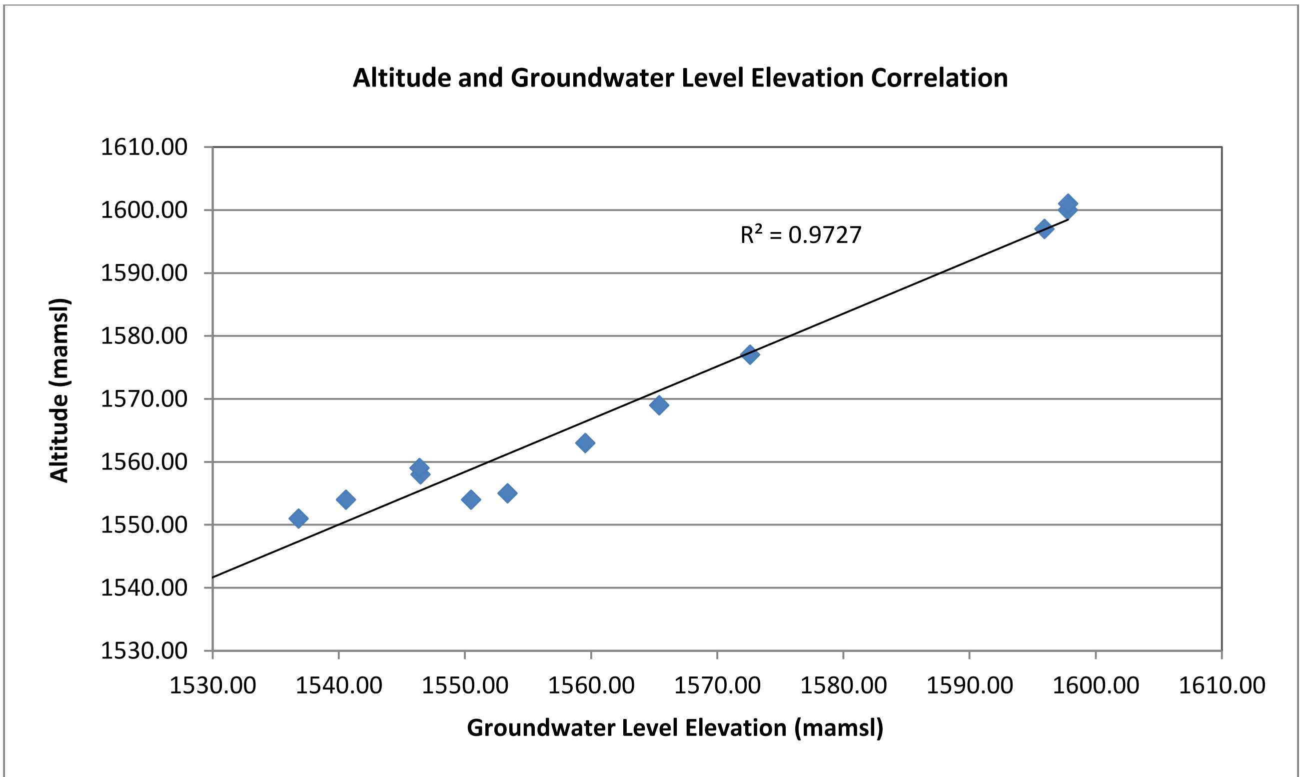


Figure 17: Correlation between Altitude and Groundwater levels observed at Site H

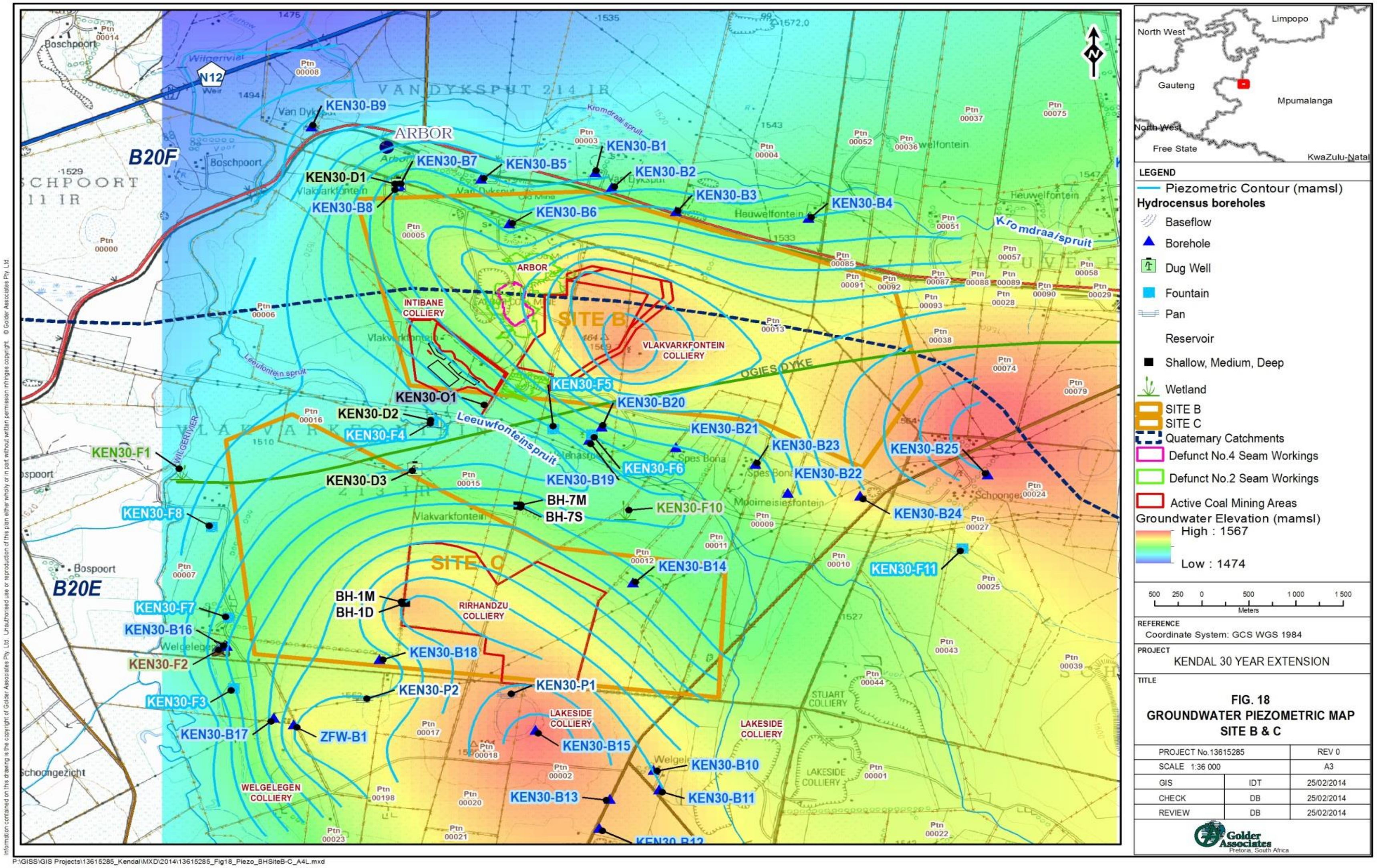


Figure 18: Groundwater Piezometric Contour Map Site B and Site C

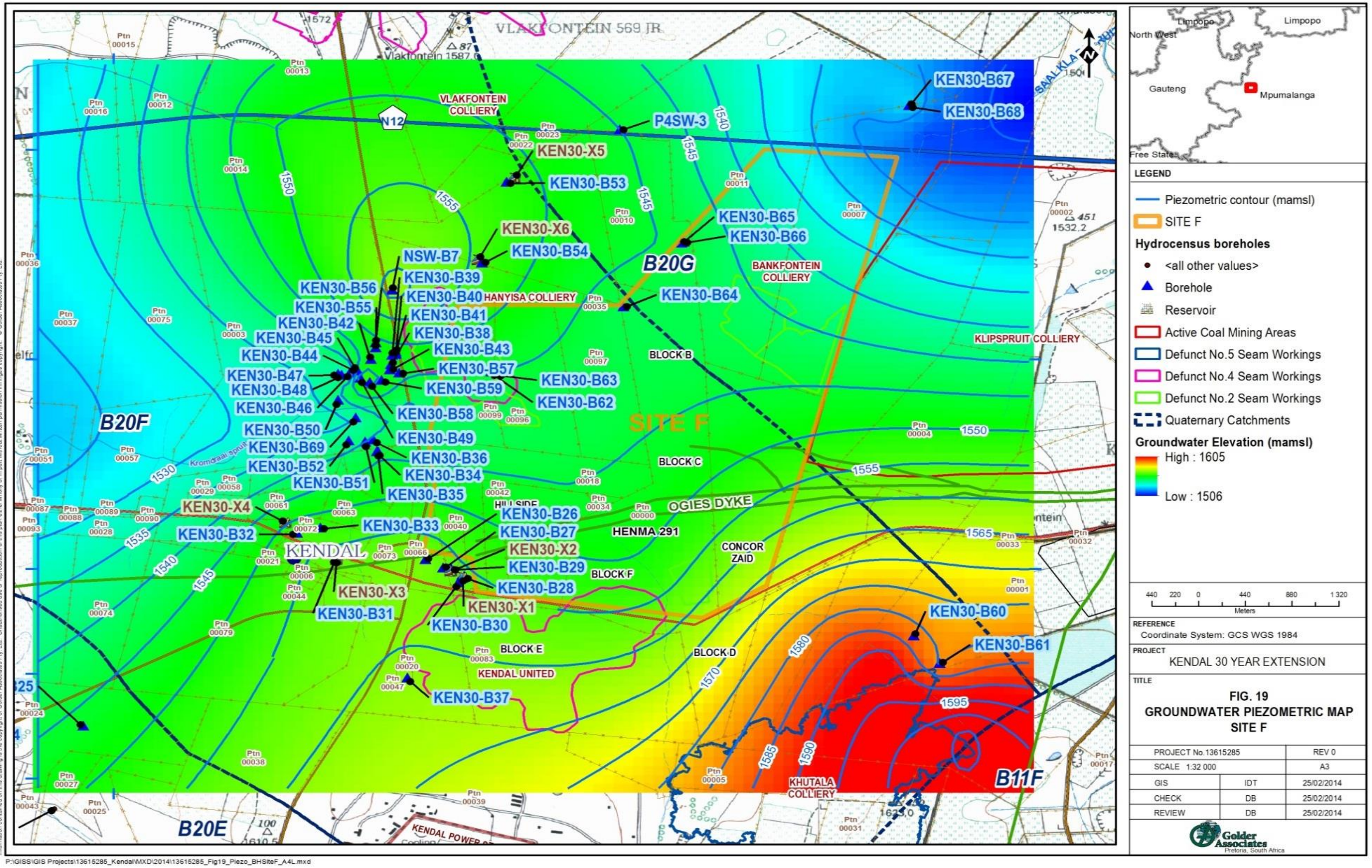


Figure 19: Groundwater Piezometric Contour Map Site F

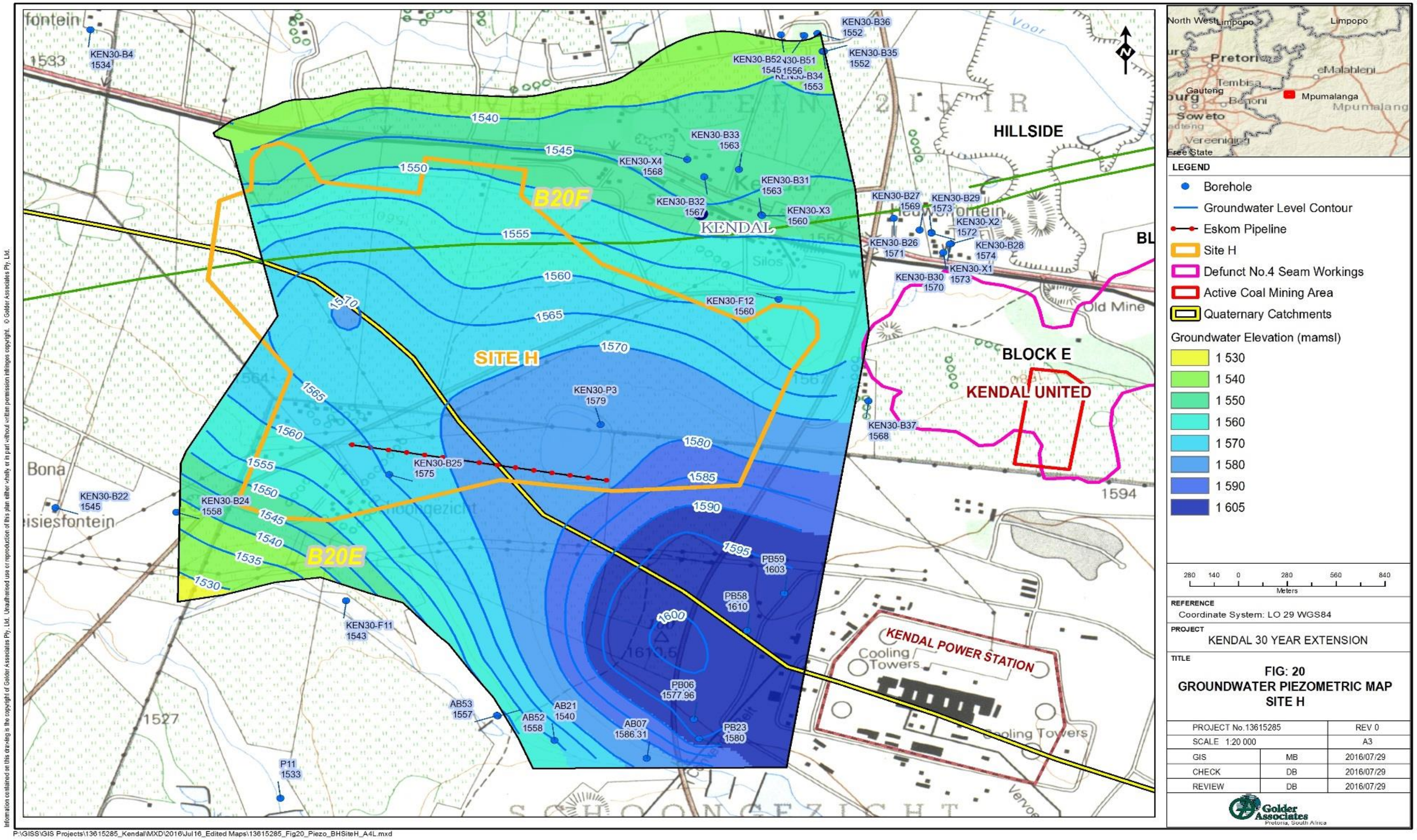


Figure 20: Groundwater Piezometric Contour Map Site H

Table 8: Analytical Results of Hydrocensus Samples

BH No.	Site	Sampling Date	pH	TDS mg/l	EC mS/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Fe mg/l	Mn mg/l	M Alk. mg/l	Cl mg/l	SO4 mg/l	NO3 as N mg/l	Al mg/l	F mg/l	B mg/l	PO4 mg/l
SANS 241 (2011) Drinking Water Standard Lowest Compliance Limit			5-9.7	1200	170	-	-	200	-	0.3	0.1	-	300	250	11	3.0	1.5	-	-
Groundwater Analytical Results September/2013																			
KEN30-	C	20130916	6.05	72	11.3	6.99	5.25	5.31	3.78	<0.0	<0.0	9.2	8.18	2.12	9.56	0.039	<0.1	0.01	<0.8
KEN30-D3	C	20130916	6.48	158	16.5	12.6	11.5	3.88	1.43	<0.0	<0.0	27.1	6.15	7.66	12.3	0.392	<0.1	<0.0	<0.8
KEN30-F1	C	20130916	7.47	50	14.8	8.9	9.81	8.29	3.42	0.22	<0.0	48.8	16.6	2.69	1.53	0.434	0.199	<0.0	<0.8
KEN30-F6	B	20130917	7.9	198	25.1	29.4	14.8	9.49	2.29	0.05	<0.0	133	2.8	6.38	1.47	0.062	<0.1	<0.0	<0.8
KEN30-B6	B	20130917	6.46	452	53	41.4	28.3	29	8.81	<0.0	0.05	20	11	226	8.38	<0.0	<0.1	<0.0	<0.8
KEN30-B4	B	20130917	6.99	214	21.7	16.9	10.3	15.7	1.26	<0.0	<0.0	56.7	6.45	18.7	8.58	<0.0	0.182	<0.0	<0.8
KEN30-	F	20120918	7.19	276	29.8	28.7	14.8	13.7	3.37	<0.0	<0.0	82.7	25.4	9.5	8.09	<0.0	<0.1	<0.0	<0.8
KEN30-	F	20130919	6.93	136	19.2	20.9	9.31	9.79	3.27	<0.0	<0.0	89.8	5.02	8.59	0.54	<0.0	0.152	<0.0	<0.8
KEN30-	F	20130919	6.71	106	16	13.3	6.67	10.7	4.56	<0.0	0.14	67.6	12.3	3.17	<0.3	0.069	0.277	0.01	<0.8
KEN30-	F	20130925	7.77	153	23.6	26.4	8.49	16.4	1.84	<0.0	0.13	115	3.74	17.5	<0.3	<0.0	0.578	<0.0	<0.8
KEN30-	H	20140211	5.33	238	28.7	12.6	13.1	16.9	5.4	<0.0	0.08	3.7	30.4	10.2	21.3	<0.0	<0.1	<0.0	<0.8
KEN30-	H	20140211	7.86	162	20.1	18.5	14.6	4.46	1.82	<0.0	<0.0	94.7	1.54	2.31	4.62	<0.0	<0.1	<0.0	<0.8
KEN30-	H	20140211	6.17	206	22.2	16.3	7.38	13.9	3.47	0.05	0.05	12.9	14.3	24.4	13.6	<0.0	<0.1	<0.0	<0.8

A fairly good correlation exits between the depth to groundwater rest level and the surface elevation (r^2 = 0.97270 - Figure 16). In general it is safe to assume that the groundwater level elevation distribution within the shallow weathered zone aquifer, unaffected by mining, will mimic the surface topography (Figure 19 - snapshot in time).

5.11 Groundwater Quality

A total of 13 groundwater samples were taken during the recent hydrocensus, 3 at Site B, 3 at Site C, 4 at Site F and 3 at site H. The samples were handed in at UIS Analytical Services for analyses of the following constituents:

- pH, EC, TDS, Total Alkalinity;
- F, Cl, SO4, NO3, as N, NO2 and PO4 (Anions by Ion chromatography);
- Ca, Mg, Na, K, Si, P, Fe, Mn, Ti, Zn (Dissolved Cations in Water by ICP-OE);
- ICP-MS Scan

The hydro-chemical results for these 13 samples, together with SANS 241 (2011) compliance criteria are presented in Table 1.

The Analytical Result Certificates of the samples taken during hydrocensus are attached in Appendix B.

The chemical signatures of the major ion compositions of the water samples are portrayed in an Expanded Durov diagram presented inFigure 1.

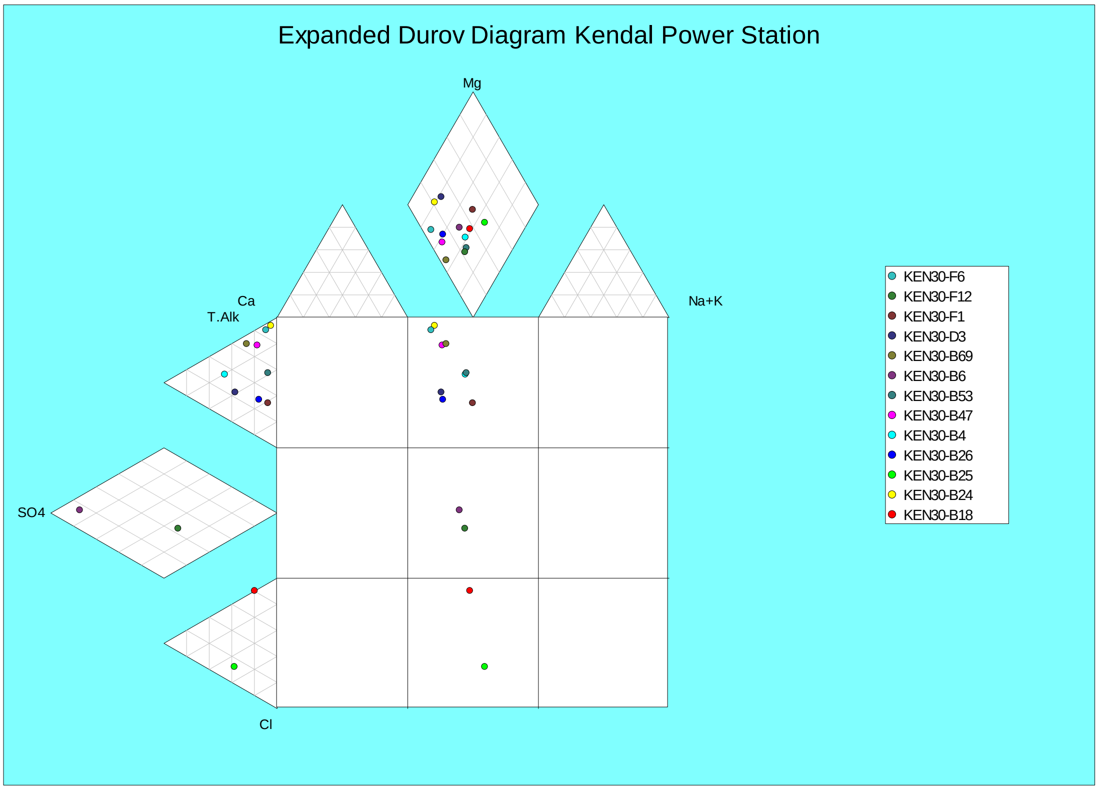


Figure 21: Expanded Durov Diagram of Hydrocensus Results

5.11.1 Site B Groundwater Quality

The constituents of Site B's groundwater samples are all below the SANS 241 (2011) drinking water compliance standards. The SO4 concentration of 200mg/l observed for borehole KEN30-B6 is definitely elevated above background groundwater quality levels and can be attributed to a mining related impact associated with the historic Arbor Colliery.

As can be seen in Figure 20, KEN30-F6 and KEN30-B4 are representative of a magnesium bicarbonate type of water (Mg)(HCO3)2. The plotting positions of these two samples represent uncontaminated water while the plotting position of KEN30-B6, with the dominant cations and anions being Mg and SO4, is representative of water from an opencast coal mine environment;

5.11.2 Site C Groundwater Quality

The constituents of Site C's groundwater samples are all below the SANS 241 (2011) drinking water compliance standards except for the reported nitrate concentration of 12.3mg/l for KEN30-D3 which exceeds the drinking water compliance limit of 11.0mg/l. The related noncompliance can most likely be attributed to agricultural activities which are still the predominant land use.

As can be seen in Figure 20, KEN30-F1 and KEN30-D3 both represent a calcium bicarbonate type of water (Ca) (HCO3)2. The plotting positions of the two samples represent uncontaminated water while the plotting position of KEN30-B18, with the dominant cations and anions being Mg and Cl, are representative of seldom found water;

5.11.3 Site F Groundwater Quality

The constituents of Site F's groundwater samples are all below the SANS 241 (2011) drinking water compliance standards except for the reported manganese concentrations of 0.14mg/l and 0.13mg/l, respectively for boreholes KEN30-B53 and KEN30-B69, which exceeds the drinking water compliance limit of 0.1mg/l.

As can be seen in Figure 20, all 4 water samples taken during the recent census represent a magnesium bicarbonate type of water (Mg)(HCO3)2. The plotting positions all represent uncontaminated water.

5.11.4 Site H Groundwater Quality

The Kendal Power Station Routine Monitoring Phase 58 Report No. RVN 601.11/1286 by GHT Consulting Scientists indicates that:

- The Power Station activities have a very limited impact on the groundwater qualities of the 'Schoongezicht Drainage System' area; and
- The Power Station activities have a very limited impact on the groundwater qualities of the 'Schoongezicht Drainage System'.

The constituents of Site H's groundwater samples are all below the SANS 241 (2011) drinking water compliance standards except for the reported nitrate concentration of 21.3mg/l for KEN30-B25 and of 13.6mg/l for KEN30-F12 which exceeds the drinking water compliance limit of 11.0mg/l. The related noncompliance can most likely be attributed to agricultural activities which are still the predominant land use.

As can be seen in Figure 20, KEN30-B26 is represent a calcium bicarbonate type of water (Ca) (HCO3)2, representing uncontaminated water. The plotting position of KEN30-F12, with the dominant cations and anions being Mg and SO4, is representative of water from an opencast coal mine environment' while the plotting position of KEN30-B25, with the dominant cations and anions being Mg and Cl, are representative of seldom found water.

5.12 Existing and Future Impacts

All four of the feasible "Sites" feature either active, or/and mined out opencast workings. Impacts associated with opencast coal mining are generically summarised below. It is important to note that the cumulative effects of neighbouring mines are not taken into account in this summary:

Construction/Operational Phase:

- Groundwater levels in the immediate vicinity of the open pit will be influenced due to groundwater inflows into the opencast sections;
- Dewatering zones generally range between 100m to 200m from the pit perimeter for the first couple of years, gradually expanding over time, although typically not distinguishable from seasonal groundwater trends beyond 200m;
- Groundwater flow into the opencast workings is expected to be of similar quality than the background groundwater quality;
- Once in contact with the various materials within the workings, the water quality can be expected to deteriorate over time. In-pit water is pumped out to keep the workings operational and SO4 concentrations are generally not expected to exceed the 200mg/l - 500mg/l range;
- Due to groundwater flowing toward the dewatered mining areas, the surrounding aquifers are not expected to be impacted on in terms of groundwater quality during the operational phase;

Post-mining Phase:

- Although decant at pit perimeter is a possibility, sub-surface decant will occur as contaminated base-flow to low-lying areas and the natural discharge boundaries;
- Apart from the time to decant the type and manner of backfill can also be expected to have major influence on the long-term water quality trends;
- Although somewhat speculative, SO4 concentrations in the backfill of pits, can reach values ranging between 2 000mg/l to 4 500mg/l, peaking over a period roughly ranging between 20 and 60 years where-after it will decrease again to a range of < 500mg/l to around 2 000mg/l depending on a number of factors including the thickness of the unsaturated zone;
- Within the first 20years, the contamination plume can be expected to be restricted to a zone within 200m of the pit.

As mentioned in Section 5.9, surface infiltration sources such as unlined water ponds heaps and dumps, will most likely represent constant head (hydraulic) influx boundaries causing induced lateral migration through the shallow weathered zone aquifer and any perched aquifers present.

5.12.1 Site B Existing and Future Impacts

As indicated in Section 5.5.1, this Site not only hosts the old Arbor Coal Mine where both the No.2 and No.4 Coal Seams were historically mined underground by board-and-pillar extraction, as well as by opencast mining; but also two active opencast mines namely Vlakvarkfontein Colliery and Intibane Colliery.

The Site features a historic mine drainage decant seepage zone (KEN30-O1) along the slope to the Leeuwfonteinspruit. Apart from salt load crystallisations on the rocks no visible surface seepages were observed during the recent hydrocensus.

The SO4 concentration of 200mg/l recorded for the Arbor Village water supply borehole KEN30-B6, from a sample taken during the recent hydrocensus, is definitely elevated above background groundwater quality levels and can be attributed to a mining related impact associated with the historic Arbor Colliery.

With regard to Vlakvarkfontein Colliery’s future risk to the groundwater environment, upon review of the following documentation

- Geohydrological Report for the Proposed Vlakvarkfontein Mine Report Number GeVla-08-152 (July 2008) Geo Pollution Technologies Gauteng;
- Vlakvarkfontein Mine Groundwater Impact Assessment Study Report No 069_Vlakvarkfontein (November 2009) Groundwater Square;

SRK in their report, “An Independent Competent Persons’ Report on the Material Assets of Continental Coal Limited CCL CPR 15 Aug 2011 final.doc/Project Number 427952 (August, 2011) SRK Consulting (South Africa) (Pty) Ltd” states the following:

- On closure, the mine will flood to a level of 1 540mamsl in the decant area to the south (due to the lower topography) and is estimated at 0.8l/s increasing to a maximum of 4.4l/s some 10 to 15 years after closure”;
- “Following closure, the long term sulphate concentration will be 1 000mg/l but if only 10% of the carbonaceous material remains unsaturated, the sulphate concentrations in the pit could possibly reach 2 200mg/l. Within the first 20 years the contamination plume will be restricted to the vicinity of the pit and a maximum of 250m from the southern pit. Based on a decant rate of 4.4l/s and a sulfate concentration of 1 000mg/l, the salt load that could be added directly to the surface water environment is calculated as 140tpa or 380kg/day.”

5.12.2 Site C Existing and Future Impacts

As indicated in Section 5.5.2, Site C hosts the Mbuyelo Group’s Rirhandzu Colliery within Portions 4, 12, 14 and 15 of the farm Vlakvarkfontein 213 IR. Operations commenced only recently on the 5th of July 2013. LoM is estimated as 6 to 8 years with additional reserves still to be confirmed.

In terms of impacts from neighbouring mines, Site C is bounded in the north by an un-rehabilitated opencast pit (Lakeside Colliery) on Portion 2 of the farm Welgelegen 221 IR.

5.12.3 Site F Existing and Future Impacts

As indicated in Section 5.5.3, Site F hosts:

- The historic Hillside opencast workings (within Portions 9, 18, 40, 41 & 42 of the farm Heuwelfontein 215 IR, Portions R/E, 40, 41(R/E) and 42 are listed as belonging to Shanduka Coal (Synergistic 2010);
- WesCoal’s Khanyisa Colliery within Portions 96, 97 and 99 of the farm Heuwelfontein 215 IR. During July 2012 the Khanyisa reserve was estimated at 1Mt with a life of 10 to 12 months;
- Homeland Energy Group Ltd’s (now the Joe Singh Group of Companies) Kendal Colliery (previously named Zaid Colliery) within the farm Henma 291 IR and Portion 83 of the farm Heuvelfontein 215 IR (to the immediate south of Site F), covering some 587ha;
- Shanduka Coal’s defunct Bankfontein Colliery within Portions 7 and 10 and 11 of the farm Bankfontein 216 IR (listed as belonging to Trutor Boedery, Synergistic 2010). According to the mine surveyor, the mine footprint area is some 178ha contained in a lease area of 419ha. Rehabilitation is almost complete. A void with a softs stockpile for final rehabilitation is left. Drainage across the rehabilitated opencast section is towards the northeast. The site also features a partially covered dry slimes dam, a discard dump (60 000m3) with a small slimes dam to the immediate north of it, as well as a mini-pit previously used as water supply/reservoir to the wash plant.

Two samples taken during the hydrocensus from external user’s boreholes KEN30-B53 and KEN30-B69 recorded manganese concentrations of 0.14mg/l and 0.13mg/l that exceed the SANS 241 (2011) drinking water compliance standards compliance limit of 0.1mg/l. The potability of the water from KEN30-B53 was reported as poor during the recent hydrocesus. The noncompliance is however not indicative of a mining impact but can most likely be attributed to the geology of the saturated interstices.

The water levels measured in monitoring boreholes KEN30-B64 (borehole depth = 36.69mbs) and KEN30-B66 (borehole depth = 30.33mbs), respectively at 32.76mbc and 18.44mbc can be attributed to mining impacts. These two boreholes are located on the farm Henma 291 IR and Portion 10 of the farm Bankfontein 216 IR in close proximity to both the Shanduka and Homeland Energy (now the Joe Singh Group of Companies) opencast workings.

Reports of replacement boreholes being drilled by the mine on Plot 32 of The Kendal Forest Holdings were recorded during the recent hydrocensus.

The Site is further neighboured in the east by BECSA's Klipspruit Colliery, in the south by Homeland Energy Group Ltd's (now the Joe Singh Group of Companies) Block E and Block D mining activities as well as the old New Largo Colliery to the north, including an active opencast operation on Vlakfontein 569 JR immediately north of the N12 along the upper reaches of the Saalklapspruit's catchment area.

5.12.4 Site H Existing and Future Impacts

Although Site H does not feature any current or known historical coal mining activities, it is bounded in the northeast by the historic Kendal United No.4 seam underground workings. Open cast mining (including pillar extraction on the historically mined No.4 seam) at Block E by Just Coal is currently taking place.

Centrally Site C features a perennial pan (KEN30-P3) that is intersected by the boundary between Heuwelfontein 215 IR and Schoongezicht 218 IR. The pan forms part of the local agricultural irrigation system totalling some 230ha (maize & soya). Infrastructure allows for water to be pumped from the 'Schoongezictspruit Drainage System' at KEN30-F11 between Kendal Power Station's surface water monitoring points R04 and PP05 as well as from the dam in the 'Leeuwfonteinspruit Drainage System' located between the current ashing activities and Lakeside Colliery's infrastructure (Kendal Power Station's surface water monitoring point P11). The latter is currently in use as the former's pipeline is leaky. The pump station in the 'Leeuwfonteinspruit Drainage System' apart from pumping to the pan also drives two centre pivots situated between these two 'Drainage Systems'. The pump station at the pan drives 3 centre pivots located to the southwest, north and northeast of the pan. Water pumped from the 'Leeuwfonteinspruit Drainage System' has a strong hydrogen sulphide smell. According to the farm manager this has been the case since the beginning of the current rainfall season.

As the pan is used as a reservoir for irrigation purposes (3 x centre pivots), it most likely represent an intermittent constant head (hydraulic) influx boundary.

The Kendal Power Station Routine Monitoring Phase 58 Report No. RVN 601.11/1286 by GHT Consulting Scientists indicates that:

- There are a sulphate, sodium, calcium and potassium impact on the 'Schoongezictspruit Drainage System' associated with the ash transfer system in the Power Station Area, the Ash Stack and its associated operation just north of the stack;
- There is a mining impact (elevated sulphate concentrations) on the 'Leeuwfonteinspruit Drainage System'.
- The Power Station activities have a very limited impact on the groundwater qualities of the 'Schoongezicht Drainage System' area;
- The Power Station activities have a very limited impact on the groundwater qualities of the 'Schoongezicht Drainage System'.

6.0 SITE SELECTION

Site selection is presented in Table 9. Ranking is based on the foregoing sections of this report with rating based on a simplistic positive / negative scale with score values ranging between a maximum of +3 and a minimum of -1.

6.1 Site B Ranking and Rating

Although Site B can accommodate a 500ha area on undisturbed land (mining) land across its eastern extent it scored the lowest rating. Reasons include:

- Complex groundwater flow regime with steep gradients, geological discontinuities, natural discharge boundaries on both sides of the surface water divide intersecting the potentially available land, as well as the flow regime to the south of this divide being intersected by the Ogies dyke which most probably represents a preferential groundwater flow zone;
- Loskop Formation strata featuring rocky outcrop areas are present over a substantial portion of the available land. Apart from limited soil cover the rocky areas can also be associated with enhanced

infiltration with lateral movement along shallow fresh bedrock and surface seepages where these pinch out or are intersected by present day topography.

6.2 Site C Ranking and Rating

From a groundwater perspective Site C is the 2nd most suitable of the 4 feasible sites. It can accommodate a 500ha area on undisturbed land (mining) across its western extent. Unfortunately this would mean the sterilisation of the shallow coal resources across this piece of land.

Table 9: Site Selection Ranking and Rating

SITE SELECTION RANKING	SITE B	SITE C	SITE F	SITE H
Aquifer Classification Yielding Potential	MINOR	MINOR	MINOR	MINOR
	+(3)	+(3)	+(3)	+(3)
Aquifer Vulnerability	Medium-L	Low-Medium	Low	Low
	-(1)	-+(2)	+(3)	-+(2)
Total length of potential zones of influence/ discharge boundaries (km)	21.5	13	3.4	14.1
	-(1)	-+(2)	+(3)	-+(2)
Topographic & water level gradients	Steep	Moderate to steep	Mostly moderate	Moderate to steep
	-(1)	-+(2)	+(3)	-+(2)
Rocky outcrops	YES	NO	NO	YES
	-(1)	+(3)	+(3)	-+(2)
Number of external users groundwater abstraction points within a 1km radius	14	7	24	8
	-+(2)	+(3)	-(1)	+(3)
Existing impacts	DEFINITE	MINOR	DEFINITE	MINOR
	-(1)	-+(2)	-(1)	+(3)
Dolomite basement rock close to floor of opencast workings historic & current	NOT REPORTED	NOT REPORTED	REPORTED	NOT REPORTED
	+(3)	+(3)	-- (-1)	+(3)
Availability of required 404.7 ha: undisturbed land	YES	CURRENTLY	NO	YES
	+(3)	+(3)	-(1)	+(3)
Availability of required 404.7 ha: undisturbed land without large scale sterilization of shallow coal reserves	PROBABLE	NO	PROBABLE	PROBABLE
	-(1)	-- (-1)	-(1)	-(1)
Major linear geological structures intersecting required 404.7 ha: undisturbed land	YES	NO	UNAVAILABLE	NO
	--(-1)	+(3)	+(3)	+(3)
Neighbouring impacts	NO	YES	YES	YES
	+(3)	-+(2)	-(1)	-+(2)
SCORE	19	27	22	29

6.3 Site F Ranking and Rating

Site F scored the 2nd lowest rating. It cannot accommodate a 500ha area that has not been disturbed by mining. Apart from the extent of the mining disturbance and the associated liabilities, in addition to potential cumulative impacts associated with neighbouring mines, the base of the Karoo is reported to overly pre-Karoo dolomites of the Malmani Subgroup with the Dwyka Formation occasionally discontinuous (SRK, 2007). The latter has been addressed in Section 5.8.3 but warrants verification.

6.4 Site H Ranking and Rating

From a groundwater point of view Site H achieved the highest rating of the 4 feasible sites.

7.0 GROUNDWATER BASELINE CONCLUSIONS

Apart from Site H, none of the other viable sites are “greenfield” areas. The other sites feature active and historical coal mining operations or both of the aforementioned. Both Site B and Site C can accommodate 404.7 ha areas unaffected by mining within their footprint areas, although both have their own unique problems.

From a groundwater point of view Site C has a better ranting than site B, but its selection as the preferred site could mean large scale sterilization of shallow coal reserves. Mining within Site C’s footprint area commenced last year on the 5th of July 2013.

Site B features a complex groundwater flow regime with steep gradients, geological discontinuities, natural discharge boundaries or potential zones of impact on both sides of the surface water divide intersecting the potentially available land as well as a potential, major groundwater preferential flow zone intersecting the flow regime south of the divide. Loskop Formation strata featuring rocky outcrop areas are present over a substantial portion of the available land. Apart from limited soil cover the rocky areas can also be associated with enhanced infiltration through the fractured rock with lateral movement along shallow fresh bedrock and surface seepages where these pinch out or are intersected by present day topography.

In addition to the known decant seepage zone associated with the historic Arbor Mine, hydro-chemical fingerprinting is indicative of a mining impact on one external user’s borehole sampled during the recent hydrocensus.

Site F scored the 2nd lowest rating. It cannot accommodate a 404.7 ha area that has not been disturbed by mining. Problems unique to this site include the extent of the mining disturbance and the associated liabilities, the potential cumulative impacts associated with neighbouring mines as well as a reported dolomitic basement. Should this site be considered due to any other discipline or considerations these aspects warrant verification. Dewatering of the weathered zone aquifer was observed in close proximity to opencast workings during the recent hydrocensus.

From a groundwater point of view, Site H achieved the highest rating of the 4 feasible sites.

The relevant historic, active and future coal mining areas portrayed and comprehensively discussed in the foregoing sections to this report is not complete and remain an issue in terms of information gaps and uncertainties.

8.0 GROUNDWATER SURFACE WATER INTERACTION

8.1 Introduction

Golder Associates Africa (Golder) has been appointed by Zitholele Consulting (Pty) Ltd to provide specialist groundwater inputs in support of the EIA, Waste Management License Application and IWULA processes at Kendal Power Station for the new 30 year ash disposal facility. Part of the investigation is to determine the interaction between the surface water and groundwater for the site H of Kendal Power Station focussing on the surface water features and mainly the pan, as advised by DWS (Departmnet of Water and Sanitation).

It is understood that an understanding of the natural functioning of the pan (on site ‘H’) is required in order to establish the connection between the pan and the regional groundwater. Further, due to the presence of the pan which might be in hydraulic connection with the free groundwater surface the potential for contaminants (from the ash dump) to reach the underlying aquifer needs to be assessed.

Based on the baseline assessment very little site specific (around the pan itself) groundwater information was obtained. To accommodate for uncertainties in the conceptual functioning of the pan and to quantify and predict the potential impact from the proposed ash dump an intrusive investigation comprising of the drilling of shallow piezometers surrounding the pan was proposed and undertaken to increase the confidence in the modelling predictions and detail of the results.

8.2 Objective

The main objective of the groundwater-surface water interaction study, are to develop a groundwater numerical flow model to assess the shallow groundwater flow regime and surface seepages/wetlands in the vicinity of the proposed Site 'H' ash dump and potential impacts of the other wetlands that are within the larger Site 'H' area.

8.3 Proposed scope of work

This groundwater specialist study will comprise the following inputs although this report only addresses the geophysical survey:

- Limited geophysical survey at the pan ;
- Drilling of 5 monitoring boreholes;
- Aquifer testing (slug testing) of new monitoring boreholes;
- Sampling of the new monitoring boreholes;
- Groundwater conceptual model;
- 3D Numerical groundwater flow modelling; and
- Reporting.

8.3.1 Geophysical Survey

A limited geophysical survey was conducted to assist with the selection of drill sites for the drilling of the shallow (~15m) monitoring boreholes outside the hill slope of the pan.

The geophysical survey targeted weathering in the Karoo Sequence sediments and possible fractures associated with dolerite dyke contact zones which could act as preferential groundwater flow paths.

Four geophysical traverses as indicated on Figure 22 were conducted which comprises magnetic and electromagnetic methods, which are discussed below.

8.3.1.1 Magnetic Method

The aim of the magnetic method is to investigate sub surface geology on the basis of anomalies in the earth's magnetic field resulting from the varying magnetic properties of underlying rocks. Different rock types have different magnetic susceptibilities, which may have remnant magnetism. The contrast in magnetic susceptibility and/or remnant magnetism gives rise to anomalies related to structures like intrusive dykes, faults, lithological contacts and weathered/fractured bedrock.

8.3.1.2 Electromagnetic Method

Geophysical traverses were surveyed by means of the Geonics EM-34. The EM34 system is calibrated to measure terrain conductivities in milliSiemens/m (mS/m) using different coil separations and orientations to vary investigation depths and detection/mapping of horizontal or near vertical and fracture systems.

The survey was conducted with a 20m coil separation, with a maximum effective penetration depth of approximately 7.5m for vertical coil orientation and 15m respectively for horizontal coil orientation.

The EM-34 was applied for its effectiveness to detect sub surface conductivity associated with weathering and remanent and nonmagnetic dykes and geological structures.

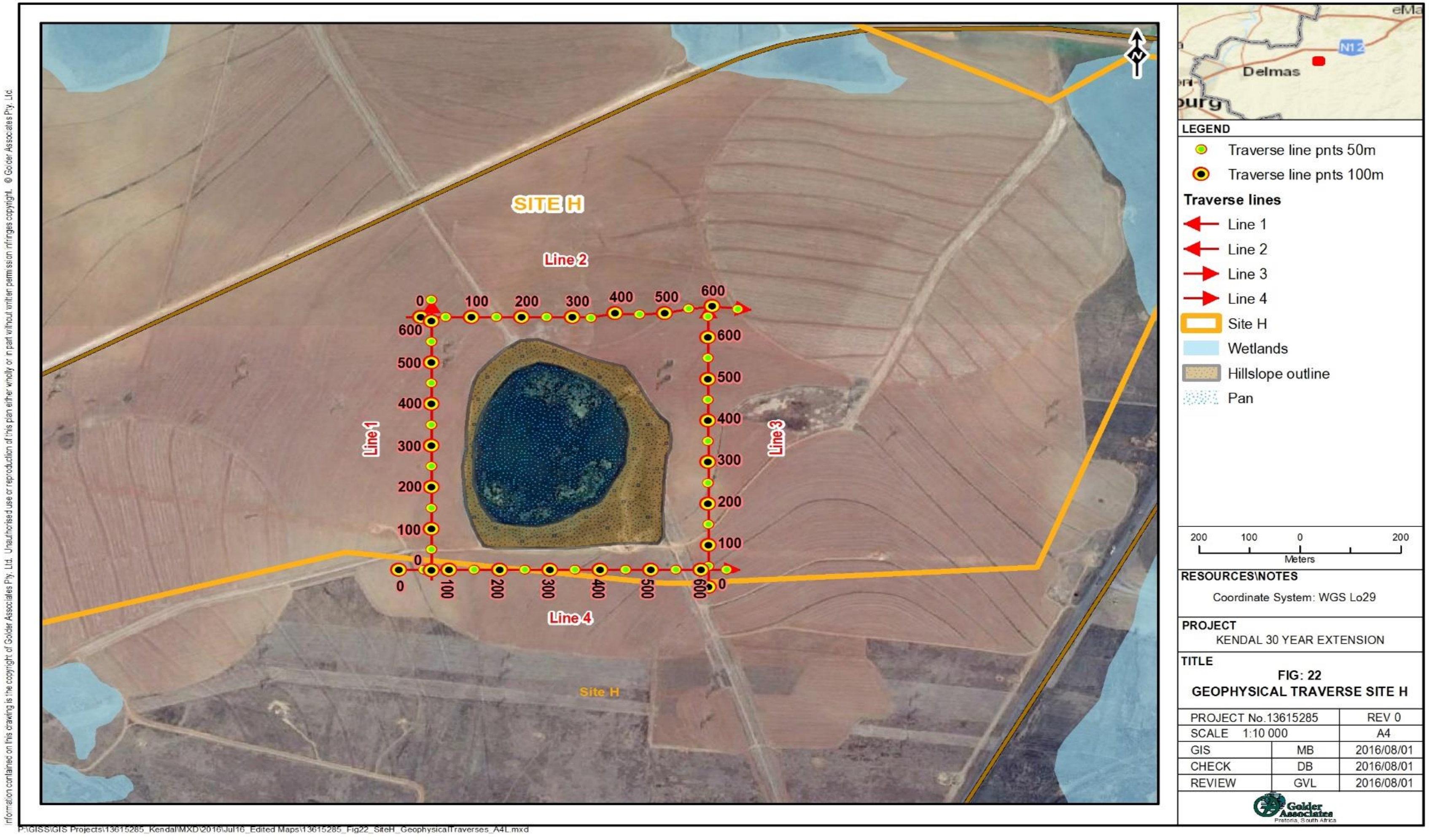


Figure 22: Geophysical Traverse

8.3.1.3 Geophysical Results

Geophysical data were evaluated by plotting the data on linear graphs, which permits a comparison of different geophysical methods used.

Various power lines affected the geophysical data quality as the magnetic and electromagnetic methods are extremely sensitive to lateral effects caused by these structures.

The geophysical traverses were surveyed at 10m station intervals, with all station marked in the field and a hand held GPS was use to take coordinates at every 100m intervals in WGS-84 format.

The geophysical traverses are indicated on Figure 23to Figure 26 and the traverse positions are indicated on Figure 22.

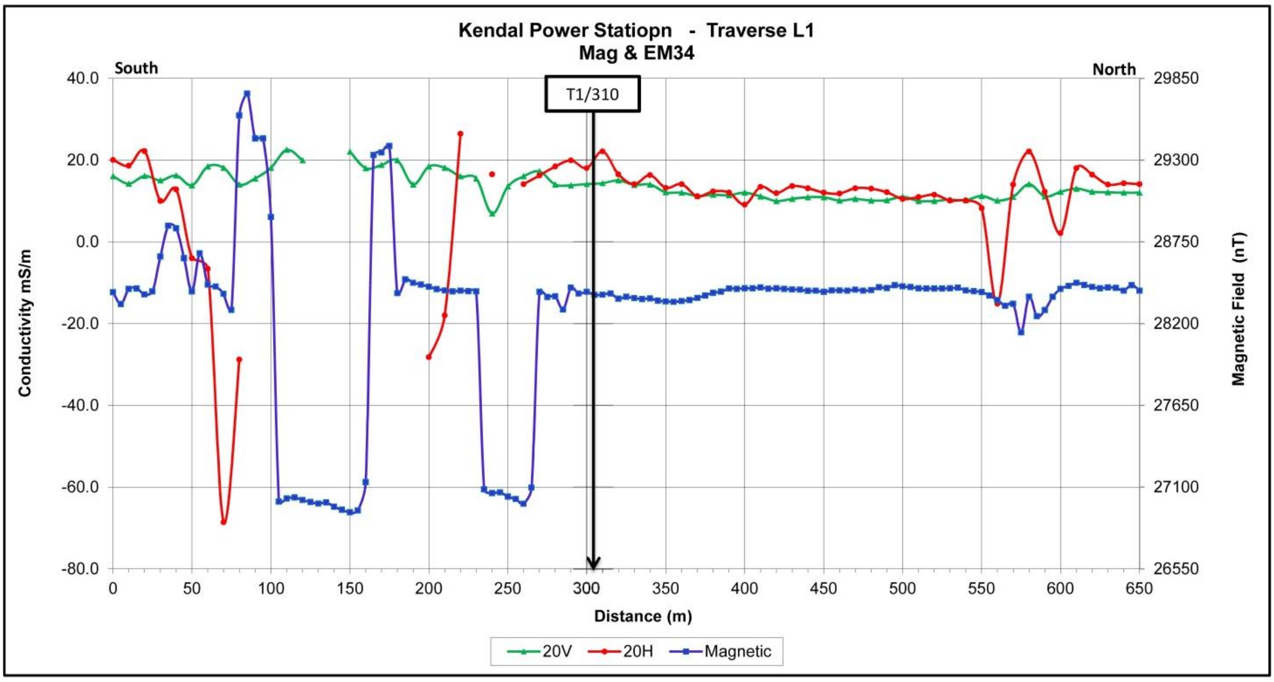


Figure 23: Traverse 1

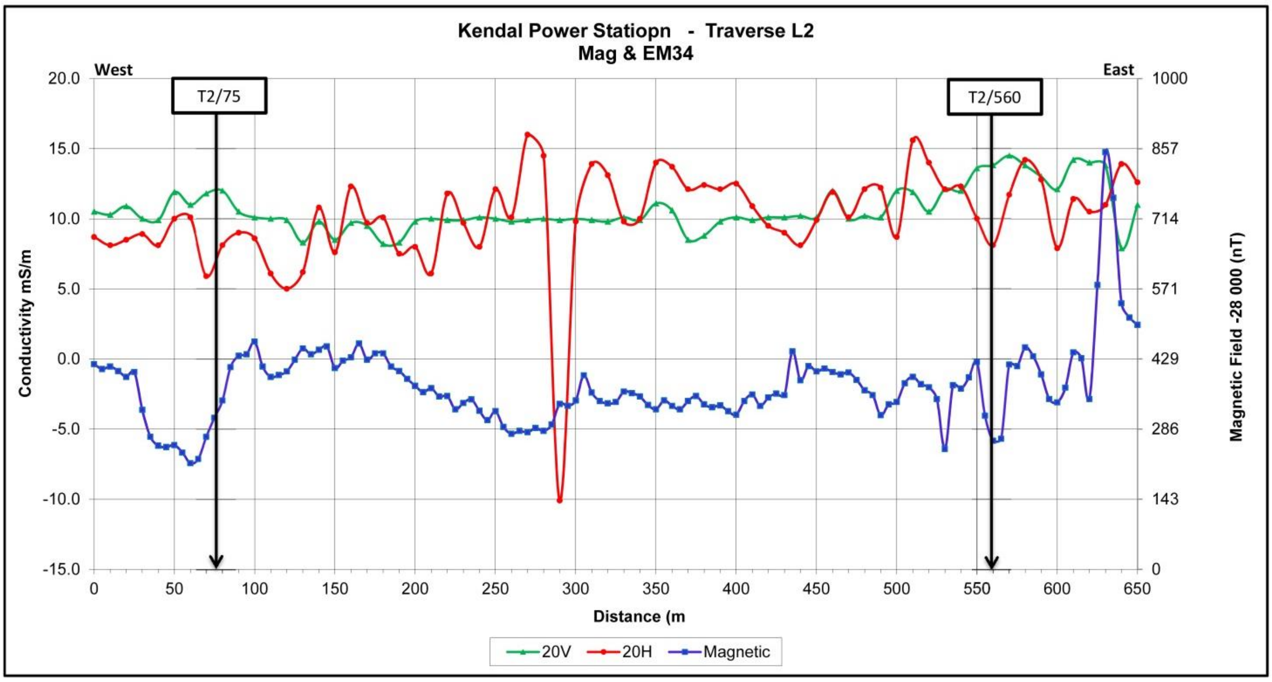


Figure 24: Traverse 2

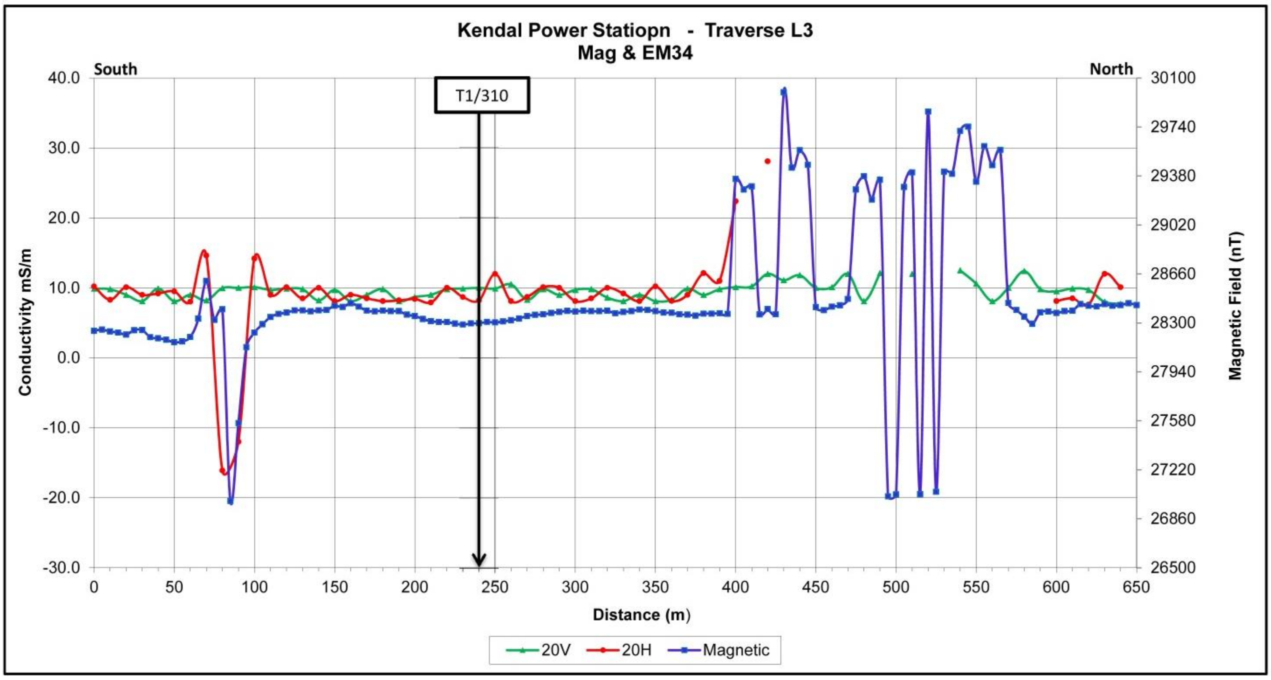


Figure 25: Traverse 3

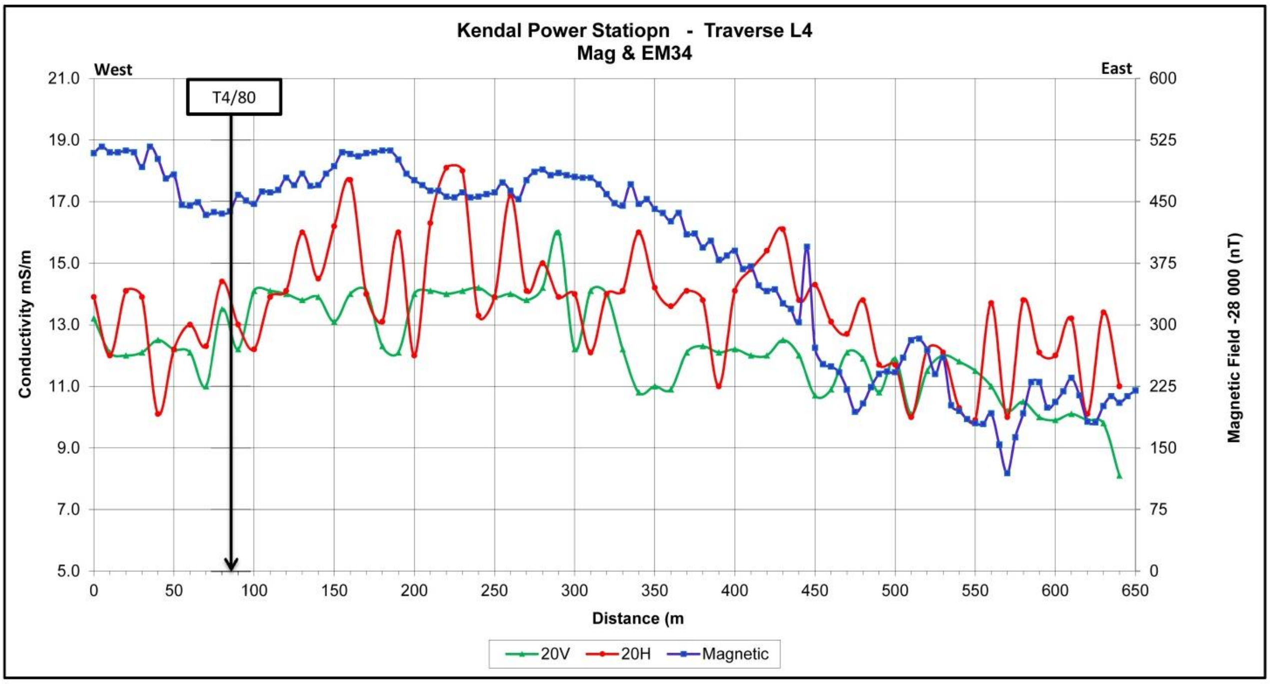


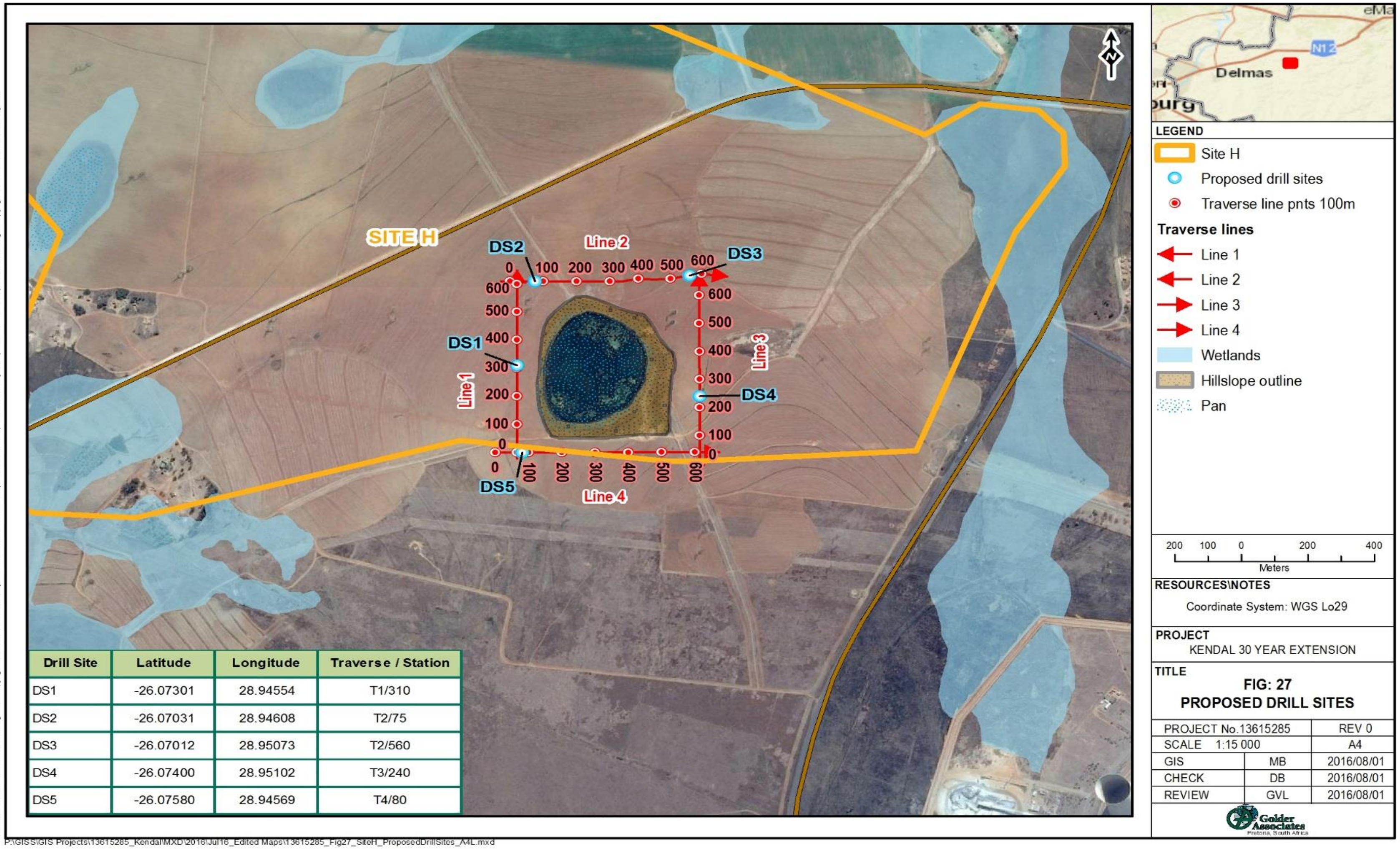
Figure 26: Traverse 4

8.3.1.4 Proposed Drill sites

Five proposed drill sites were selected based on geophysical results and are listed Table 10 and indicated on Figure 27.

Table 10: Proposed Drilling Sites

Drill Site	Latitude	Longitude	Traverse/ Station	Drilling Target	Geophysical Method	Proposed Depth (m)
DS1	-26.07301	28.94554	T1/310	Weathering zone	EM-34	15
DS2	-26.070306	28.946079	T2/75	Possible Dyke contact zone/weathering	Magnetic/EM-34	15
DS3	-26.07012	28.95073	T2/560	Possible Dyke contact zone/weathering	Magnetic/EM-34	15
DS4	-26.07400	28.95102	T3/240	Weathering zone	EM-34	15
DS5	-26.07580	28.94569	T4/80	Weathering zone	Magnetic/EM-34	15



Drill Site	Latitude	Longitude	Traverse / Station
DS1	-26.07301	28.94554	T1/310
DS2	-26.07031	28.94608	T2/75
DS3	-26.07012	28.95073	T2/560
DS4	-26.07400	28.95102	T3/240
DS5	-26.07580	28.94569	T4/80

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Figure 27: Proposed Drill Sites

8.3.2 Drilling

Five new monitoring boreholes (Figure 28) were drilled at 216mm diameter through weathered clay formations of the Karoo Super Group and cased with 53mm (inside diameter) Upvc casing. Perforated casing were installed from 3.8m to 15m to allow groundwater seepage in to the boreholes.

Gravel packs were installed in the annulus between the sides of the borehole and the casing of monitoring boreholes to stabilise the geological formation and allow groundwater inflow into the borehole. Bentonite seals of 1m were installed above the gravel pack at surface. The borehole head works at surface consists out of a 1m 165mm steel casing, cement collar block, maker pole and the casing was closed with a steel cap which can be opened with a 12 mm Alan key.

Four of the new monitoring boreholes encountered seepage, whereas KMBH-03 was dry. The drilling results are summarised in Table 11 with geology intersected.

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Figure 28: Shallow Monitoring Borehole Positions

Table 11: Summarised Drilling Results

Borehole number	Latitude	Longitude	Drilling Depth (m)	Diameter (mm)	Water Strike (l/s)	Final Blow Yield (l/s)	Measured WL (mbgl)	Geological Formation Intersected	BH Status
KMBH-01	-26.073010	28.945540	15	53	Seepage	Seepage	6.22	Overburden and clay	Monitoring
KMBH-02	-26.070300	28.946070	15	53	Seepage	Seepage	7.25	Overburden, clay and sandstone(14-15m)	Monitoring
KMBH-03	-26.07012	28.95073	15	53	Dry	Dry	-	Overburden, clay and shale(14-15m)	Monitoring
KMBH-04	-26.07400	28.95102	15	53	Seepage	Seepage	3.94	Overburden, clay and sandstone(7-15m)	Monitoring
KMBH-05	-26.075800	28.945690	15	53	Seepage	Seepage	6.70	Overburden, clay and sandstone(12-15m)	Monitoring

8.3.3 Slug Testing

Slug tests were conducted on four of the monitoring boreholes (KMBH-03 – dry) after a period of approximately a week, allowing inflow of groundwater and boreholes to reach static water level (SWL).

Slug tests provide a rapid means of assessing the in-situ hydraulic conductivity in boreholes with insufficient yields to undertake pumping tests. The test involves measuring the water-level response in a borehole to a rapid displacement of water. The displacement was induced through the introduction of a slug below the rest water level. The rate of recession of the water level displacement provides an indication of the hydraulic conductivity of the borehole. The water level responses were measured using a water level data recorder.

The slug testing results were interpreted by means of *WHI Aquifer Test version 3 software, by Waterloo Hydrogeologic Inc*. and are summarised in Table 12.

Table 12: Summarised Slug Testing Results

Borehole Number	Borehole Depth (m)	Static Water level (mbgl)	Hydraulic conductivity(k) Slug in (m/day)	Geology Intersected
KMBH-01	15	6.22	0.00116	Overburden and clay
KMBH-02	15	7.25	0.00214	Overburden, clay and sandstone(14-15m)
KMBH-04	15	3.94	0.00551	Overburden and clay
KMBH-05	15	6.70	0.00674	Weathered Dolerite/Karoo Formation
Average		6.03	0.00389	

8.3.4 Groundwater Quality

Groundwater samples were collected at four of the monitoring boreholes during the slug testing as per Golder standard sampling procedures and submitted to Water LAB in Silverton an accredited laboratory.

The water samples consist of 1 litre hydrochemistry samples. Samples were analysed for the following:

- Major cations Ca, Mg, K, Na;
- Major anions Cl, F, SO_4, No_3;
- Physiochemical parameters pH, EC, TDS, alkalinity as $CaCO_3$; and
- ICP scan for trace metals.

The analytical results of the four groundwater samples were compared to the following standard:

- South African National Standards, drinking water standards, 2011 (SANS 241:2011).

The analytical results of the groundwater samples of the new monitoring boreholes are summarised inTable 13. A highlighted value in red exceeds the SANS 241:2011 maximum allowable limit.

The samples are characterized by elevated Fe, Al and Mn (KBMB-02) concentrations, whereas the elevated nitrate value present at KMBH-05 is probably related to fertilizer used for irrigation purposes.

Table 13: Summarised Analytical Results

Borehole Number	PH	EC (mS/m)	Total Dissolved Solids	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Total Alkalinity $CaC0_3$ (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	F (mg/l)	Ba (mg/l)	Mn (mg/l)	Fe (mg/l)	Zn (mg/l)	Al (mg/l)	Cr (mg/l)	Ni (mg/l)
KMBH-01	6.9	22.5	196	12.43	7.201	23.49	4.56	28	16	37	7.2	<0.2	0.128	0.34	**4.77**	0.070	**7.79**	<0.010	0.10
KMBH-02	6.9	8.3	58	6.191	3.289	6.906	4.61	12	5	7	4	<0.2	0.238	**0.70**	**5.85**	0.094	**8.17**	0.010	0.05
KMBH-04	6.8	13.9	95	7.062	2.764	10.56	7.50	20	8	7	8.9	<0.2	0.200	0.45	**4.21**	0.078	**3.58**	<0.010	0.03
KMBH-05	6.6	15.9	110	15.94	5.317	7.111	5.15	20	5	7	**12**	<0.2	0.189	0.46	**5.87**	0.155	**7.00**	0.014	0.05
SANS241: 2011	9.7	<170	1200	-	-	200	-	-	300	500	11	1.5	-	0.5	0.3	<0.5	<0.3	<0.05	<70
Minimum	6.6	8.3	58	6.19	2.764	6.91	4.56	12	5	7	4	<0.2	0.128	0.34	4.21	0.070	3.58	0.010	0.03
Maximum	6.9	22.5	196	15.94	7.201	23.49	7.50	28	16	37	12	<0.2	0.238	0.70	5.87	0.155	8.17	0.014	0.10
Average	6.8	15.2	115	10.41	4.643	12.02	5.45	20	8.5	14.5	8.0	<0.2	0.189	0.48	5.18	0.099	6.64	0.012	0.06

8.3.4.1 Groundwater Classification

The groundwater quality results of the four sampled monitoring boreholes are visually represented on an expanded Durov and Piper diagrams to distinguish between the different water quality classes/types.

Expanded Durov diagrams graphically represent the relative percentages of anions and cations in water samples. The cation percentages are plotted in the top part of the diagram and the anion percentages in the left part. A projection of these cation and anion percentages onto the central area presents the chemical signature of the major ion composition of the water. The chemical signature can be related to various hydrochemical environments and conditions.

On the Expanded Durov Diagram (Figure 29) the results of samples KMBH-05 represents unpolluted water whereas KMBH-04 plot on the third sector representative of sodium potassium bicarbonate type of water (Na, K)$(HCO_3)_2$. The plot position on the diagram indicates towards minor sodium potassium enrichment.

KMBH-01and KMBH-02 are representative of water affected by high extraction underground coal mines (impacted with magnesium and sulphate enrichment). These samples are representative of magnesium sulphate type of water (Mg)SO_4.

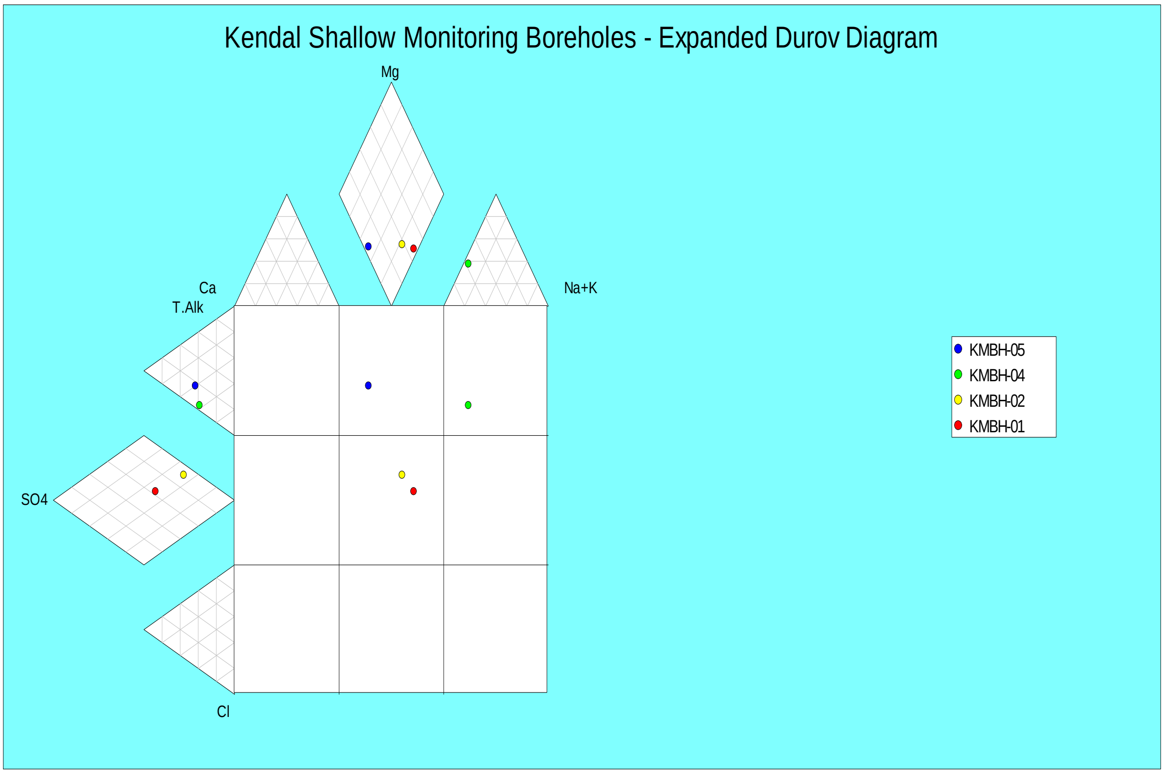

Figure 29: Expanded Durov Diagram

Piper diagrams graphically represent the relative percentages of anions and cations in water samples. The cation percentages are plotted in the left triangle and the anion percentages in the right triangle. A projection of these cation and anion presentations onto the central diamond presents the chemical signature of the major ion composition of the water.

The sampled borehole KMBH-05 groundwater quality on the Piper diagram (Figure 30) show a signature of calcium/magnesium bicarbonate type of water (blue sector), whereas KMBH-01and KMBH-02 show a signature of calcium/sodium sulphate type of water. KMBH-04 show a signature of sodium bicarbonate/chloride type of water.

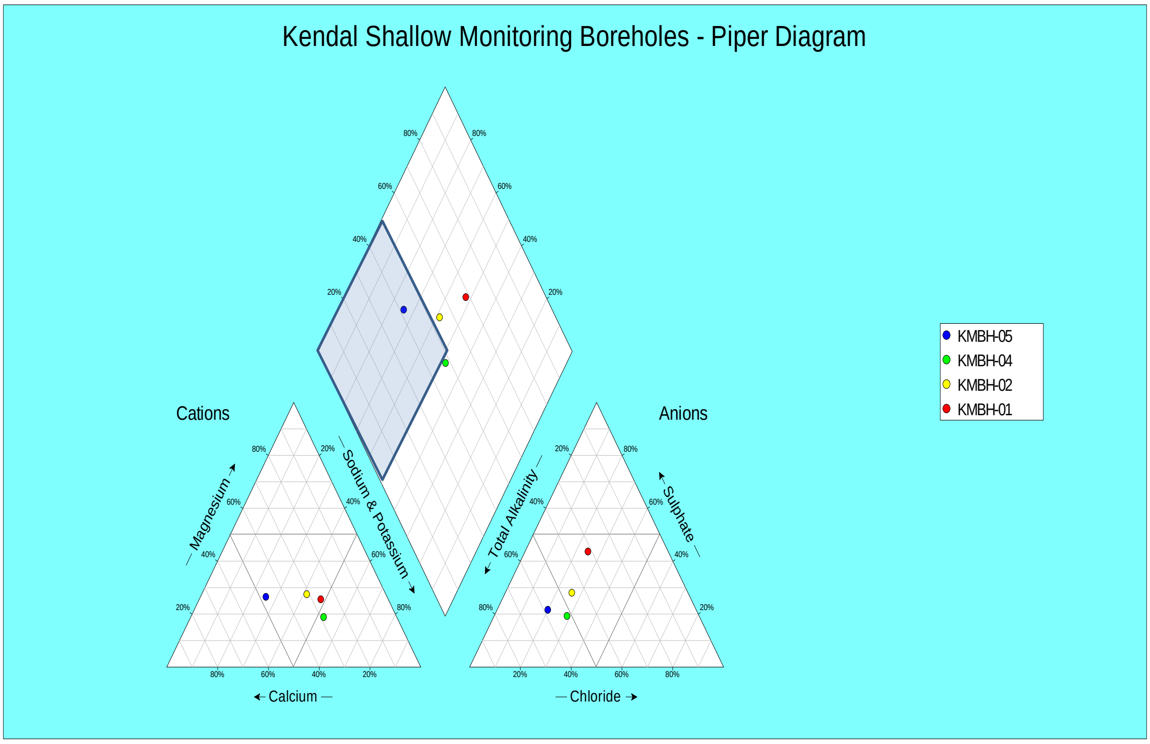

Figure 30: Piper Diagram

8.3.5 Groundwater Conceptual Model

A groundwater conceptual model is an interpretation of the characteristics and dynamics of an aquifer system which is based on an examination of all available hydrogeological data for a modelled area. This includes the external configuration of the system, location and rates of recharge and discharge, location and hydraulic characteristics of natural boundaries, and the directions of groundwater flow throughout the aquifer system.

A groundwater conceptual model was derived from the 1:250 000 geology map series and groundwater information of this study. The groundwater conceptual model was derived to illustrate the the shallow groundwater flow regime and surface seepages/wetlands (pan area) in the vicinity of the proposed Site 'H' ash dump (Figure 31).

The conceptual model forms the basis for the understanding of the groundwater occurrence and flow mechanisms in the area of investigation (pan), and is use as basis for future numerical groundwater modelling.

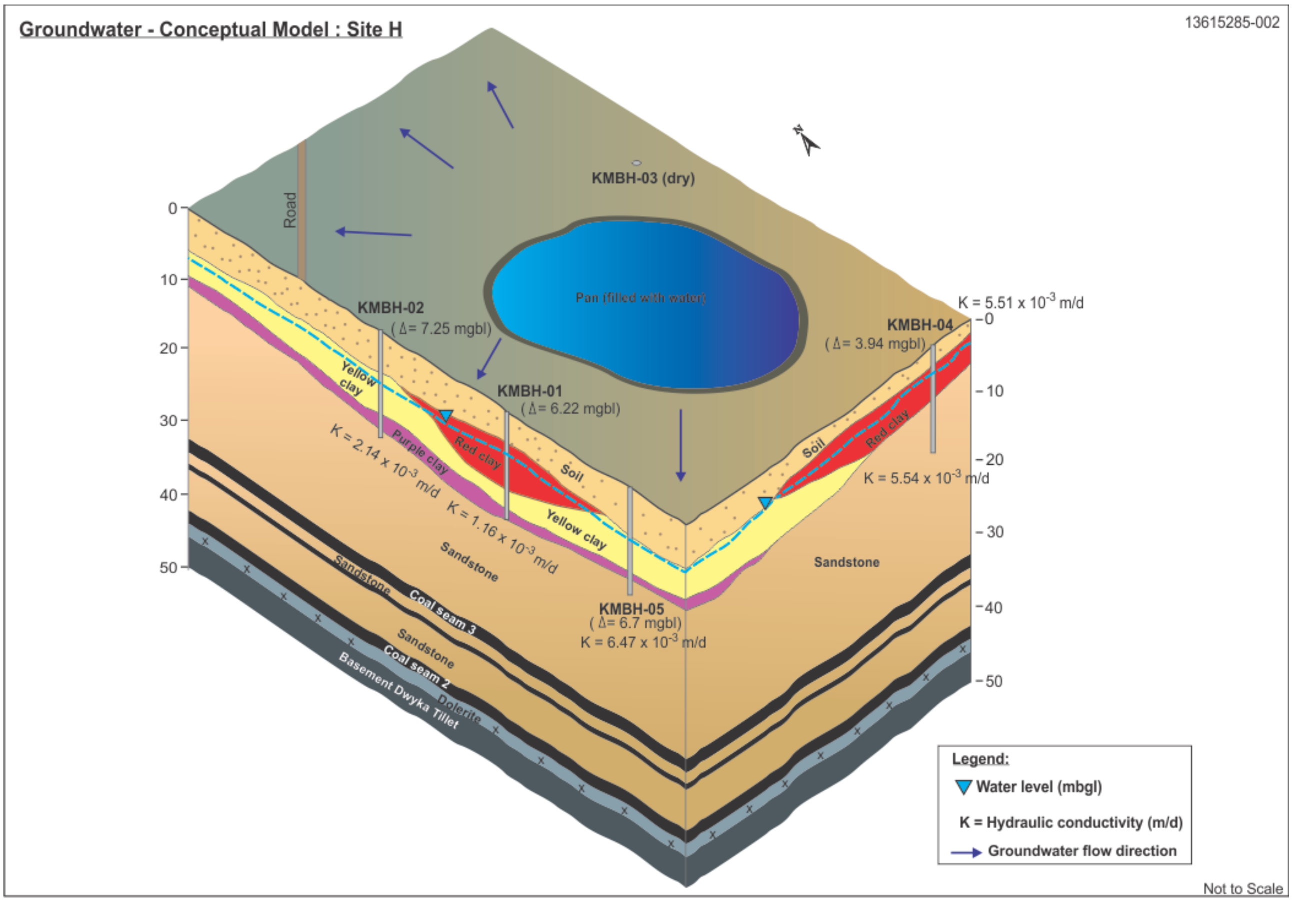

Figure 31: Groundwater Conceptual Model – Site H

9.0 GROUNDWATER NUMERICAL MODEL

9.1 Background

Golder Associates Africa (Golder) has been appointed by Zitholele Consulting (Pty) Ltd to provide specialist groundwater inputs in support of the Waste License Application process at Kendal power station and for the waste management licencing for the continues ash disposal at the existing ash dump. As part of the specialist groundwater investigation Delta H (Delta-H Water System Modelling PTY Ltd) has been appointed by Golder Associates Africa PTY Ltd (Golder) to develop a site specific 3D numerical groundwater flow model for the pan underlying the proposed Site 'H' Ash Disposal Facility (ADF) and wetlands in the immediate vicinity to determine the impacts on groundwater flow, surface seepages and spring discharges (Figure 32).

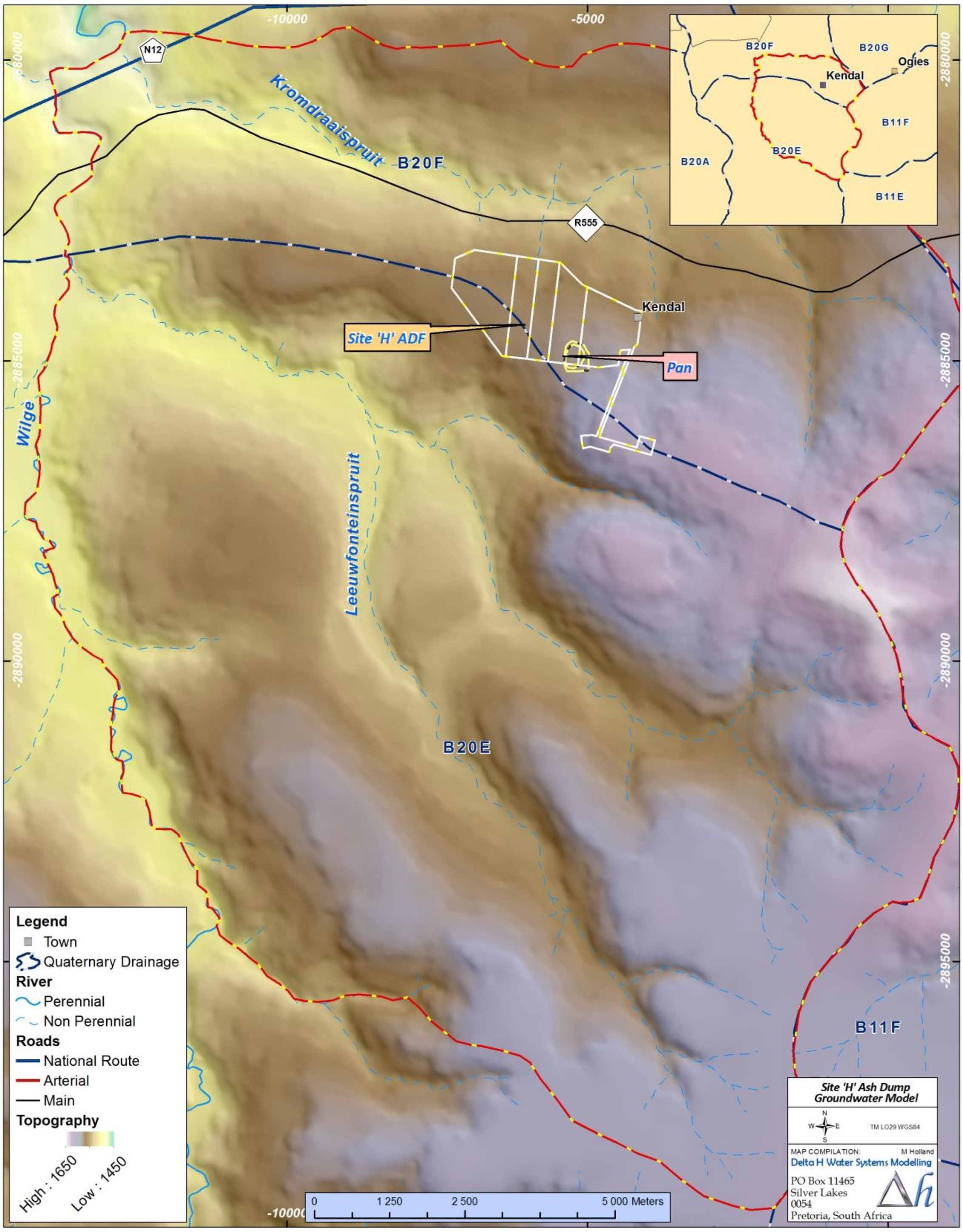

Figure 32: Regional setting of site 'H' ADF

As part of the environmental authorisation it was advised by DWS to investigate and determine the interaction between the surface water and groundwater for the site H of Kendal Power Station focussing on the surface water features and mainly the pan. Further, due to the presence of the pan which might be in hydraulic connection with the free groundwater surface, the potential for contaminants (from the ADF) to reach the underlying aquifer needs to be assessed.

Based on the Golders groundwater specialist investigation, baseline assessment very little site specific (around the pan itself) groundwater information was obtained. To accommodate for uncertainties in the conceptual functioning of the pan and to quantify and predict the potential impact from the proposed ADF an intrusive investigation comprising of the drilling of shallow piezometers surrounding the pan was proposed by Delta-H to increase the confidence in the modelling predictions and detail of the results. As a result the groundwater model is based on the conceptual understanding developed as part of Golder's groundwater investigation for the ADF Site 'H', which included drilling, testing and sampling of 5 boreholes in the vicinity of the pan.

9.2 Scope of Work

The scope of the study is interpreted as follows:

- Develop and calibrate a site-specific 3D numerical groundwater flow model which is able to simulate surface seepages (to the pan(s)) and spring discharges (potentially feeding the hill slopes and valley bottom wetlands).
- Use the model to predict the impacts on the groundwater flow, including surface seepages and spring discharges.
- Evaluate the impacts of the proposed ADF on the ambient groundwater quality using a conservative advective-dispersive transport model, taking into consideration the 2014 waste classification report for the Site 'H' ADF (Jones & Wagner, 2014).

9.3 Deliverable

A three-dimensional groundwater flow model will be constructed using available aquifer parameters established during the conceptualisation phase by Golder.

The potential impacts from the Site 'H' ADF on the groundwater system and migration of contaminant plumes from these sources will be evaluated through the groundwater modelling. The purpose of the numerical groundwater flow and transport model is to assess the impacts of the proposed ADF site on the groundwater environment. Such impacts might be related to:

- A change in the groundwater quality,
- A change in the volume of groundwater in storage or entering groundwater storage (recharge), or
- A change in the groundwater flow regime.

The model development, simplifying assumptions and outcomes of predictive simulations will be presented in accordance with the Standard Guide for Documenting a Groundwater Flow Model Application (ASTM 2006).

9.4 Data sources

The development of the conceptual site and numerical groundwater flow and transport model was based on the following information and data made available to the project team:

- Regional and local geological maps (Council for Geoscience published 1:250 000 geological map sheet 2628).
- Digital elevation model based on National survey's 5m contours)
- Digital layout of Site 'H' ADF (as provided by Zitholele – 11 April 2016)
- Hydrocensus information collated from the baseline study conducted by Golder (2014)
- Intrusive investigation around the pan by Golder (2016)

9.5 Locality and topographic setting

The study area is located along a tributary of the Wilge River and largely within quaternary catchment B20F and forms part of the Olifants River Water Management Area (WMA). The Wilge River flows in a north easterly direction until it's confluence with the Oilfants River. The topography of the region is gently undulating to moderately undulating landscape of the Highveld Plateau. Scattered wetlands and pans occur in the area. To the north across catchment area B20F drainage is affected by a number of tributaries of the Kromdraaispruit of which one originates within the site's north-eastern corner. The altitude ranges between 1 450 – 1 650 metres above mean sea level (mamsl) sloping from south-east to north-east. Local drainage around the perennial pan (Figure 33) is towards the pan at an elevation of approximately 1580 mamsl. The mean annual precipitation (MAP) for the study area is 660 mm.

Figure 33: South-westerly view of pan (Golder, 2014)

9.6 Conceptual Understanding

9.6.1 Geology

The surface geology of the study area (Figure 34) is dominated by the sediments (shale, siltstone, sandstone and coal) of the Vryheid Formation (Ecca Group, Karoo Supergroup), which were deposited on the igneous rocks consisting mainly of strata of the Selons River Formation (Vse) and the overlying Loskop Formation (Vlo - regarded as the last phase of sedimentation associated with the Transvaal sequence) hosting Nebo Granite (the main part of the Bushveld Granite) and diabase sill intrusions.

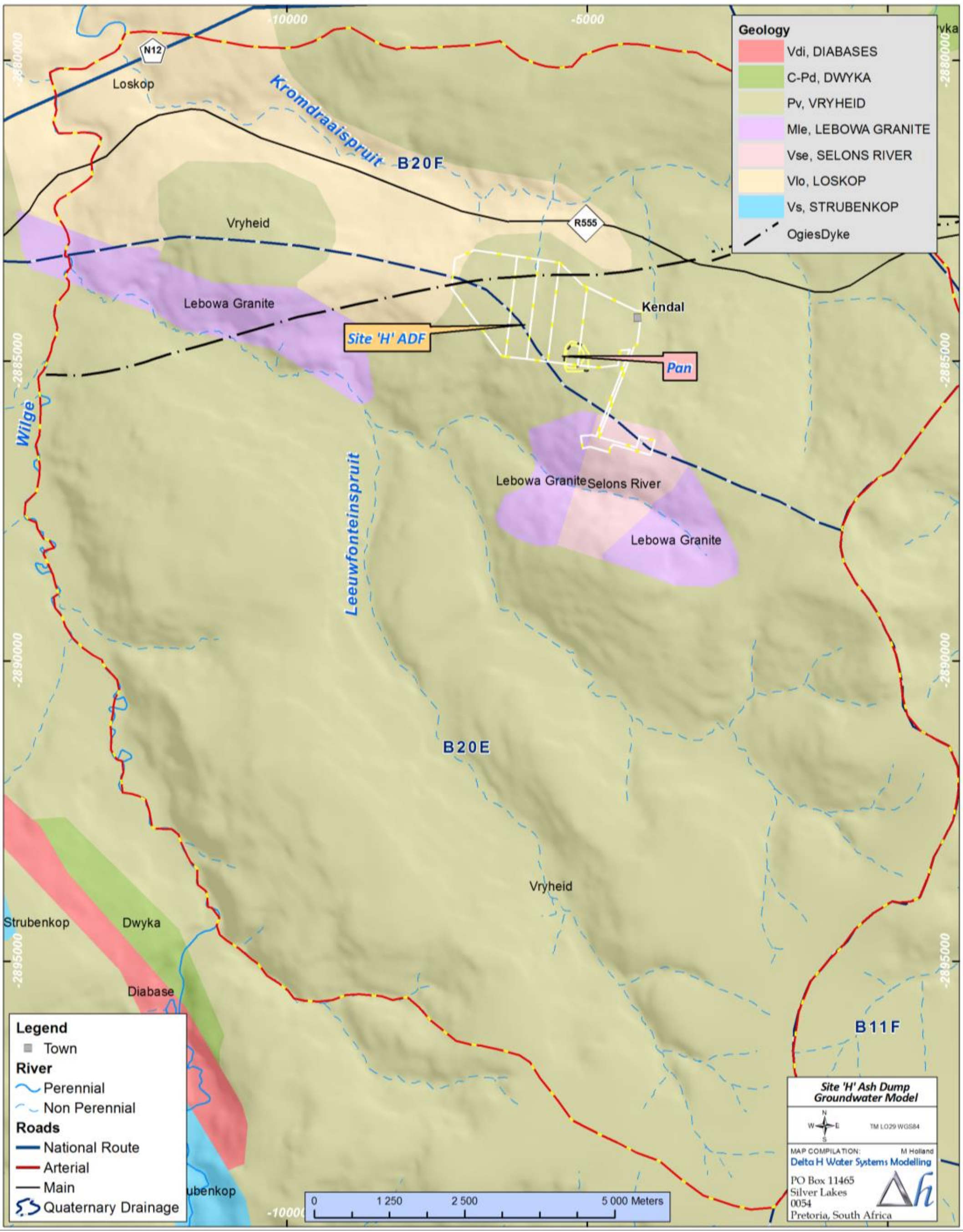

Figure 34: Surface geology of Site 'H'

Transecting the area of investigation is the west-east striking, post deposition, Ogies dyke, which attains a thickness of approximately 15 m. Local aeromagnetic data in the vicinity of Ogies, is indicative of the Ogies dyke dipping roughly between 73 and 79 degrees to the south. The dyke is also known to feature smaller off-shoots to both the north and south. Sediments up to 20m either side of the dyke have been subjected to folding and jointing (Golder, 2014).

Site H is almost entirely underlain by sediments of the Vryheid Formation featuring two small Nebo Granite inliers as well as a small diabase sill outcrop along the central northern boundary of the site. The Karoo sediments can be seen to pinch out against basal outcrops of the Loskop Formation some 500m to 1.4km to the north and west as well as diabase sill, Nebo Granite and rocks of the Selons River Formation to the south. The south-western corner of the site transects a minor portion of the sill outcrop while the south-eastern corner of the site intersects a portion of the mentioned Selons River Formation. The western half of

Site H's is transected to the north by the west-east striking, post deposition, Ogies dyke. Although Site H does not feature any current or known historical coal mining activities, it is bounded in the northeast by the historic Kendal United No.4 seam underground workings. Open cast mining (including pillar extraction on the historically mined No.4 seam) at Block E by Just Coal is currently taking place

9.7 Regional Aquifer Systems

Based on various hydrogeological studies undertaken in the area as well as the own conceptual understanding of the site, two major aquifer systems can be differentiated within the study area:

Shallow primary aquifers

- Shallow alluvial and weathered Karoo aquifer

Karoo aquifers and aquiclude

- Fractured Karoo aquifer.
- Dwyka aquicludes.

9.7.1 Weathered Karoo aquifer

The weathered zone of the Karoo sediments hosts the unconfined or semi-confined shallow weathered Karoo aquifer. Water levels are often shallow (few meters below ground level) and the water quality good due to direct rainfall recharge and dynamic groundwater flow through the unconfined aquifer in weathered sediments, which makes it also vulnerable to pollution. Localised perched aquifers may occur on clay layers or lenses, but are due to their localised nature of no further interest in the context of the current study. Water intersections in the weathered aquifer are mostly encountered above or at the interface to fresh bedrock, where the vertical infiltration of water is typically limited by impermeable layers of weathering products and capillary forces, with subsequent lateral movement following topographical gradients. Groundwater daylights as springs (contact springs) where the flow path is obstructed by paleo-topographic highs of the basement rocks or, to a minor extent for the area of interest, where the surface topography cuts into the groundwater level at e.g. drainage lines (free draining springs).

Based on non-referenced studies undertaken in the area, Golder reported an average hydraulic conductivity of 0.13 m/d or 1.5E-06 m/s for the weathered zone of the Karoo and Pre-Karoo rocks.

9.7.2 Fractured Karoo aquifer and aquiclude

The fractured Karoo aquifer consists of the various lithologies of siltstone, shale, sandstone and the coal seams. Groundwater flow is governed by secondary porosities like faults, fractures, joints, bedding planes or other geological contacts (including coal seams), while the rock matrix itself is considered impermeable. Geological structures are generally better developed in competent rocks like sandstone, which subsequently show better water yields than the less competent silt- or mudstones and shales. Not all secondary structures are water bearing due to e.g. compressional forces by the neo-tectonic stress field overburden closing the apertures. The fractured Karoo aquifer is considered a semi-confined aquifer, depending on the prevailing sedimentary succession.

Fractured Karoo aquifers have typically a low hydraulic conductivity (<0.001 m/d), but are known to be highly heterogeneous with yields ranging from 0.5 to 2 L/sec. Higher yields are typically associated with higher hydraulic conductivities along shallow coal seams and at contact zones with intrusive rocks. The contact zones of dolerite dykes and sills with the host rock provide preferential flow paths, while the dolerite itself is rather impermeable or semi-permeable. This setting promotes groundwater flow along, but not across the dykes or sills. Depending on the residence time of the water in the aquifer, groundwater quality can be poor.

If present, the irregularly developed tillite horizon of the Dwyka Group if generally thought to form an important vertical flow barrier at the base of the Karoo rocks, forming the bottom of the Karoo flow system

9.8 Shallow Aquifer System in the Pan Area

Drilling around the pan focused exclusively on the shallow aquifer system. Based on the drilling results perched aquifers occur within the weathered zone on top of low permeability soil layers or more clayey layers within the weathered zone. While these perched aquifers contribute to seepages towards hill slope wetlands and the pan itself, they are limited in spatial extent as well as saturated thickness. It is therefore assumed that the seepage rates are limited and often only seasonal as the perched aquifer is drained out over the winter season. The perched aquifers are evident in the newly drilled boreholes as shallow (below 8 mbgl) water strikes associated with logged clay layers (see for example geological logs, Appendix A) and low yields (below 0.05 L/s). Due to the localised nature of these perched aquifers, a spatial mapping thereof requires substantial resources and is beyond the scope of the current project

9.9 Groundwater levels and flow direction

Water level measurements in the newly drilled boreholes (refer to Table 11) together with data collated from Golder's (2014) hydrocensus and with available monitoring data provided by the client were used for the purpose of model development and calibration. Using a total of 50 measured groundwater table elevations, Delta H established the correlation between surface topography and elevation of the groundwater level (Figure 35) for the wider study area. The data was collated from various sources (i.e. previous hydrocensus data) and the National Groundwater Archive maintained by the DWS. Based on the regional results a very good correlation between the measured water levels and surface topography is obvious (R^2 = 0.91, i.e. approximately 91 % of observed water level variations can be explained by variations in surface elevation) and it can be assumed that the water table mimics the surface topography at the regional scale.

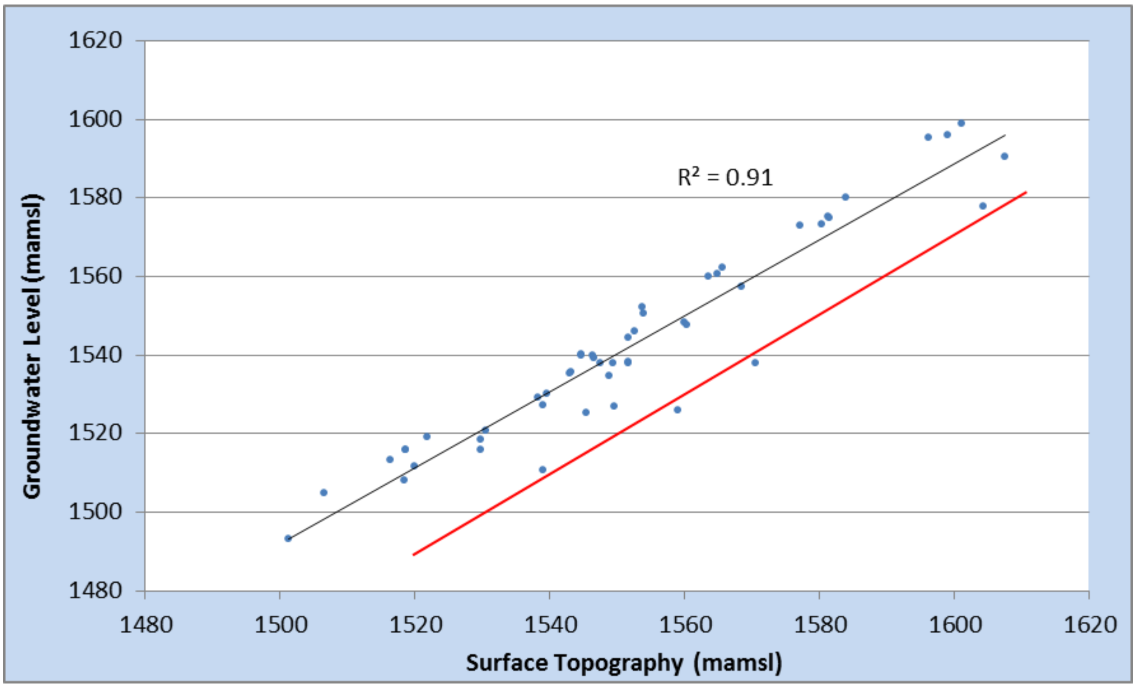

Figure 35: Correlation between surface topography and potentiometric heads (regional data) (subdued red line indication of deeper groundwater levels)

However, some poorly correlated water levels plot on a separate regression line underneath the indicated one. This is related to the occurrence of two distinct aquifer systems (plus local perched aquifers) with different water levels and can be attributed to the semi-confined nature of the fractured aquifer. While these outliers reduce the overall correlation, the observed correlation coefficient is sufficiently large to assume that the potentiometric surface mimics surface topography.

The Bayesian (co-kriging) interpolation method uses the established correlation between surface topography and groundwater elevation to improve the estimates of unknown water levels based on known surface elevations. As a Universal Kriging algorithm, it relies on a mathematical description of the change (or variance) of a variable with distance, i.e. to what extent neighbouring observations are spatially correlated. Such correlation is expressed in a semi-variogram, as depicted in the empirical semi-variogram (Figure 36) with the fitted Bayesian model used for the interpolation. The semi-variogram model is then used in combination with the knowledge of the surface elevation (with its correlation to the groundwater elevation used as a qualified guess) to improve the spatial estimation of water levels.

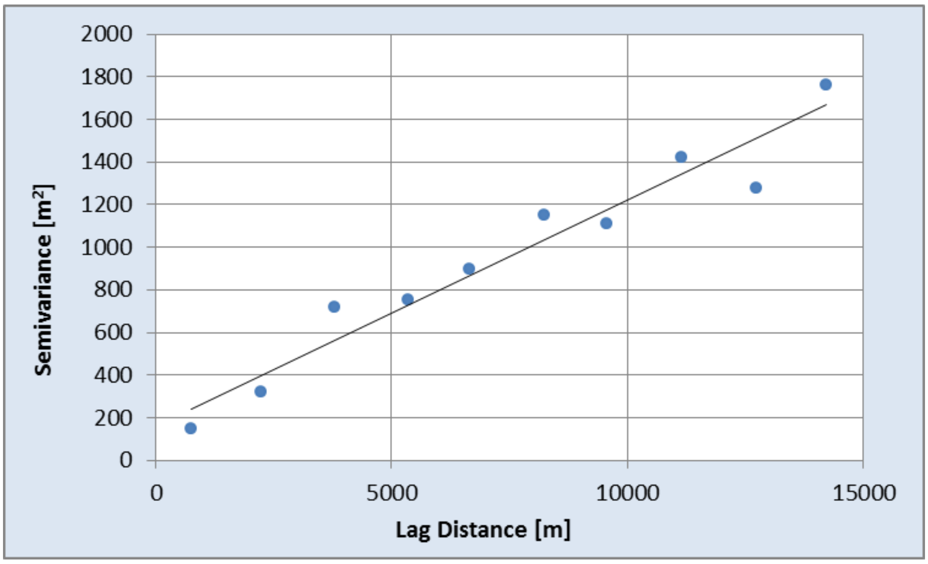

Figure 36: Empirical semi-variogram and fitted Bayesian model

The interpolated (unconfined) groundwater piezometric map using Bayesian interpolation is shown Figure 37 and was subsequently used as initial heads for the model calibration. It must be noted that initial heads only accelerate the mathematical convergence of a steady-state model, but do not change the outcome of the model i.e. the calculated steady-state heads.

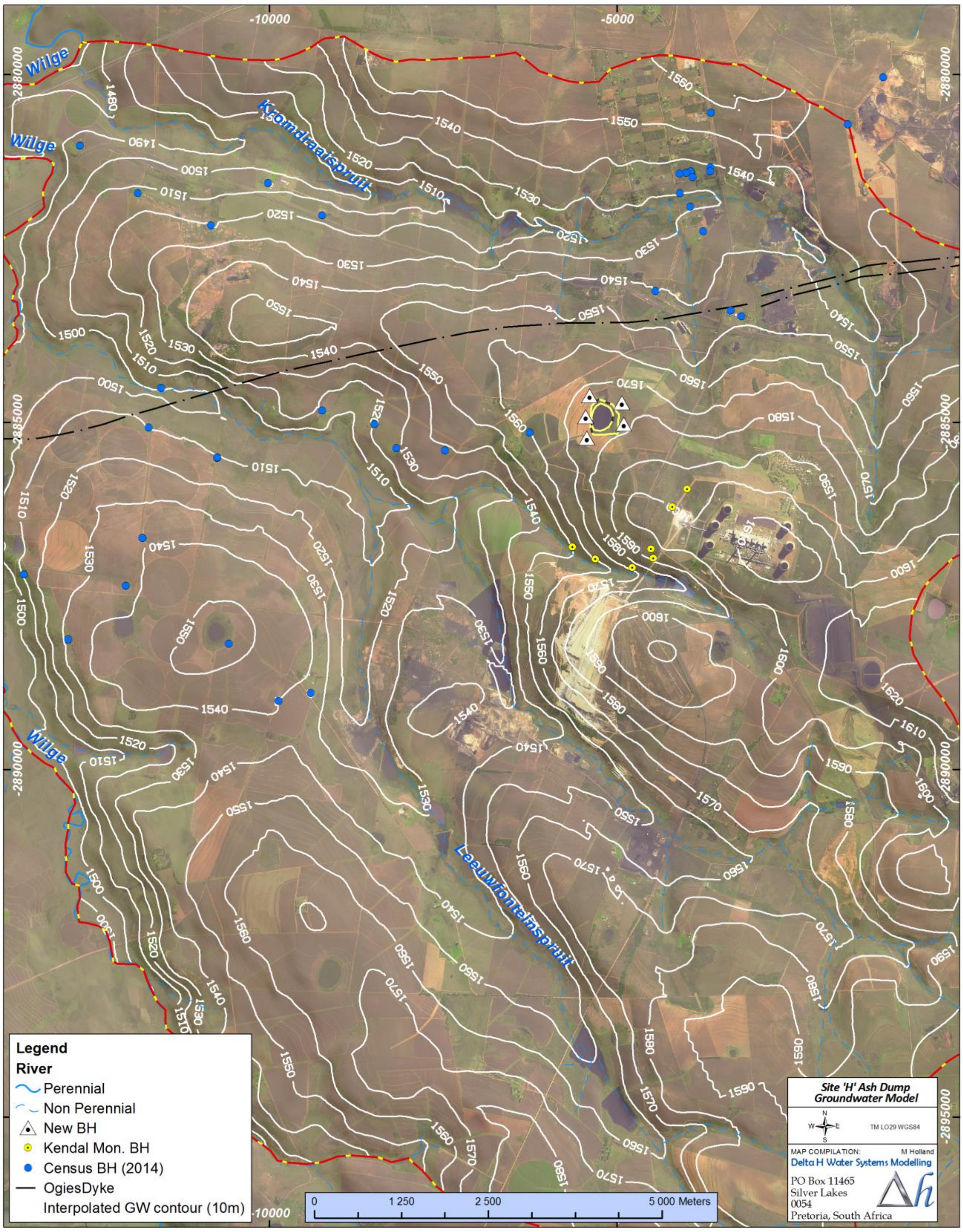

Figure 37: Bayesian interpolated groundwater levels

9.10 Model Development

9.10.1 Computer Code

The software code chosen for the numerical finite-element modelling work was the 3D groundwater flow model SPRING, developed by the delta h Ingenieurgesellschaft mbH, Germany (König, 2011). The program, formerly known as SICK 100, was first published in 1970, and since then has undergone a number of revisions. The current saturated and unsaturated program module SPRING-SITRA is based on the well-known SUTRA model (Voss, 1984). SPRING is widely accepted by environmental scientists and associated professionals. SPRING uses the finite-element approximation to solve the groundwater flow equation. This means that the model area or domain is represented by a number of nodes and elements. Hydraulic properties are assigned to these nodes and elements and an equation is developed for each node, based on the surrounding nodes. A series of iterations are then run to solve the resulting matrix problem utilising a pre-conditioning conjugate gradient (PCG) matrix solver for the current model. The model is said to have “converged” when errors reduce to within an acceptable range. SPRING is able to simulate steady and non-steady flow, in aquifers of irregular dimensions.

SPRING solves the stationary flow equation independent of the density for variable saturated media as a function of the pressure according to:

$$-\nabla\left(K_{ij}\nabla h\right) = -\nabla\left(K_{perm}\frac{\rho g}{\mu}\nabla h\right) = q = -\nabla\left[\frac{K_{perm}\cdot k_{rel}}{\mu}(\rho g\nabla z + \nabla p)\right]$$

∇ $\left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)$

q Darcy flow
K_{ij} Hydraulic conductivity tensor
ρg Density $\cdot$ gravity

K_{perm} Permeability

μ Dynamic viscosity
k_{rel} Relative permeability
p Pressure

The relative hydraulic conductivity is hereby calculated as a function of water saturation, which in turn is a function of the saturation:

$$k_{rel}(S_r) = (S_e)^l\left[1-\left(1-(S_e)^{\frac{1}{m}}\right)^m\right]^2$$

$$S_e = \frac{S_r(p) - S_{res}}{S_s - S_{res}} = \left[1+\left(\frac{p_c}{p_e}\right)^n\right]^{\frac{1-n}{n}}$$

$S_r(p)$ Relative saturation dependent on pressure
S_e Effective saturation
l Unknown parameter, determined by van Genuchten to 0.5

m equal to $1-(1/n)$
n Pore size index
S_{res} Residual saturation

S_s Maximum saturation
p_c Capillary pressure
p_e Water entry pressure

Solving these equations for the relative saturation as a function of the capillary pressure $S_r(p_c)$ results in the capillary pressure- saturation function according to the Van Genuchten (1980) model as used in SPRING:

$$S_r(p_c) = S_{res} + (S_s - S_{res})\cdot\left[1+\left(\frac{p_c}{p_e}\right)^n\right]^{\frac{1-n}{n}}$$

The water entry pressure is a soil specific parameter and defined as the inverse of a = 1/p_e in the saturation parameters.

Figure 38 shows examples of the pressure-saturation functions according to van Genuchten for different soil types

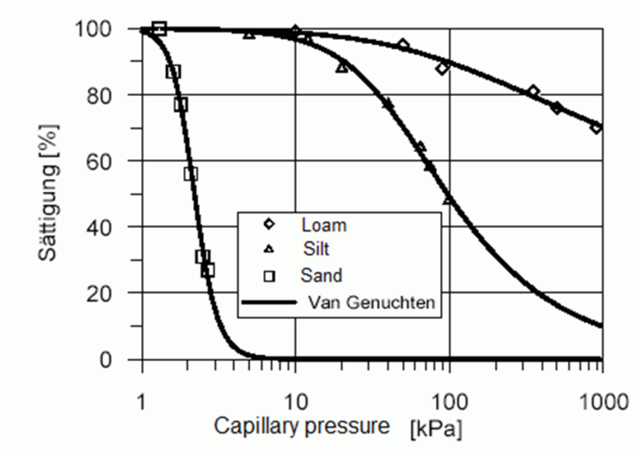

Figure 38: Examples of capillary pressure- saturation functions (König, 2011)

The density independent, instationary flow equation for variable saturated media as a function of the capillary pressure is given as follows:

$$\rho\left(S_r(p_c)S_{sp} + \theta\frac{\partial S_r(p_c)}{\partial p}\right)\frac{\partial p}{\partial t} + \theta S_r(p_c)\frac{\partial \rho}{\partial t} - \nabla\left[\rho\frac{K_{perm}k_{rel}}{\mu}(\nabla p + \rho g\nabla z)\right] = q$$

The specific pressure dependent storage coefficient S_{sp} is hereby given as

$$S_{sp} = \alpha(1-\theta) + \beta\theta$$

α Compressibility of porous media matrix
β Compressibility of fluid (water)
θ Aquifer porosity

The transport equation for a solute in variably saturated aquifers is given as follows:

$$\theta S_r(p_c)\frac{\partial c}{\partial t} + \theta S_r(p_c)v\nabla c - \nabla\big(\theta S_r(p_c)\big(D_m\bar{\bar{1}} + D_d\big)\nabla c\big) = qc^* + R_i$$

qc^* Volumetric source/sink term with concentration c *
D_m Molecular diffusion
$\bar{\bar{1}}$ Unit matrix
D_d Hydrodynamic dispersion
R_i Reactive transport processes (sorption, decay, etc.)

The software is therefore capable to derive quantitative results for groundwater flow and transport problems in the saturated and unsaturated zones of an aquifer. While SPRING allows the consideration of sorption as well as chemical or biological decay processes, the current model assumes non-retarded transport behaviour of the simulated solutes: according to the precautionary principle (and in the absence of measured geochemical parameter an ideal).

9.10.2 Model Domain

The model domain covers a surface area of 220 km^2 and coincides with the lower B20E quaternary catchment and straddles portion of the B20F quaternary catchment, to ensure a dependable water balance for the model with recharge being the main driver of groundwater flow (Figure 39). Insufficient water levels were available in the narrower area of interest to accurately define flow boundaries. Accordingly, the boundaries follow mostly topographic highs, which are considered to also define regional groundwater divides and therefore outer no-flow model boundaries. The model boundaries towards the west the model boundary follow the perennial Wilge River course.

The finite-element model was set-up as a three-dimensional groundwater flow model. The model domain was discretised into multiple layers in accordance with the conceptual model developed as part of this investigation. The final 3D numerical model area of 220 km^2 is spatially discretised into 57 190 nodes on 5 node layers, which make up four element layers comprising of 63 643 elements (triangles and quadrangles) per layer.

While the model layers generally correlate with the various hydrogeological units underlying the project area. The horizontal element size (side length) varies from 15 to 50 m along surface drainages, mapped dykes and the ADF footprint area with expected steeper head and concentration gradients, to a maximum side length of 70 m further away from the area of interest.

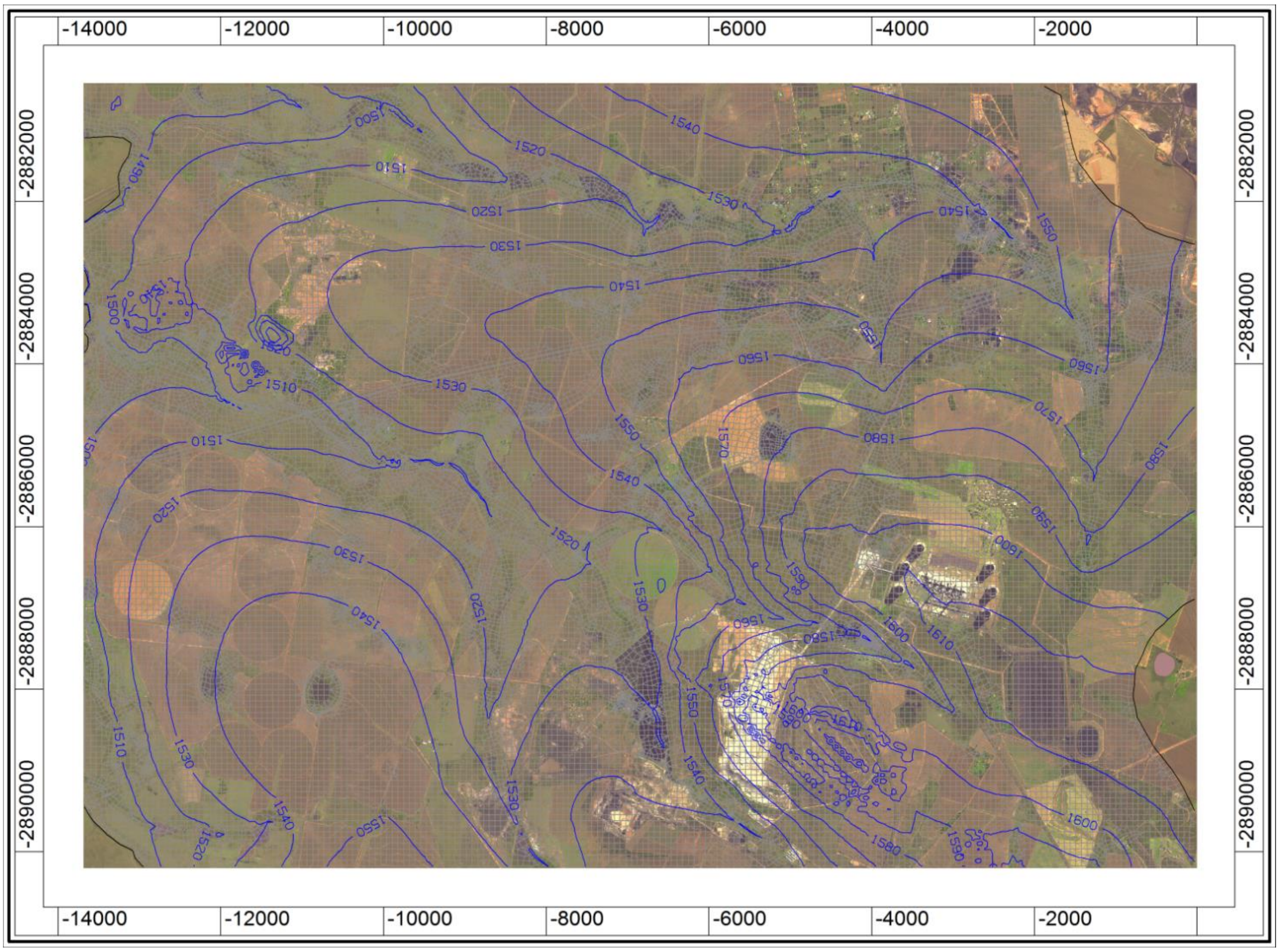

Figure 39: Finite element mesh of the Site 'H' groundwater model

9.10.2.1 Model Layers

A summary of the layer arrangement is provided in Table 14. In accordance with the developed conceptual model, the upper two element layers represent the weathered aquifers, whereas the lower two element layers represent the fractured aquifers. The split into two model layers per aquifer unit was solely to ensure numerical stability and an accurate calculation of unsaturated flow processes.

Table 14: Model layer arrangement

Node Layer	Element layers	Aquifer feature	Data used for interpolation
I, top	I, top	Surface elevation	Digital Elevation Model (DEM) SRTM 30 m
I, bottom	1	Weathered aquifer	DEM – 5m
II, bottom	1	Weathered aquifer	DEM – 10m
III, bottom	2	Fractured aquifer	DEM – 50m
IV, bottom	3	Fractured aquifer, lower limit of active flow system	DEM – 100m

9.10.3 Sources and Sinks

9.10.3.1 The Mean annual recharge

The main source of recharge into the shallow primary aquifers is rainfall recharge that infiltrates the aquifer through the overlying unsaturated zone. Recharge of the deep Karoo aquifer as limited seepage from the shallow Karoo aquifer through permeable fracture systems that link the two aquifers hydraulically. Due to the heterogeneous nature of such fracture systems, it is assumed to be highly variable. Rainfall recharge to the weathered aquifers was estimated by JMA (2012) to vary between 3% and 7% of a mean annual precipitation (MAP) of 657 mm. An average regional recharge rate of 3 % of MAP or 18 mm was used for the current groundwater model.

9.10.3.2 River courses

Water leaves the model domains via a number of non-perennial and perennial (Wilge River) rivers (Figure 32). All non-perennial rivers or drainage lines were generally classified within the model domain as continuously gaining rivers (i.e. groundwater is only allowed to discharge into them) and therefore described within the model using SPRING's 'river package', with no exfiltration of surface water allowed. The chosen approach ensures no water losses from rivers into the model domain, while simulating potential leakage of groundwater into surface water courses. The stage of each river node was carefully aligned with the height of the Digital Elevation Model (DEM) at that point and an incision the river bottom of 4 m below topography assumed. A river bed conductance of 1E-7 m/s was assumed for all river courses within the model area.

9.10.3.3 Hill slope and valley bottom wetlands

The hill slope and valley bottom wetlands, as supplied by the wetland specialists (Wetland Consulting Services, 2013).), were incorporated into the model as free leakage boundaries. Should the calculated water table elevation exceed the surface elevation for these areas, water is allowed to flow out freely and removed from the system. It is assumed that any groundwater outflows within these wetland areas are removed from the groundwater system via evapotranspiration or surface run-off. Only absolute volumes of groundwater seepage per wetland are calculated and no differentiation of how these seepages are further subdivided and removed from the system is suggested or simulated. While it would have been desirable to incorporate the wetlands as zones of unique and likely increased evapotranspiration rates, the absence of estimated evapotranspiration rates for these ecosystems excluded such approach. The locality and assigned balance number for the assorted wetlands is shown in Figure 40.

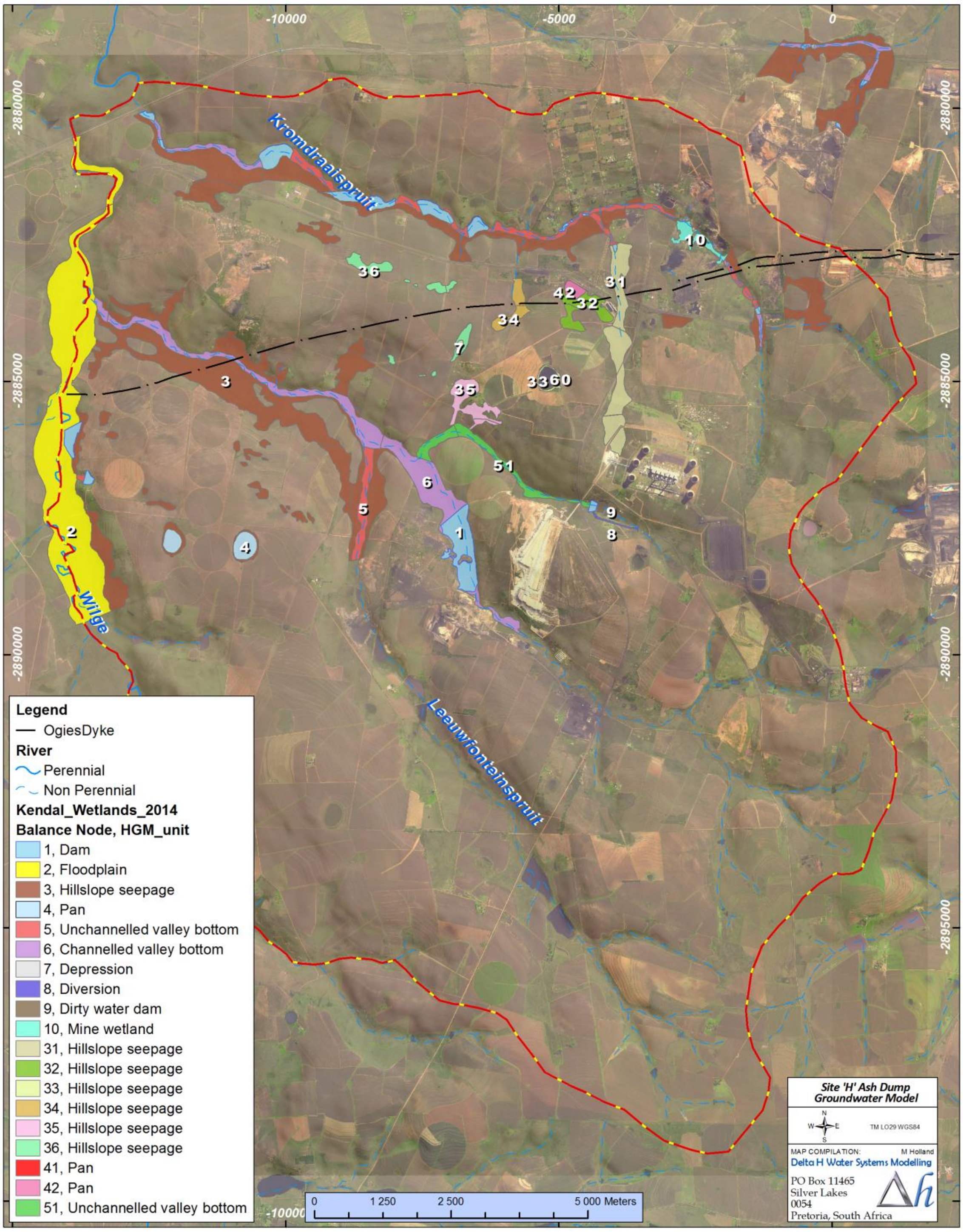

Figure 40: Delineated wetlands within the larger site 'H' development footprint (Adapted from: WCS, 2013)

9.10.3.4 Pans

The delineated pans (Figure 40) including the Pan of interest were incorporated into the model domain as free seepage boundaries. Should the calculated water table elevation exceed the surface elevation for the pans, water is allowed to flow out freely and removed from the system. It is essentially assumed that any groundwater flowing into these pans is removed from the system via evaporation. The assumption is based on the fact the annual average evaporation from the pans exceeds the annual average leakage of groundwater into the pans and therefore considered appropriate for a steady-state model which represents long-term average conditions and not the seasonal variability of water levels or seepages.

9.10.3.5 Regional groundwater flow

While shallow groundwater flow follows surface topography (9.10.3.5) and shallow (unstressed) groundwater divides coincide therefore with surface water catchment boundaries, the latter is most likely not true for deeper groundwater flow systems. However, the actual deeper flow system is unknown due to the lack of data (i.e. water levels) for the deeper fractured aquifer and was therefore neglected in the model. The associated errors are considered acceptable in the context of the model study.

9.10.3.6 Ash Disposal Facility

9.10.3.6.1 Seepage quality

In the absence of actual seepage samples for the proposed ADF, the likely seepage quality can only be estimated based on laboratory tests. Jones & Wagner (2014), 3rd revision report) on behalf of Zitholele Consulting performed a geochemical waste classification of the ash generated by Kendal Power station. Two (2) ash samples from the Kendal Power Station were collected in November 2012, with one of the samples used for organic and one for inorganic analysis.

The geochemical assessment and waste classification is therefore essentially based on a single ash sample only. The assessment is statistically not significant (e.g. could represent an outlier) and should be substantiated **by additional samples** for geochemical analysis as well as sampling of actual seepage (if available) as soon as possible.

The test results reported by Jones & Wagner in 2014 entailed leach testing (Australian de-ionised water leach), total extraction (aqua regia digestion) and radiological analysis (by NECSA) to enable a classification in accordance with the Government Notices R. 634, 635 and 636 (Government Gazette No. 36784, 23/08/2013) pertaining to the National Environmental Management: Waste Act (Act No. 59 of 2008) by the Department of Environmental Affairs.

Based on boron concentrations in the leachate exceeding with 0.733 mg/l its LCT0 threshold (0.5 mg/l) and total concentrations of barium and fluoride (570 and 112 mg/l respectively) exceeding their TCT0 thresholds (62.5 and 100 mg/l respectively), the ash was classified as a type 3 waste, requiring a class C barrier system.

While concentrations of all analysed organic constituents and several metals in the de-ionised water leachate from the ash were below their limit of detection, selected inorganic constituents listed in Table 15 showed leachate concentrations above the limit of detection.

Table 15: De-ionised water leachate concentrations for the Kendal ash sample (from Jones and Wagner, 2014)

Constituent	Leachable concentration (mg/l)
B	0.733
Ba	0.044
Cr(VI)	0.028
V	0.049
SO_4	36
F	0.4
TDS	80

It is evident from Table 15 that the concentrations measured in the distilled water leachate are rather low, which is attributable to the extraction method. The solid phase is extracted over 18 hours with distilled water as an extraction fluid and a liquid-to-solid ratio of 20:1. Although the tests can determine the leachability of determinants, the liquid-to-solid ratio of 20:1 does by no means represent actual field conditions (it would essentially equal a porosity of 95%). Therefore, leachate concentrations do not necessarily represent the quality of seepage from the ADF. Furthermore, the test assessed only the concentrations of determinants, where neutral de-ionised water (pH7) is the only external factor influencing leachate generation and not for example acid rain.

However, in the absence of any further geochemical assessments like humidity cell (kinetic) tests, the leachate concentrations are used as a first estimate of expected seepage concentrations. The percentages of the simulated seepage plumes (chapter 9.7) can then be multiplied with the concentrations in Table 15 to arrive at expected concentrations for a specific constituent in the aquifer. It must be noted that only the boron concentrations in the leachate exceed at source the WHO (2011) guideline for drinking water.

9.10.3.7 Seepage rate

Kendal Power Station employs a dry ash disposal method (Jones & Wagner 2014), which limits the water available for leachate generation from the ADF considerable. Furthermore, the ADF will be a lined facility (class C liner), which will limit any potential seepage generation from the ADF into the sub-surface even further. While no seepage rates for the lined ADF are available, Delta H used a worst case estimate of 50% of the regional recharge rate (18 mm/a) or 9 mm/a for the footprint area of the ADF to account for potential punctures in the liner system. The predicted seepage plumes are therefore conservative.

Additional studies are recommended to determine the actual seepage rate of the lined ADF (e.g. as part of the quality control during liner installation) with subsequent model updates in the highly unlikely case that the determined value exceeds the assumed seepage rate.

9.10.4 Solute Transport Modelling

9.10.5 Selection of Calibration Targets and Goals

The regional groundwater flow directions (hydraulic head gradients) in the area of interest, interpolated from the 50 regional groundwater level measurements (see 9.9), were used as optimisation targets for the steady state model calibration.

The elevations of the delineated pans (Wetland Consulting Services, 2013) were incorporated as virtual water level measurements in a secondary calibration data set. It is assumed that the pans are in direct contact with the groundwater table and therefore reflect minimum groundwater elevations at this point. While not used as an absolute calibration target, the delineated hill slope and valley bottom wetlands were also used as a secondary calibration target. It is assumed that these wetlands are at least partially fed by groundwater and the simulated water tables should therefore be close to (< 1 m) or above land surface within these wetland areas. This target was considered to be especially important for the valley bottom wetlands, which are unlikely to be fed by interflow or other processes

The groundwater levels (in metres above mean sea level) observed from the recent as well as previous hydrocensus are considered representative of the aquifers and used as calibration targets for the Steady State flow model calibration. Since the modelled groundwater levels are directly related to the assigned recharge rates and hydraulic conductivities, an independent estimate of one or the other parameter is required to arrive at a potentially unique solution of the model. The estimated recharge rates were therefore considered fixed for the calibration.

9.10.6 Numerical Parameters

SPRING uses an efficient preconditioned conjugate gradient (PCG) solver for the iterative solution of the flow equation. The closure criterion for the solver, i.e. the convergence limit of the iteration process was set at a residual below 1e-06 m. The Picard iteration, used for the iterative computation of the relative permeability for each element as a function of the relative saturation (i.e. capillary pressure), used a damping factor of 0.5 and was limited to 8 iterations. The mean difference between the computed pressures for the last two iterations was generally lower than 0.01 m.

9.10.7 Initial and Assigned Conditions

The initial conditions specified in the numerical model were as follows:

- Starting heads for the shallow aquifer were interpolated from measured water levels using Bayesian interpolation, i.e. co-kriging using the established correlation between surface topography and groundwater elevation.
- Hydraulic conductivities of 1E-06 m/s for the weathered Karoo aquifer and 1E-07 for the fractured aquifer.
- Vertical hydraulic conductivities were set at 10% of the horizontal conductivities
- Effective porosity values were specified as 15% for the weathered Karoo aquifer and 3 to 5% for the fractured aquifer.
- In the absence of site specific data, values of dispersivity were inferred from literature values.
  - A uniform longitudinal dispersivity of 50 m was used for all aquifers units.
  - The transversal dispersivity is set at 10 % of the longitudinal dispersivity (NRC, 1990).

9.11 Model Calibration

9.11.1 Steady State Calibration

Since the calibration is undertaken for an assumed steady state scenario, it is necessary to use calibration heads and initial conditions that are as close as possible to the steady state conditions of the real system.

Using the 50 regional groundwater level measurements (see section 9.9) as calibration targets, a very good correlation (95%) between observed and modelled water levels was achieved (Figure 41). The almost linear slope (0.99) of the regression line in Figure 41 and the even spread of simulated heads around the line points to no obvious bias towards too high or low heads.

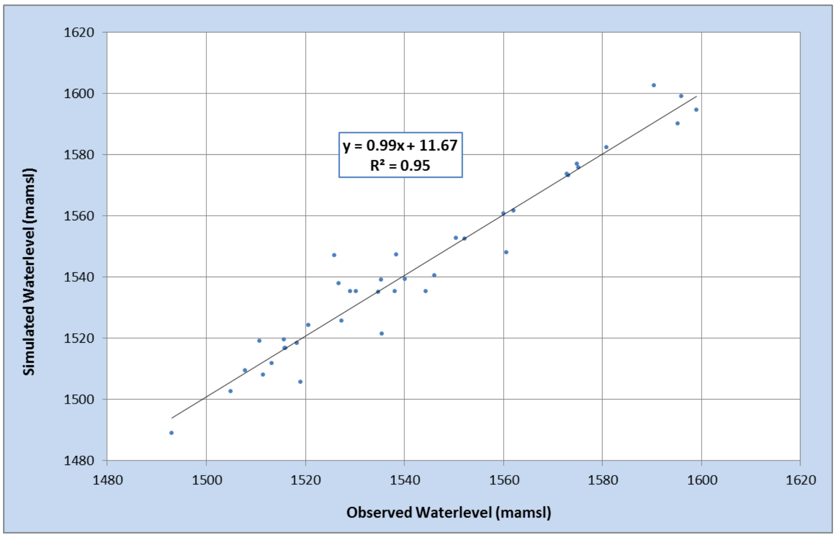

Figure 41: Steady state calibration of the Site 'H' groundwater model

The root mean square error (RMSE) and the normalised root mean square error (NRMSE) were used as quantitative indicators for the adequacy of the fit between the 50 (=n) observed (h_{obs}) and simulated (h_{sim}) water levels:

$$RMSE = \sqrt{\frac{\sum(h_{obs} - h_{sim})^2}{n}}$$

$$NRMSE = \frac{RMSE}{h_{max} - h_{min}}$$

The normalised root mean square error scales the error value to the overall range of observed heads within a model domain ($h_{max} – h_{min}$ = 1599 mamsl – 1493 mamsl = 106m), with values lower than 10% considered acceptable. The corresponding normalised root mean square error of **6.7%** (and a RMSE of **7.05**) for the 50 observed heads are considered acceptable for the model application.

The calibrated conductivity values (Table 16) appear plausible and correlate well with literature values and more importantly with the site specific hydraulic parameters obtained during intrusive investigations of the site (Golder, 2016). The simulated steady-state head contours of regional model are shown in Figure 42. Expectedly, the modelled groundwater contours follow the regional groundwater flows from the higher lying areas in the south and east to the lower drainage areas in the north-west.

Table 16: Calibrated hydraulic conductivities

Aquifer	Hydraulic conductivity	
	[m/s]	[m/d]
Weathered Karoo	2 - 3.5E-06	0.173 - 0.302
Fractured Karoo	1 - 3.0E-07	0.01 - 0.026
Igneous rocks, weathered	6E-07	0.052
Igneous rocks, fractured	4E-08	0.003

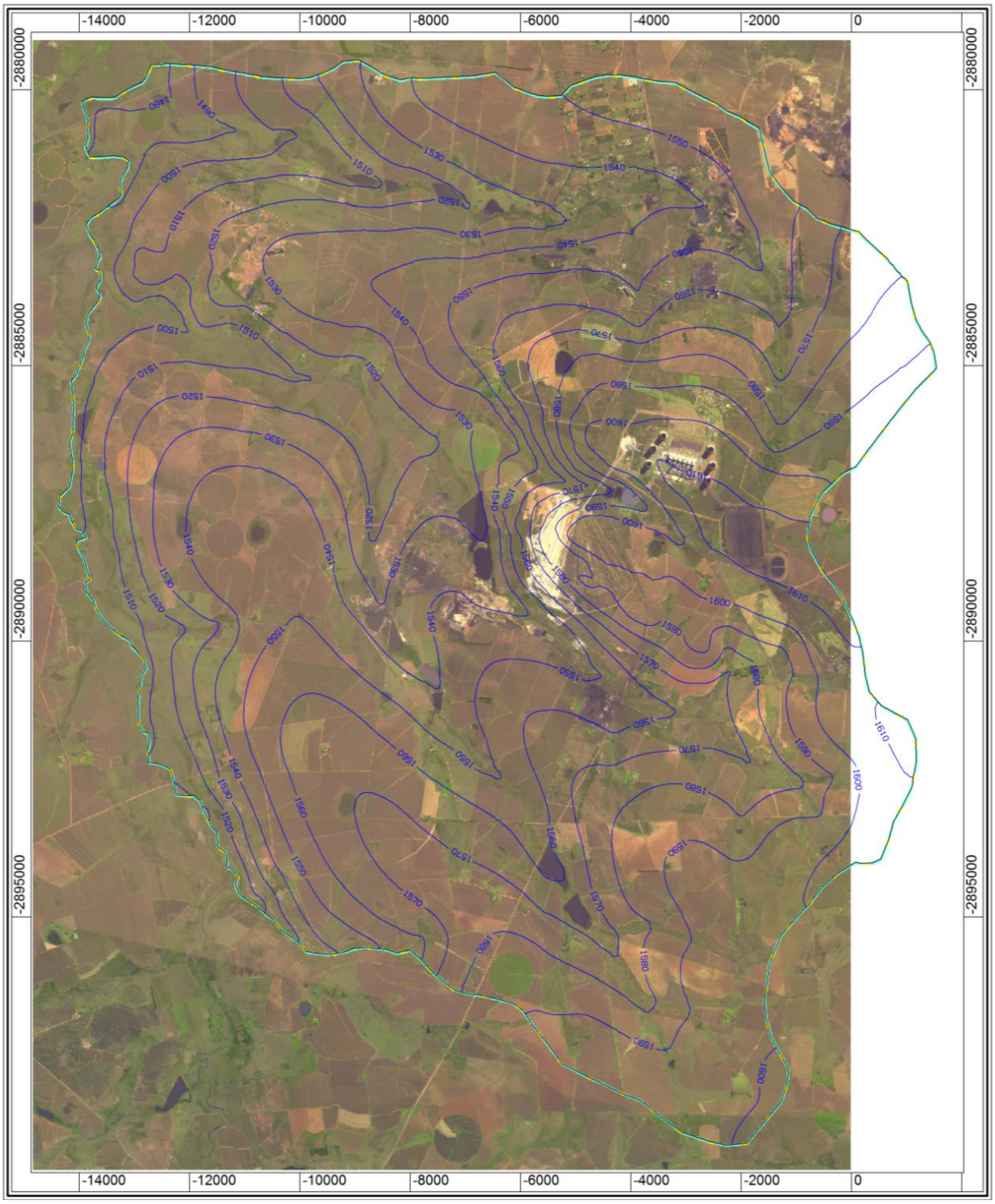

Figure 42: Simulated steady state head contours (10 m interval)

9.12 Predictive Scenarios

The solution of the calibrated steady-state groundwater model was subsequently used for the predictive model simulations. The following scenarios were assessed:

1. Predict the groundwater contributions to delineated hill-slope and valley bottom wetlands.
2. Evaluate the impacts of the proposed ADF on the ambient groundwater quality using a conservative advective-dispersive transport model

9.12.1 Estimated Groundwater Contributions to Wetlands

The calibrated groundwater flow model and a groundwater flow model with the proposed ADF implemented were used to estimate the groundwater contributions to wetlands. The second model simulation was used to estimate the reduction of groundwater leakages into the delineated pans, hill slope and valley bottom wetlands due to the development of the ADF with reduced recharge rates over its footprint area at full development or year 27. Table 16 gives the estimated steady-state groundwater leakage rates into the delineated pans, hill slope and valley bottom wetlands with ID's as supplied by client before and after complete development of the ADF.

Table 17: Simulated groundwater seepage rates to delineated wetlands

Wetland	Status Quo Model		ADF (year 27)		Difference
ID	m^3/a	l/s	m^3/a	l/s	%
1	770	0.02	277	0.01	64%
2	28 493	0.90	28 492	0.90	0%
3	76 232	2.42	69 142	2.19	9%
6	2 833	0.09	2 531	0.08	11%
8	925	0.03	446	0.01	52%
9	2 464	0.08	1 272	0.04	48%
31	11 652	0.37	11 651	0.37	0%
51	7 767	0.25	1 500	0.05	81%
60 (incl. 33) (Pan)	**1 027**	**0.03**	**0**	**0**	**100%**

Most of the wetlands do apparently not receive significant groundwater contributions (please note that the wetland ID3 represents a large area of hillslope wetlands, (see Figure 43) and appear therefore to be predominantly driven by direct rainfall run-off or shallow interflow within the soil zone. While this assessment is supported by site-specific data for the pan itself (wetland ID 60), it is in the absence of site specific data more uncertain for the other delineated wetlands covered by the regional groundwater model.

The relative reduction for wetlands or pans receiving groundwater leakage range from a 'null' reduction (0 %) to a complete removal of any groundwater contribution (100%). With the exception of the pan (ID 60) and the wetlands to be covered by the ADF or immediately downstream of the ADF (IDS 1, 8, 9 and 51), the reductions due to development of the ADF are insignificant. A summary of the groundwater balance of the pan under investigation is shown in Table 18. From the results it's evident that the pan not only receives groundwater but also seeps into the underlying aquifer with a net inflow of 0.03 l/s.

Table 18: Simulated groundwater seepage rates in- and out the Pan (ID 60)

Balance	Inflows from Pan	
	m^3/a	l/s
In	2 743	0.09
Out	-1 758	-0.06
Net	985	0.03

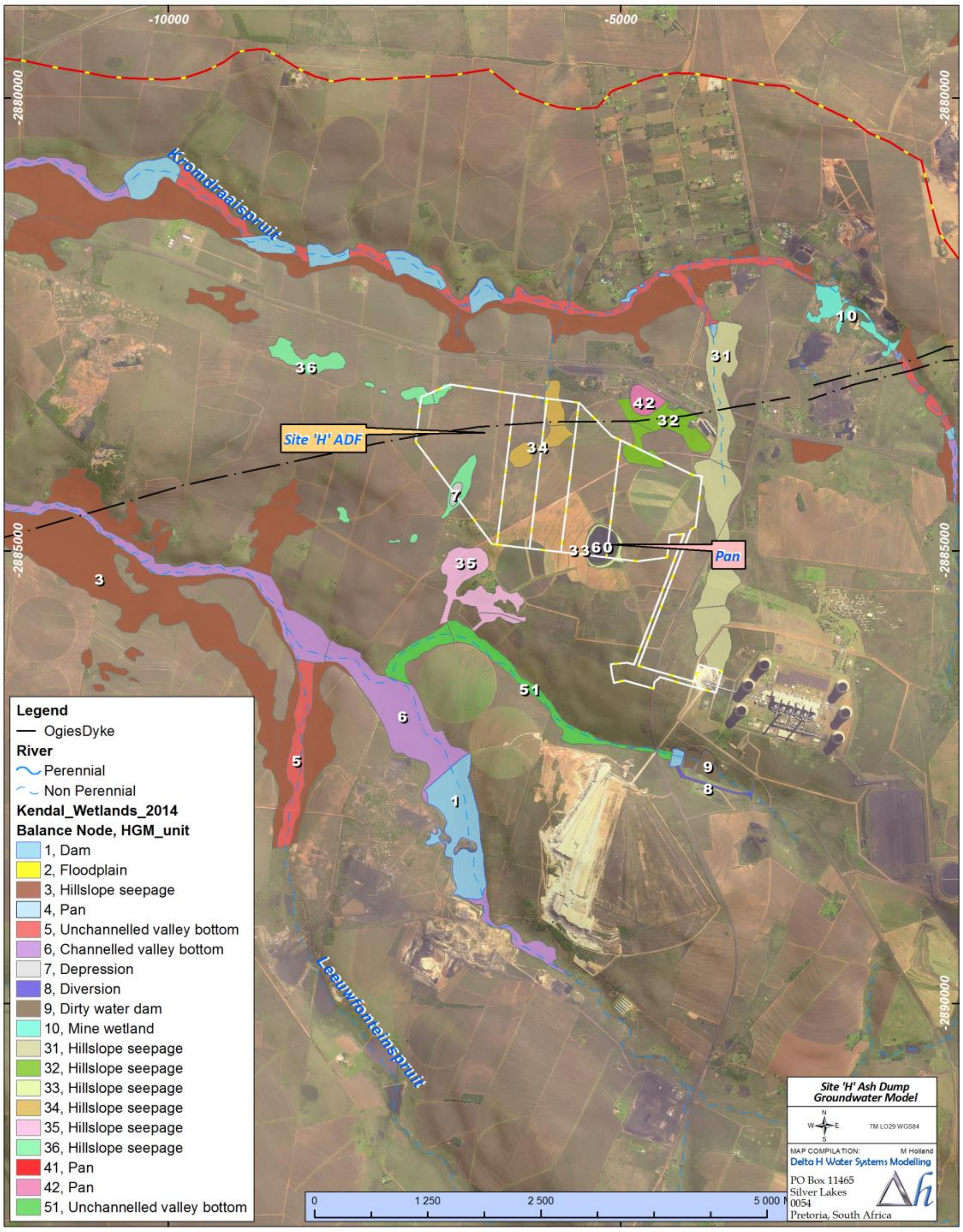

Figure 43: Delineated Kendal wetlands considered in the groundwater model

It must be noted that the assessment of the groundwater contribution to these ecological sites should be seen as a relative and not as an absolute assessment. While the relative reduction of the groundwater contributions due to the ADF might be accurate, the absolute volumes are not necessarily and should be verified by field measurements. It is exactly the absence of such field data (of groundwater contributions to these ecosystems) which prevents a calibration of the model for the purpose of an absolute evaluation.

9.12.2 Non-reactive Transport Model

The solution of the calibrated steady-state groundwater model was used as the basis for the transport model using the transport code built into SPRING (chapter 9.10.1). Following the precautionary principle, only advective-dispersive transport without any retardation or transformation was simulated and the impact of the potential pollution source (ADF) on the groundwater quality therefore a likely overestimation.

9.12.2.1 Stability criteria

In order to simulate the solute transport accurately and to comply with applicable numerical stability criteria (Courant Criteria), a time step width of 10 days was used for the predictive scenarios.

Courant criteria: $C_r = \left|\frac{v\Delta t}{L}\right| \leq 1$

The geometry of the mesh can have an undesirable effect (numerical dispersion) on the simulated spreading of solutes, if the elements are too large in relation to the dispersion length. The mesh was therefore designed to comply with the Peclet criteria:

Peclet criteria: $L < 2\alpha_l$

v Flow velocity
Δt Discrete time step
L Longest dimension of an element in the direction of flow

α_l Longitudinal dispersion coefficient

A measure of this ratio is the Peclet number P_e, which should be less than 2 so that the proportion of the non-hyperbolic part of the transport equation dominates:

$$P_e = \left|\frac{v\Delta l}{D}\right| < 2$$

It describes the ratio of the advective part to the dispersion part (D) with respect to a characteristic length (side length of the elements, Δl). The lower the Peclet number, the less iterations are necessary to achieve a pre-defined maximum value of the residuals. Once this dimensionless number exceeds the value of 10, is no longer guaranteed that the solution converges. An optimal discretization in space results for a Peclet number < 2.

9.12.2.2 Model set up and transport parameter

One of the uncertainties encountered during transport modelling of pollutants is the kinematic or effective porosity of the aquifer. Effective (transport) porosity values were conservatively specified as 10% for the weathered and 5% for the fractured Karoo aquifer. In the absence of site specific data, values of dispersivity were inferred from literature values, with a uniform longitudinal dispersivity of 50 m assigned to all aquifers units and the transversal dispersivity set at 10 % of the longitudinal dispersivity (NRC, 1990).

9.12.2.3 Boundary conditions

The steady-state heads as simulated by the calibrated flow model with a locally reduced recharge rate (9 mm/a due to dry deposition) for the lined ADF footprint area developing over time (with increments of footprint sizes and associated reduced recharge rates for 5, 10, 15, 20 and 27 years after commissioning considered) were used as heads for the transient transport simulations. In other words, the spreading of potential solutes was simulated in parallel to the increasing extent and decreasing recharge rate of the ADF footprint area. No further reduction of post-closure (beyond simulation year 27) recharge rates for the ADF was assumed for the 50 years plume simulation.

The source concentration of the ADF was specified as 100% using a first type boundary condition over the respective footprint areas of the stockpile area, emergency dump, conveyor belt (to allow for spillages with subsequent infiltration by rainfall) and the ADF itself. In other words, a constant concentration of 100% was assigned to any seepage over the footprint areas and since no element specific retardation or transformation is simulated, concentrations for individual elements of concern (Table 15) can be easily derived by multiplying given percentages of the unit (100%) source concentration with the respective source concentration for an element. The constant input concentrations for the stockpile area, emergency dump and conveyor belt were removed post-closure and only the dissipation of the residual plume within the aquifer simulated, the source concentration for the ADF was assumed to remain constant post-closure. Again, this is an unrealistic worst case assumption and the post-closure transport simulation therefore considered very conservative.

No initial background concentrations of potential constituents of concern were specified for the predictive transport simulation and the simulated plumes represent therefore the predicted net effects of leachate from the ADF on the ambient groundwater quality.

9.12.2.4 Predicted Plume development

The predicted plume extents within the weathered aquifer over the 27 years of active life of the ADF as well as 23 years post closure (total simulation time 50 years) are shown in Figure 44 to Figure 49. In order to account for uncertainties associated with the transport simulations, the simulated seepage plumes are generally shown with a cut-off value of 10% of the unit (100%) source concentration. It can furthermore be assumed that a 10% cut-off value represents the limit of detection for several potential constituents of concern (e.g. boron) or would be masked by regional background concentrations (e.g. fluoride or sulphate).

According to the simulation conducted, no significant seepage plume is likely to develop from the lined ADF during its operational life. The simulated plumes are essentially limited to the immediate vicinity of the ADF and associated infrastructure footprint areas. Due to the low seepage rate from the lined ADF, no significant pollutant load is predicted and associated concentrations disperse in the shallow weathered aquifer underlying the ADF.

A minor elongation of the post-closure seepage plume is recognisable in Figure 49 for the north-eastern corner of the ADF and for the residual plume in the northern edge of the stockpile area, although at significantly diminishing concentrations. The elongation of the plume at the north-eastern corner of the ADF (around 150 m extent) for concentrations between 20 and 10% of the already low source concentration can be related to the conservative assumption of continuous source strength for the post closure simulation, although this is not expected

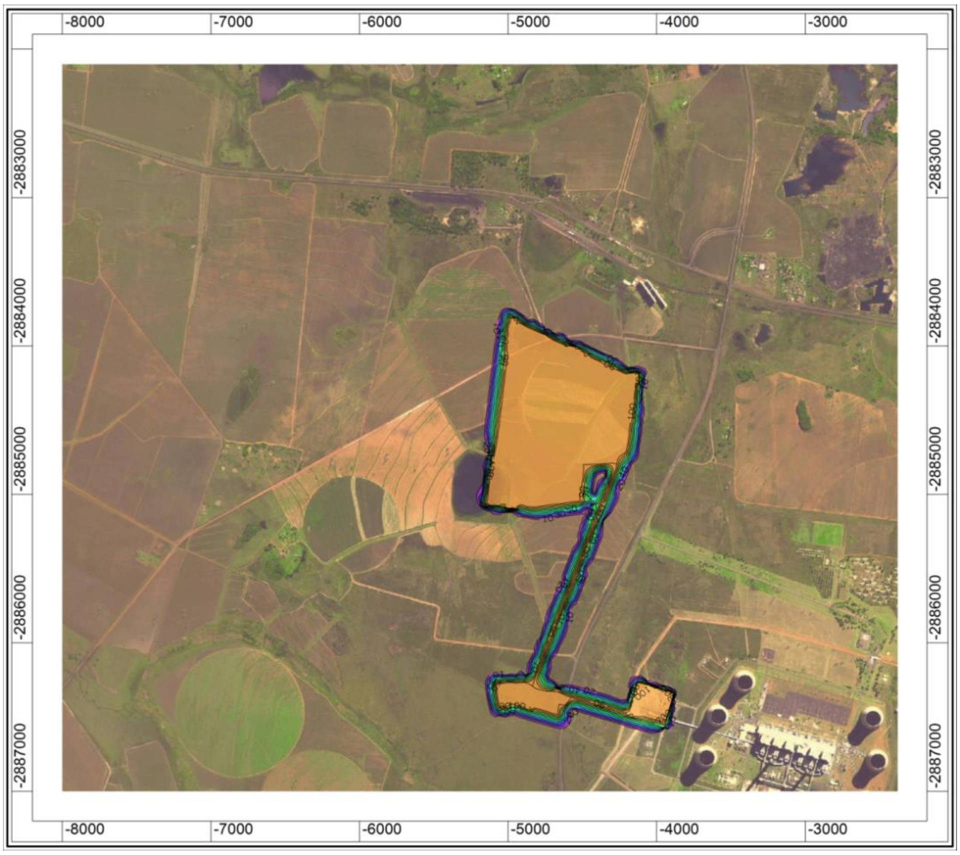

Figure 44: Simulated plume development 5 years after commissioning of the ADF

Figure 45: Simulated plume development 10 years after commissioning of the ADF

Figure 46: Simulated plume development 15 years after commissioning of the ADF

Figure 47: Simulated plume development 20 years after commissioning of the ADF

Figure 48: Simulated plume development 27 years after commissioning of the ADF (end of life)

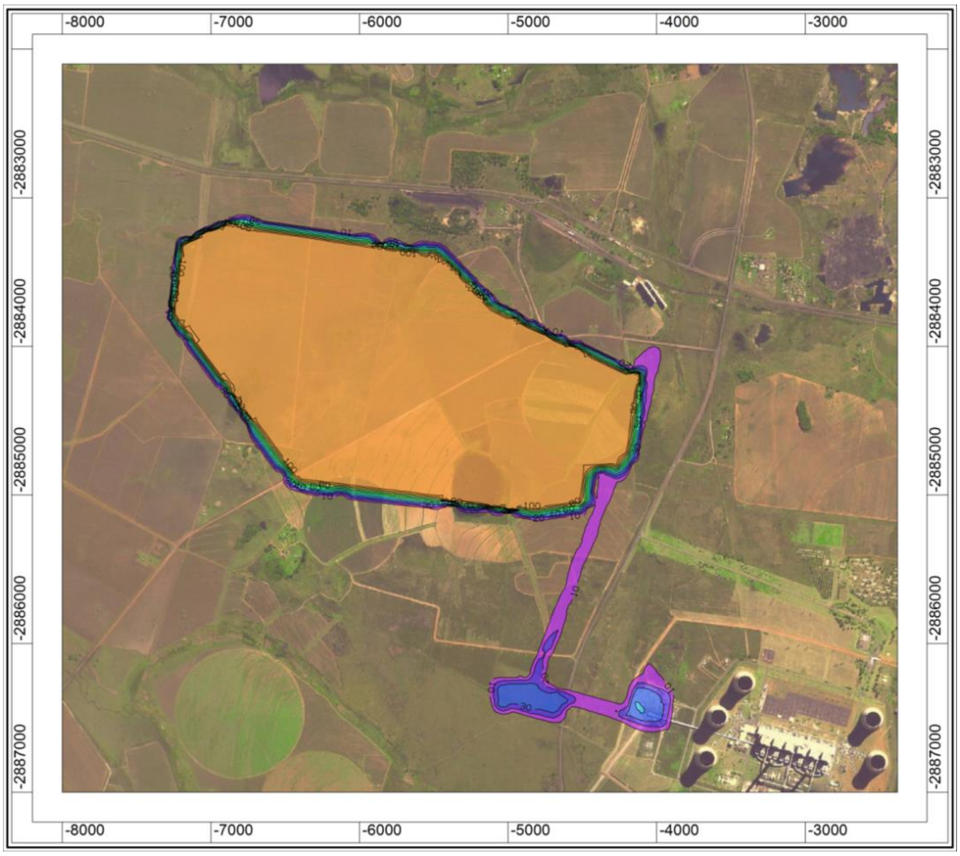

Figure 49: Simulated plume development 50 years after commissioning (23 years post closure) of the ADF

9.13 Model Confidence

Preamble: "*A decision often must address the fact that something bad may happen. We may be willing to pay a price to reduce the likelihood of its occurrence. How much we are prepared to pay depends on the cost of its occurrence and the amount by which its likelihood can be reduced through pre-emptive management. The role of modelling in this process is to assess likelihood. This must not be confused with predicting the future*." (Australian groundwater modelling guidelines, Barnett *et al*. 2012). Delta H shares this view, specifically for long-term predictions beyond the model calibration timeframe.

9.13.1 Methodology

In the absence of other internationally accepted standard, Delta H follows the Australian groundwater modelling guidelines (Barnett *et al*. 2012) to distinguish the confidence-levels (Class 1, Class 2 or Class 3 in order of increasing confidence) of a model. The factors used for the classification according to this guideline are given in Appendix A and depend foremost on:

- The available data, including their spatial and temporal coverage to fully characterise the aquifer and the historic groundwater behaviour;
- The calibration procedures, including types and quality of data used as calibration targets;
- The consistency between the calibration and predictive analysis, e.g. a steady state calibration is bound to produce transient predictions of low confidence and a transient prediction is expected to have a high level of confidence if the time frame of the predictive model is of less or similar to that of the calibration model (e.g. a 10 year transient calibration period would be required for a high confidence prediction over 10 years); and
- The level of stresses applied in predictive model in relation to the stresses included in the calibration (e.g. if a model was calibrated without major abstractions, simulations of significant abstractions or mine inflows will be of low confidence).

9.13.2 Classification

In accordance with the guideline, Delta H provides a classification for each of these criteria as well as an overall model classification that reflects their importance with regard to the model objectives (Table 19).

Table 19: Type table title here.

Criteria	Confidence level classification	Key indicators
Data	1	Spatial distribution of groundwater head observations is limited to adequately define regional groundwater behaviour Local geological logs are available No aquifer testing or monitoring data to define key transport parameters.
Calibration	1-2	Calibration against head observations only (not concentrations) Calibration statistics acceptable Mass balance closure error less than 0.5% of total
Prediction	1	Model predictive time frame is more than 10 times longer than (steady-state) calibration period Predictive transport model not calibrated
Overall	1	At least one criteria falls into Class 1 Model to be updated once quality monitoring become available

Based on the model classification (Class 1 or low confidence), the model could be used for:

- Predicting long-term impacts of proposed developments in low-value aquifers.
- Estimating impacts of low-risk developments.
- Designing monitoring networks.
- As a starting point on which to develop higher class models as more data is collected and used.

10.0 IMPACT ASSESSMENT

10.1 Impact Assessment Methodology

The impacts will be ranked according to the methodology described below. Where possible, mitigation measures will be provided to manage impacts. In order to ensure uniformity, a standard impact assessment methodology will be utilised so that a wide range of impacts can be compared with each other. The impact assessment methodology makes provision for the assessment of impacts against the following criteria:

- Significance;
- Spatial scale;
- Temporal scale;
- Probability; and
- Degree of certainty.

A combined quantitative and qualitative methodology was used to describe impacts for each of the aforementioned assessment criteria. A summary of each of the qualitative descriptors along with the equivalent quantitative rating scale for each of the aforementioned criteria is given in Table 20.

Table 20: Quantitative rating and equivalent descriptors for the impact assessment criteria

Rating	Significance	Extent Scale	Temporal Scale
1	VERY LOW	*Proposed site*	Incidental
2	LOW	*Study area*	Short-term
3	MODERATE	*Local*	Medium-term
4	HIGH	*Regional / Provincial*	Long-term
5	VERY HIGH	*Global / National*	Permanent

A more detailed description of each of the assessment criteria is given in the following sections.

10.1.1 Significance Assessment

Significance rating (importance) of the associated impacts embraces the notion of extent and magnitude, but does not always clearly define these since their importance in the rating scale is very relative. For example, the magnitude (i.e. the size) of area affected by atmospheric pollution may be extremely large (1 000 km^2) but the significance of this effect is dependent on the concentration or level of pollution. If the concentration is great, the significance of the impact would be HIGH or VERY HIGH, but if it is diluted it would be VERY LOW or LOW. Similarly, if 60 ha of a grassland type are destroyed the impact would be VERY HIGH if only 100 ha of that grassland type were known. The impact would be VERY LOW if the grassland type was common. A more detailed description of the impact significance rating scale is given in Table 21 below.

Table 21: Description of the significance rating scale

Rating		Description
5	Very high	Of the highest order possible within the bounds of impacts which could occur. In the case of adverse impacts: there is no possible mitigation and/or remedial activity which could offset the impact. In the case of beneficial impacts, there is no real alternative to achieving this benefit.
4	High	Impact is of substantial order within the bounds of impacts, which could occur. In the case of adverse impacts: mitigation and/or remedial activity is feasible but difficult, expensive, time-consuming or some combination of these. In the case of beneficial impacts, other means of achieving this benefit are feasible but they are more difficult, expensive, time-consuming or some combination of these.
3	Moderate	Impact is real but not substantial in relation to other impacts, which might take effect within the bounds of those which could occur. In the case of adverse impacts: mitigation and/or remedial activity are both feasible and fairly easily possible. In the case of beneficial impacts: other means of achieving this benefit are about equal in time, cost, effort, etc.
2	Low	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts: mitigation and/or remedial activity is either easily achieved or little will be required, or both. In the case of beneficial impacts, alternative means for achieving this benefit are likely to be easier, cheaper, more effective, less time consuming, or some combination of these.
1	Very low	Impact is negligible within the bounds of impacts which could occur. In the case of adverse impacts, almost no mitigation and/or remedial activity are needed, and any minor steps which might be needed are easy, cheap, and simple. In the case of beneficial impacts, alternative means are almost all likely to be better, in one or a number of ways, than this means of achieving the benefit. Three additional categories must also be used where relevant. They are in addition to the category represented on the scale, and if used, will replace the scale.
0	No impact	There is no impact at all - not even a very low impact on a party or system.

10.1.2 Spatial Scale

The spatial scale refers to the extent of the impact i.e. will the impact be felt at the local, regional, or global scale. The spatial assessment scale is described in more detail in Table 22.

Table 22: Description of the significance rating scale

Rating		Description
5	Global/National	The maximum extent of any impact.
4	Regional/Provincial	The spatial scale is moderate within the bounds of impacts possible, and will be felt at a regional scale (District Municipality to Provincial Level).
3	Local	The impact will affect an area up to 10 km from the proposed site.
2	Study Site	The impact will affect an area not exceeding the Eskom property.
1	Proposed site	The impact will affect an area no bigger than the ash disposal site.

10.1.3 Duration Scale

In order to accurately describe the impact it is necessary to understand the duration and persistence of an impact in the environment. The temporal scale is rated according to criteria set out in Table 23.

Table 23: Description of the temporal rating scale

Rating		Description
1	Incidental	The impact will be limited to isolated incidences that are expected to occur very sporadically.
2	Short-term	The environmental impact identified will operate for the duration of the construction phase or a period of less than 5 years, whichever is the greater.
3	Medium term	The environmental impact identified will operate for the duration of life of facility.
4	Long term	The environmental impact identified will operate beyond the life of operation.
5	Permanent	The environmental impact will be permanent.

10.1.4 Degree of Probability

Probability or likelihood of an impact occurring will be described as shown in Table 24 below.

Table 24: Description of the degree of probability of an impact occurring

Rating	Description
1	Practically impossible
2	Unlikely
3	Could happen
4	Very Likely
5	It’s going to happen / has occurred

10.1.5 Degree of Certainty

As with all studies it is not possible to be 100% certain of all facts, and for this reason a standard “degree of certainty” scale is used as discussed in Table 25. The level of detail for specialist studies is determined according to the degree of certainty required for decision-making. The impacts are discussed in terms of affected parties or environmental components.

Table 25: Description of the degree of certainty rating scale

Rating	Description
Definite	More than 90% sure of a particular fact.
Probable	Between 70 and 90% sure of a particular fact, or of the likelihood of that impact occurring.
Possible	Between 40 and 70% sure of a particular fact or of the likelihood of an impact occurring.
Unsure	Less than 40% sure of a particular fact or the likelihood of an impact occurring.
Can't know	The consultant believes an assessment is not possible even with additional research.
Don't know	The consultant cannot, or is unwilling, to make an assessment given available information.

10.1.6 Quantitative Description of Impacts

To allow for impacts to be described in a quantitative manner in addition to the qualitative description given above, a rating scale of between 1 and 5 was used for each of the assessment criteria. Thus the total value of the impact is described as the function of significance, spatial and temporal scale as described below:

$$\textbf{\textit{Impact Risk}} = \frac{\text{SIGNIFICANCE} + \textit{Spatial} + \text{Temporal}}{3} \times \frac{\text{Probability}}{5}$$

An example of how this rating scale is applied is shown below Table 26:

Table 26: Example of Rating ScaleTable

Impact	Significance	Spatial Scale	Temporal Scale	Probability	Rating
	LOW	*Local*	Medium-term	*Could Happen*	
Impact to air	**2**	***3***	**3**	**3**	**1.6**

Note: The significance, spatial and temporal scales are added to give a total of 8, that is divided by 3 to give a criteria rating of 2,67. The probability (3) is divided by 5 to give a probability rating of 0,6. The criteria rating of 2,67 is then multiplied by the probability rating (0,6) to give the final rating of 1,6.

The impact risk is classified according to five classes as described in the Table 27 below.

Table 27: Impact Risk Classes

Rating	Impact Class	Description
0.1 – 1.0	**1**	Very low
1.1 – 2.0	**2**	Low
2.1 – 3.0	**3**	Moderate
3.1 – 4.0	**4**	High
4.1 – 5.0	**5**	Very high

Therefore with reference to the example used for air quality above, an impact rating of 1.6 will fall in the Impact Class 2, which will be considered to be a low impact.

10.1.7 Cumulative Impacts

It is a requirement that the impact assessments take cognisance of cumulative impacts. In fulfilment of this requirement the impact assessment will take cognisance of any existing impact sustained by the operations, any mitigation measures already in place, any additional impact to environment through continued and proposed future activities, and the residual impact after mitigation measures.

It is important to note that cumulative impacts at the national or provincial level will not be considered in this assessment, as the total quantification of external companies on resources is not possible at the project level due to the lack of information and research documenting the effects of existing activities. Such cumulative impacts that may occur across industry boundaries can also only be effectively addressed at Provincial and National Government levels.

10.1.8 Notation of Impacts

In order to make the report easier to read the following notation format is used to highlight the various components of the assessment:

- Significance or magnitude- IN CAPITALS.
- Temporal Scale – in underline.
- Probability – in *italics and underlined.*
- Degree of certainty - in **bold.**
- Spatial Extent Scale – in *italics.*

11.0 IMPACT ASSESSMENT RATING

11.1 Groundwater Impacts

Based on the results of the groundwater model (Delta H 2016), the potential impacts of the ADF and associated infrastructure on the aquifer can be generally classified into:

- A change in the groundwater quality;
- A change in the volume of groundwater in storage or entering groundwater storage (recharge); or
- A change in the groundwater flow regime.

11.1.1 Groundwater Quality

It is expected that seepage from the ADF will impact on the ambient groundwater quality of the underlying weathered aquifer. Seepage from the ADF will contain elevated concentrations of identified constituents of concern, which will migrate into the underlying aquifer and result in a measurable increase of these constituents in the aquifer. This will cause a moderate deterioration of the ambient groundwater quality. The predicted impact of seepage from the ADF on the ambient groundwater quality is:

- Of LOW significance based on the low leachate concentrations (if representative of the ash) and seepage rates
- Localised, within the study site boundary (not exceeding Eskom property), if surface run-off from potential seeps at the toe of the dump is contained.
- Long-term, with moderate increases of pollutant concentrations beyond closure.
- **Probable** to occur.

Due to the substantial uncertainties associated with the potential seepage quality from the ADF, Delta H assigns only a high degree of uncertainty to the predictions. In other words, Delta H is less than 40% sure of the likelihood of the low impacts on the groundwater quality occurring, due to the absence of leachate quality assessments.

The Impact from the ADF on the ambient groundwater quality of the underlying weathered aquifer for the different phase of the ADF are listed in Table 28 to Table 30.

Table 28: Impact rating – Groundwater Quality – Construction Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Short-term	LOW	*Could Happen*	
Groundwater quality	Existing	*2*	2	2	*3*	1.2 - LOW
	Cumulative	*2*	2	2	*3*	1.2 - LOW
	Residual	*2*	2	2	*3*	1.2 - LOW

Table 29: Impact rating – Groundwater Quality – Operational Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Medium-term	LOW to MODERATE	*Unlikely to Could Happen*	
Groundwater quality	Existing	*2*	3	2	*2*	0.9 - VERY LOW
	Cumulative	*2*	3	3	*3*	1.6 - LOW
	Residual	*2*	3	2	*2*	0.9 - VERY LOW

Table 30: Impact rating – Groundwater Quality – Closure Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Short to long-term	VERY LOW	*Unlikely*	
Groundwater quality	Existing	*2*	2	1	*2*	0.7 - VERY LOW
	Cumulative	*2*	4	1	*2*	0.9 - VERY LOW
	Residual	*2*	2	1	*1*	0.3 - VERY LOW

11.1.2 Groundwater Quantity and Flow Regime

Due to dry deposition of ash on a lined ADF, a minor change in the volume of water entering groundwater storage (reduced recharge in comparison to status quo conditions) with NEGLIGIBLE changes in the groundwater flow regime are **definitely** (more than 90% sure) expected. However, these minor changes in the flow regime are not expected to result in measurable changes to groundwater contributions to the delineated wetlands as they will fall within the seasonal variability.

The Impact from the ADF on the groundwater quantity/recharge and flow regime for the different phase of the ADF are listed in Table 31 to Table 33.

Table 31: Impact rating – Groundwater Recharge and Flow - Construction Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Short-term	VERY LOW	*Could Happen*	
Groundwater Recharge	Existing	*2*	2	1	*3*	1 - VERY LOW
	Cumulative	*2*	2	1	*3*	1 - VERY LOW
	Residual	*2*	2	1	*3*	1 - VERY LOW
Groundwater Flow	Existing	*2*	2	1	*3*	1 - VERY LOW
	Cumulative	*2*	2	1	*3*	1 - VERY LOW
	Residual	*2*	2	1	*3*	1 - VERY LOW

Table 32: Impact rating – Groundwater Recharge and Flow – Operational Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Medium-term	VERY LOW	*Could Happen*	
Groundwater Recharge	Existing	*2*	3	1	*3*	1.2 - LOW
	Cumulative	*2*	3	1	*3*	1.2 - LOW
	Residual	*2*	3	1	*3*	1.2 - LOW
Groundwater Flow	Existing	*2*	3	1	*3*	1.2 - LOW
	Cumulative	*2*	3	1	*3*	1.2 - LOW
	Residual	*2*	3	1	*3*	1.2 - LOW

Table 33: Impact rating – Groundwater Recharge and Flow – Closure Phase

Discription of Impact	Impact type	Spatial Scale	Duration	Significance	Probability	Rating
		Local	Short-term	VERY LOW	*Could Happen*	
Groundwater Recharge	Existing	*2*	2	1	*3*	1 - VERY LOW
	Cumulative	*2*	2	1	*3*	1 - VERY LOW
	Residual	*2*	2	1	*3*	1 - VERY LOW
Groundwater Flow	Existing	*2*	2	1	*3*	1 - VERY LOW
	Cumulative	*2*	2	1	*3*	1 - VERY LOW
	Residual	*2*	2	1	*3*	1 - VERY LOW

Based on the impact rating classes in Table 27 the impacts of Groundwater Quality (0.3 to 1.2) and Groundwater Recharge and Flow (1.0to 1.2) fall in the Impact Classes 1 and 2, which are considered to be of a very low to low impact.

11.1.3 Mitigation Measures

The proposed lined ADF impact on groundwater regime are considered to be a very low to low and the following mitigation measures are proposed:

- Installation and testing of groundwater monitoring boreholes (see recommendations) to accommodate the final ADF layout; and
- Groundwater monitoring is recommended to form part of the mitigation and management of the proposed ADF. This monitoring must be included in the monitoring network and will be used as a warning system for contaminant migration.

12.0 CONCLUSIONS

Conclusions based on groundwater model results:

- The Delta H (Delta-H Water System Modelling PTY Ltd) has been appointed by Golder Associates Africa PTY Ltd (Golder) to develop a site specific 3D numerical groundwater flow model for the pan underlying the proposed Site ‘H’ ADF and wetlands in the immediate vicinity to determine the impacts on groundwater flow, surface seepages and spring discharges;
- The objective of the model is to assess the potential impacts of the ADF on groundwater dependent ecosystems, i.e. pans and wetlands by simulating changes in surface seepages and spring discharges (potentially feeding the wetlands). A secondary objective was to evaluate the impacts of the proposed ADF on the ambient groundwater quality using a conservative advective-dispersive transport model, taking into consideration the 2014 waste classification report for the Site ‘H’;

- Due to a lack of understanding of the site specific hydraulic parameters as well as groundwater levels in the vicinity of the pan, intrusive field work was proposed to augment the knowledge gap for the conceptual and numerical model development and to subsequently increase the level of confidence in the model predictions;
- The developed conceptual hydrogeological model was converted into a four-layer numerical finite-element groundwater model using the modelling software SPRING. Using available water levels measurements, a satisfactory steady-state calibration of the model was achieved. Following the model calibration, the leakage rates of groundwater into the delineated pans, hill slope and valley bottom wetlands within the model domain were retrieved. Most of the wetlands do apparently not receive significant groundwater contributions and appear therefore to be predominantly driven by direct rainfall run-off or shallow interflow within the soil zone. The proposed ADF were then incorporated into the groundwater flow models for the predictive simulations. The relative reduction for wetlands or pans receiving groundwater leakage range from a 'null' reduction (0 %) to a complete removal of any groundwater contribution (100%). With the exception of the pan (ID 60) and the wetlands to be covered by the ADF or immediately downstream of the ADF (IDS 1, 8, 9 and 51), the reductions due to development of the ADF are insignificant. From the results it's evident that the pan only receives insignificant volumes of groundwater (net inflow of 0.03 l/s), but appears to be predominately driven by rainfall run-off and shallow interflow;
- The steady-state heads as simulated by the calibrated flow model (with increments of footprint sizes and associated reduced recharge rates for 5, 10, 15, 20 and 27 years after commissioning considered) were used as heads for the transient transport simulations. While no seepage rates for the lined ADF are available, Delta H used a worst case estimate of 50% of the regional recharge rate (18 mm/a) or 9 mm/a for the footprint area of the ADF to account for potential punctures in the liner system. The predicted seepage plumes are therefore overly conservative. The source concentration of the ADF was specified as 100% using a first type boundary condition over the respective footprint areas of the stockpile area, emergency dump, conveyor belt (to allow for spillages with subsequent infiltration by rainfall) and the ADF itself;
- According to the simulation conducted, no significant seepage plume is likely to develop from the lined ADF during its operational life. The simulated plumes are essentially limited to the immediate vicinity of the ADF and associated infrastructure footprint areas. Due to the low seepage rate from the lined ADF, no significant pollutant load is predicted and associated concentrations disperse in the shallow weathered aquifer underlying the ADF;
- The groundwater model and impact assessment of site H results is based on the latest outlay of site H, wherease the groundwater baseline are based on the shape during the investigation of site H; and
- According to Groundwater impact assessment, the impact risk of the proposed ADF development on groundwater quality is classified as class 2 with a **low impact**, therefore it can be concluded that the proposed ADF development has a low impact on the groundwater regime.

13.0 RECOMMENDATIONS

While the model predictions are intrinsically of low confidence (for the proposed ADF development); Delta H would classify the confidence in the conceptualisation of the local aquifer system as well as the model calibration as medium. The model predictions should therefore be verified once time dependant groundwater monitoring data become available. Predicted plume migration rates for later years of the ADF development can significantly be improved by observation data from earlier years and subsequent updates of the groundwater model.

More specific recommendations are summarised below:

- Once-off geochemical assessment of further ash samples, tests to include Acid Base Accounting, XRD analysis, leach test for waste classification and roll bottle test (1:4 liquid –to-solid ratio).

- The potential seepage quality from the ADF should be monitored through the monthly monitoring of the water quality in the PCD.
- Annual sampling of ash material and geochemical analysis (ABA and leach tests).
- Testing of liner conductivity during installation is recommended to ensure liner integrity.
- Installation and testing of groundwater monitoring boreholes to accommodate the final ADF layout. A summary of the proposed monitoring boreholes is listed in Table 34 and the approximate position of the proposed boreholes is shown in (Figure 50). It must be noted that the exact positions of each monitoring borehole needs to be determined by site-specific geophysical investigations.

Table 34: Proposed monitoring boreholes, approximate locations and schedule

BH	Target	Latitude	Longitude	Implementation
ADF-BH06	PCD No.2	-26.085742	28.948576	Year 0 to 5
ADF-BH07	ADF and PCD No.1	-26.064929	28.96072	Year 0 to 5
ADF-BH08	ADF and PCD No. 4	-26.055735	28.940947	Year 10 to 15
ADF-BH09	ADF and PCD No. 7	-26.054675	28.93075	Year 20 to 27
ADF-BH10	ADF (Dyke)	-26.062588	28.926917	Year 10 to 15
ADF-BH11	ADF and PCD No. 6	-26.075066	28.931323	Year 15 to 20
KMBH-05	ADF	-26.07580	28.94569	Maintain (Pan BH)

- The monitoring boreholes should be installed prior to construction phase to determine background water qualities and form part of Eskom monitoring programme. The following monitoring tasks should be conducted to be consistent with the WUL:
  - **Quaterly monitoring** of groundwater levels and quality;
  - **Purged groundwater sampling;**
  - The analytical suite for groundwater samples should include determinants as listed in Table 35 below:

Table 35: Proposed Analytical Suite

Variable	Units
pH	pH Units
Electrical Conductivity	mS/m
Total Dissolved Solids(TDS)	mg/l
Total Alkalinity	mg/l
Major cations (Na, K, Mg, Ca)	mg/l
Major anions (Cl, F, SO_4)	mg/l
Nitrate(NO_3 as N)	mg/l

Variable	Units
Nitrite(NO_2 as N)	mg/l
Chemical Oxygen demand(COD)	mg/l
Orthophosphate	mg/l
Turbidity((as N.T.U)	mg/l
Trace elements by ICP-OES scan including Fe, Mn, Al, Cu, B,Pb,Zn,Hg, Cd and As	mg/l
Total Chromium (as Cr)	mg/l
Cyanides (as CN)	mg/l
Silica (as SIO_2)	mg/l
Free and saline Ammonia NH3 (as N)	mg/l
E.coli	In cfu/100ml

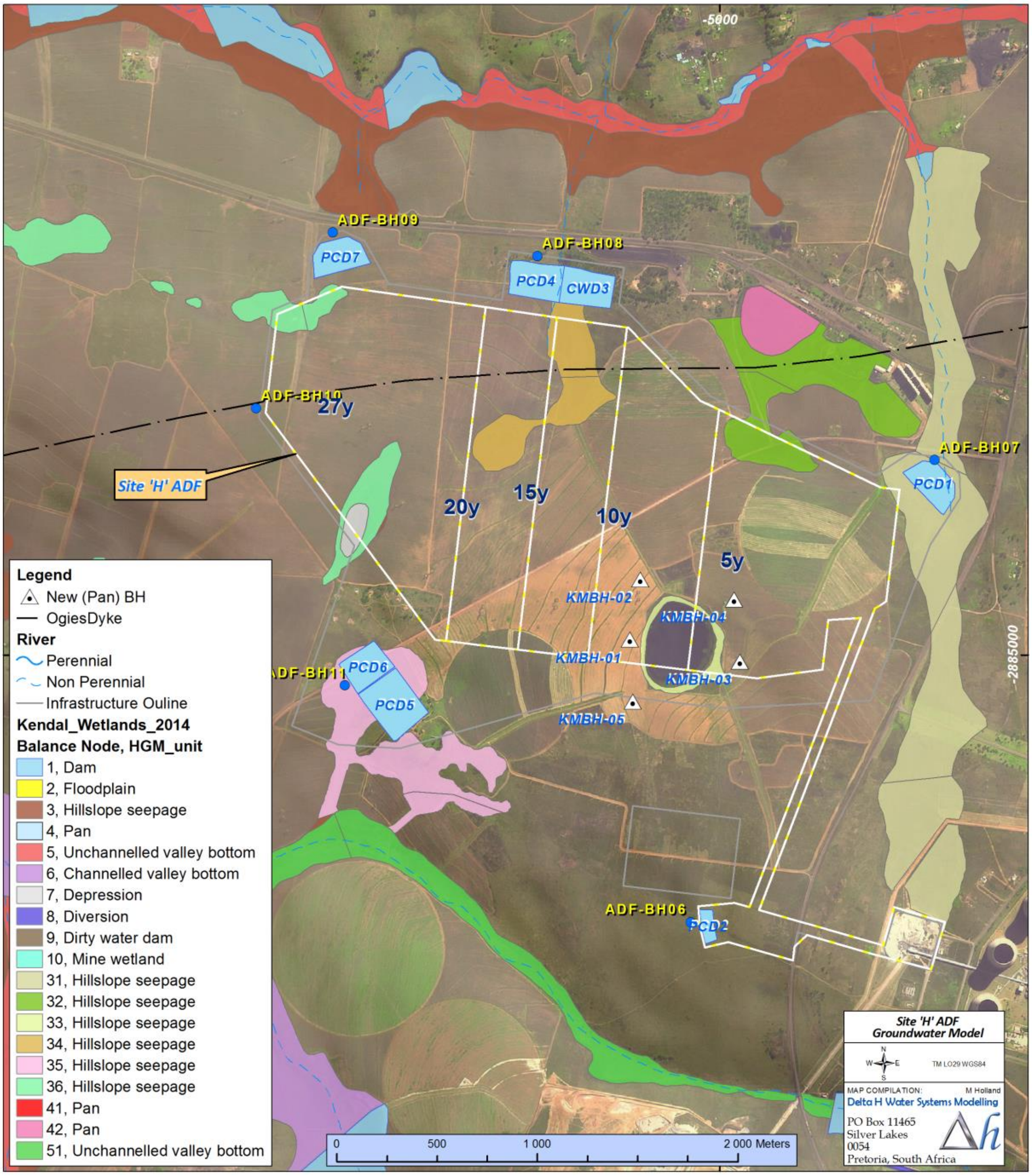

Figure 50: Proposed monitoring borehole locality for the proposed ADF

14.0 REFERENCES

Mbyelo Group. http://mbuyelo.com/news_rirhandzu_eskom.php Date of access: 18 Sep. 2013.

WESCOAL. http://www.wescoal.com/our-business/coal-mining.php Date of access: 19 Sep. 2013.

Homeland Energy Group Ltd. www.homelandenergygroup.com/s/NewsReleases.asp Date of access: 19 Sep. 2013.

SRK Consulting (South Africa) (Pty) Ltd. (2011, August 15). An Independent Competent Persons' Report on the Material Assets of Continental Coal Limited. CCL CPR 15 Aug 2011 final.doc/ Project Number 427952.

SRK Consulting (South Africa) (Pty) Ltd. (2007, July). An Independent Technical Report ("ITR") summarising the scientific and technical information concerning mineral exploration, development and production activities of the Kendal Projectmineral property, Mpumalanga Province, South Africa. NI43-101 ITR Kendal Technical Report FINAL.DOC. July2007.

D.S. Coetzee. (June 2013). Resources and Reserves Statement for WesCoal Holdings Limited as at 31 March 2013.

GHT Consulting Scientists. (April 2012). Kendal Power Station Routine Monitoring Phase 58 February 2012 Final Report. Report No. RVN 601.11/1286,

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APPENDIX A

Hydrocensus Photo Record


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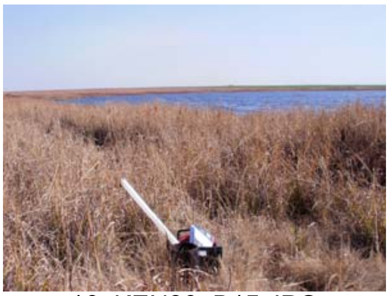
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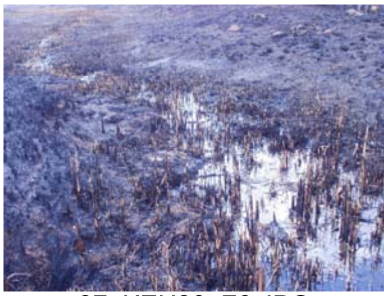
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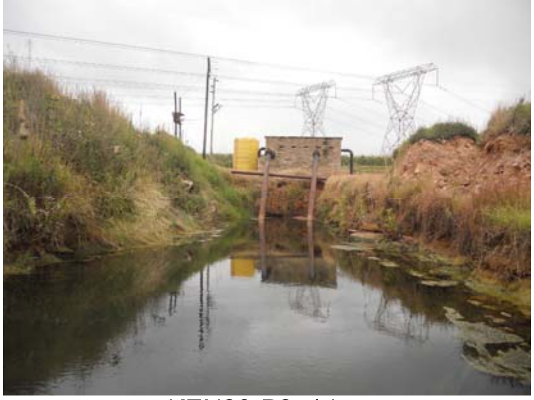
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APPENDIX B

Analytical Result Certificates of Hydrocensus and Groundwater and Surface Water Interaction Study

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FINAL CERTIFICATE OF ANALYSIS	
Report Date	2013-10-10
Date Required	2013-10-03
Contract No	
Order/Ref No	13615285

Testing Laboratory T0184

Kendal 30

Notes
The results relate specifically to the items tested.
The report shall not be reproduced except in full, without the written approval of the laboratory.
[1] SANAS accredited analysis included in the SANAS Schedule of Accreditation for this laboratory.
[2] Not SANAS accredited analysis and not included in the SANAS schedule of accreditation for this laboratory.
[3] Outsourced not performed by this laboratory.

Request ID: 8404 **Sample ID:** 359572 **Received:** 2013-09-23 **Matrix:** Water **Page:** 1 / 8
Sample Number: KEN30-B18 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.05		[1]pH Temperature	25	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	11.3	mS/m	[1]TC Temperature	24.9	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	73.5	mg/l	[2]TDS by EC * 7	79.1	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	72	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	79.8	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	9.2	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	6.99	mg/l	[2]Fe	<0.05	mg/l	[2]K	3.78	mg/l
[2]Mg	5.25	mg/l	[2]Mn	<0.05	mg/l	[2]Na	5.31	mg/l
[2]P	<0.05	mg/l	[2]S	0.66	mg/l	[2]Si	5.79	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	0.039	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	0.01	ppm	[2]Ba	0.389	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.029	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	2.52	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm

[2]Nd	<0.01	ppm	[2]Ni	0.018	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.093	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.075	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	8.18	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	42.3	mg/l	[1]NO3 as N	9.56	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	2.12	mg/l						

Request ID: 8404 **Sample ID:** 359573 **Received:** 2013-09-23 **Matrix:** Water **Page:** 2 / 8
Sample Number: KEN30-D3 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.48		[1]pH Temperature	24.9	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	16.5	mS/m	[1]TC Temperature	24.9	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	107	mg/l	[2]TDS by EC * 7	116	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	158	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	113	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	27.1	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	12.6	mg/l	[2]Fe	<0.05	mg/l	[2]K	1.43	mg/l
[2]Mg	11.5	mg/l	[2]Mn	<0.05	mg/l	[2]Na	3.88	mg/l
[2]P	<0.05	mg/l	[2]S	2.48	mg/l	[2]Si	14.8	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	0.392	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.125	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	0.01	ppm	[2]Co	0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.085	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	1.72	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	0.061	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.097	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.103	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	6.15	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	54.6	mg/l	[1]NO3 as N	12.3	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	7.66	mg/l						

Request ID: 8404 **Sample ID:** 359574 **Received:** 2013-09-23 **Matrix:** Water **Page:** 2 / 8
Sample Number: KEN30-F1 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	7.47		[1]pH Temperature	25.1	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	14.8	mS/m	[1]TC Temperature	25	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	96.2	mg/l	[2]TDS by EC * 7	104	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	50	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	64.6	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	48.8	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	8.9	mg/l	[2]Fe	0.22	mg/l	[2]K	3.42	mg/l
[2]Mg	9.81	mg/l	[2]Mn	<0.05	mg/l	[2]Na	8.29	mg/l
[2]P	<0.05	mg/l	[2]S	0.95	mg/l	[2]Si	7.85	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	0.434	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.163	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.028	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	2.95	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	0.012	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	0.011	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.086	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.07	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	0.199	mg/l	[1]Cl	16.6	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	6.79	mg/l	[1]NO3 as N	1.53	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	2.69	mg/l						

Request ID: 8404 **Sample ID:** 359575 **Received:** 2013-09-23 **Matrix:** Water **Page:** 3 / 8
Sample Number: KEN30-F6 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	7.9		[1]pH Temperature	25.2	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	25.1	mS/m	[1]TC Temperature	25.2	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	163	mg/l	[2]TDS by EC * 7	176	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	198	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	94.9	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	133	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	29.4	mg/l	[2]Fe	0.05	mg/l	[2]K	2.29	mg/l
[2]Mg	14.8	mg/l	[2]Mn	<0.05	mg/l	[2]Na	9.49	mg/l
[2]P	<0.05	mg/l	[2]S	2.17	mg/l	[2]Si	23.2	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	0.062	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.069	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.026	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	1.8	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.153	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.062	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	2.8	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	6.49	mg/l	[1]NO3 as N	1.47	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	6.38	mg/l						

Request ID: 8404 **Sample ID:** 359576 **Received:** 2013-09-23 **Matrix:** Water **Page:** 4 / 8
Sample Number: KEN30-B6 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.46		[1]pH Temperature	25.3	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	53	mS/m	[1]TC Temperature	25.2	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	345	mg/l	[2]TDS by EC * 7	371	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	452	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	394	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	20	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	41.4	mg/l	[2]Fe	<0.05	mg/l	[2]K	8.81	mg/l
[2]Mg	28.3	mg/l	[2]Mn	0.05	mg/l	[2]Na	29	mg/l
[2]P	<0.05	mg/l	[2]S	72.4	mg/l	[2]Si	12.7	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	<0.01	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.076	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.026	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	7.35	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.513	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm

[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.076	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	11	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	37.1	mg/l	[1]NO3 as N	8.38	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	226	mg/l						

Request ID: 8404 **Sample ID:** 359577 **Received:** 2013-09-23 **Matrix:** Water **Page:** 5 / 8
Sample Number: KEN30-B4 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.99		[1]pH Temperature	25.3	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	21.7	mS/m	[1]TC Temperature	25.3	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	141	mg/l	[2]TDS by EC * 7	152	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	214	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	131	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	56.7	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	16.9	mg/l	[2]Fe	<0.05	mg/l	[2]K	1.26	mg/l
[2]Mg	10.3	mg/l	[2]Mn	<0.05	mg/l	[2]Na	15.7	mg/l
[2]P	<0.05	mg/l	[2]S	6.26	mg/l	[2]Si	23.2	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	<0.01	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.053	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.047	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	0.723	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.173	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.052	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	0.182	mg/l	[1]Cl	6.45	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	38	mg/l	[1]NO3 as N	8.58	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	18.7	mg/l						

Request ID: 8404 **Sample ID:** 359578 **Received:** 2013-09-23 **Matrix:** Water **Page:** 5 / 8
Sample Number: KEN30-B26 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	7.19		[1]pH Temperature	25.5	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	29.8	mS/m	[1]TC Temperature	25.5	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	194	mg/l	[2]TDS by EC * 7	209	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	276	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	163	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	82.7	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	28.7	mg/l	[2]Fe	<0.05	mg/l	[2]K	3.37	mg/l
[2]Mg	14.8	mg/l	[2]Mn	<0.05	mg/l	[2]Na	13.7	mg/l
[2]P	<0.05	mg/l	[2]S	3.19	mg/l	[2]Si	31.6	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	<0.01	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.106	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.028	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	2.77	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.175	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.051	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	25.4	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	35.8	mg/l	[1]NO3 as N	8.09	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	9.5	mg/l						

Request ID: 8404 **Sample ID:** 359579 **Received:** 2013-09-23 **Matrix:** Water **Page:** 6 / 8
Sample Number: KEN30-B47 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.93		[1]pH Temperature	20.4	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	19.2	mS/m	[1]TC Temperature	20.3	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	125	mg/l	[2]TDS by EC * 7	134	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	136	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	77.4	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	89.8	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit

[2]Ca	20.9	mg/l	[2]Fe	<0.05	mg/l	[2]K	3.27	mg/l
[2]Mg	9.31	mg/l	[2]Mn	<0.05	mg/l	[2]Na	9.79	mg/l
[2]P	<0.05	mg/l	[2]S	2.89	mg/l	[2]Si	18	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	<0.01	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.334	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.03	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	2.67	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.174	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	0.069	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	0.152	mg/l	[1]Cl	5.02	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	2.38	mg/l	[1]NO3 as N	0.54	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	8.59	mg/l						

Request ID: 8404 **Sample ID:** 359580 **Received:** 2013-09-23 **Matrix:** Water **Page:** 7 / 8
Sample Number: KEN30-B53 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.71		[1]pH Temperature	20.3	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	16	mS/m	[1]TC Temperature	20.2	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	104	mg/l	[2]TDS by EC * 7	112	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	106	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	58.7	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	67.6	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	13.3	mg/l	[2]Fe	<0.05	mg/l	[2]K	4.56	mg/l
[2]Mg	6.67	mg/l	[2]Mn	0.14	mg/l	[2]Na	10.7	mg/l
[2]P	<0.05	mg/l	[2]S	1.03	mg/l	[2]Si	7.7	mg/l
[2]Ti	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	0.069	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	0.01	ppm	[2]Ba	0.608	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.049	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]K	3.83	ppm	[2]La	<0.01	ppm	[2]Li	<0.01	ppm
[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm
[2]Nd	<0.01	ppm	[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm	[2]Sc	<0.01	ppm
[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm	[2]Sn	<0.01	ppm
[2]Sr	0.233	ppm	[2]Ta	<0.01	ppm	[2]Tb	<0.01	ppm
[2]Te	<0.01	ppm	[2]Th	<0.01	ppm	[2]Tl	<0.01	ppm
[2]Tm	<0.01	ppm	[2]U	<0.01	ppm	[2]V	<0.01	ppm
[2]W	<0.01	ppm	[2]Y	<0.01	ppm	[2]Yb	<0.01	ppm
[2]Zn	3.54	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	0.277	mg/l	[1]Cl	12.3	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	<0.3	mg/l	[2]PO4	<0.8	mg/l	[1]SO4	3.17	mg/l

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FINAL CERTIFICATE OF ANALYSIS

Report Date	2013-10-10
Date Required	2013-10-06
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Order/Ref No	13615285

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Request ID: 8422 **Sample ID:** 359818 **Received:** 2013-09-26 **Matrix:** Water
Sample Number: KEN30-B69/25/9/13/15:10 **Revision Number:** 1

Method: [1]UIS-EA-T001(pH) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	7.77		[1]pH Temperature	20.1	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	23.6	mS/m	[1]TC Temperature	20	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	153	mg/l	[2]TDS by EC * 7	165	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2013-10-10

Parameter	Value	Unit
[1]Total Dissolved Solids	176	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2013-10-10

Parameter	Value	Unit
[2]TDS by Summation	92.5	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	115	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ca	26.4	mg/l	[2]Fe	<0.05	mg/l	[2]K	1.84	mg/l
[2]Mg	8.49	mg/l	[2]Mn	0.13	mg/l	[2]Na	16.4	mg/l
[2]P	<0.05	mg/l	[2]Si	16.7	mg/l	[2]Ti	<0.05	mg/l
[2]Zn	<0.05	mg/l						

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]Al	<0.01	ppm	[2]As	<0.01	ppm
[2]Au	<0.01	ppm	[2]B	<0.01	ppm	[2]Ba	0.112	ppm
[2]Be	<0.01	ppm	[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm
[2]Ce	<0.01	ppm	[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm
[2]Cs	<0.01	ppm	[2]Cu	0.024	ppm	[2]Dy	<0.01	ppm
[2]Er	<0.01	ppm	[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm
[2]Gd	<0.01	ppm	[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm
[2]Hg	<0.01	ppm	[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm
[2]La	<0.01	ppm	[2]Li	<0.01	ppm	[2]Lu	<0.01	ppm
[2]Mo	<0.01	ppm	[2]Nb	<0.01	ppm	[2]Nd	<0.01	ppm

[2]Ni	<0.01	ppm	[2]Os	<0.01	ppm	[2]Pb	<0.01	ppm
[2]Pd	<0.01	ppm	[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm
[2]Rb	<0.01	ppm	[2]Re	<0.01	ppm	[2]Sb	<0.01	ppm
[2]Sc	<0.01	ppm	[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm
[2]Sn	<0.01	ppm	[2]Sr	0.065	ppm	[2]Ta	<0.01	ppm
[2]Tb	<0.01	ppm	[2]Te	<0.01	ppm	[2]Th	<0.01	ppm
[2]Tl	<0.01	ppm	[2]Tm	<0.01	ppm	[2]U	<0.01	ppm
[2]V	<0.01	ppm	[2]W	<0.01	ppm	[2]Y	<0.01	ppm
[2]Yb	<0.01	ppm	[2]Zn	0.057	ppm	[2]Zr	<0.01	ppm

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2013-10-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	0.578	mg/l	[1]Cl	3.74	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	0.878	mg/l	[1]NO3 as N	<0.3	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	17.5	mg/l						

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FINAL CERTIFICATE OF ANALYSIS

Report Date	2014-03-11
Date Required	2014-02-21
Contract No	
Order/Ref No	13615285

sanas Testing Laboratory T0184

KENDAL 30 SITE H

Notes
The results relate specifically to the items tested.
The report shall not be reproduced except in full, without the written approval of the laboratory.
[1] SANAS accredited analysis included in the SANAS Schedule of Accreditation for this laboratory.
[2] Not SANAS accredited analysis and not included in the SANAS schedule of accreditation for this laboratory.
[3] Outsourced not performed by this laboratory.

Request ID: 9125 **Sample ID:** 374377 **Received:** 2014-02-11 **Matrix:** Water
Sample Number: KEN30-B25/11/2/14/09h00 **Revision Number:** 0

Method: [1]UIS-EA-T001(pH) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	5.33		[1]pH Temperature	22.5	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	28.7	mS/m	[1]TC Temperature	25	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	187	mg/l	[2]TDS by EC * 7	201	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2014-03-10

Parameter	Value	Unit
[1]Total Dissolved Solids	238	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2014-03-10

Parameter	Value	Unit
[2]TDS by Summation	192	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	3.7	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.05	mg/l	[2]Al	<0.05	mg/l	[2]As	<0.1	mg/l
[2]B	<0.05	mg/l	[2]Ba	0.54	mg/l	[2]Be	<0.05	mg/l
[2]Bi	0.15	mg/l	[2]Ca	12.6	mg/l	[2]Cd	<0.05	mg/l
[2]Co	<0.05	mg/l	[2]Cr	<0.05	mg/l	[2]Cu	<0.05	mg/l
[2]Fe	<0.05	mg/l	[2]K	5.4	mg/l	[2]Li	<0.05	mg/l
[2]Mg	13.1	mg/l	[2]Mn	0.08	mg/l	[2]Mo	<0.05	mg/l
[2]Na	16.9	mg/l	[2]Ni	<0.05	mg/l	[2]P	<0.05	mg/l
[2]Pb	<0.05	mg/l	[2]S	3.35	mg/l	[2]Sb	<0.1	mg/l
[2]Se	<0.1	mg/l	[2]Si	6.65	mg/l	[2]Sn	<0.05	mg/l
[2]Sr	0.2	mg/l	[2]Ti	<0.05	mg/l	[2]Tl	<0.05	mg/l
[2]V	<0.05	mg/l	[2]Zn	0.12	mg/l			

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]As	<0.01	ppm	[2]Au	<0.01	ppm
[2]B	0.039	ppm	[2]Ba	0.568	ppm	[2]Be	<0.01	ppm
[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm	[2]Ce	<0.01	ppm

[2]Co	0.011	ppm	[2]Cr	<0.01	ppm	[2]Cs	<0.01	ppm
[2]Cu	0.045	ppm	[2]Dy	<0.01	ppm	[2]Er	<0.01	ppm
[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm	[2]Gd	<0.01	ppm
[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm	[2]Hg	<0.01	ppm
[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm	[2]La	<0.01	ppm
[2]Li	0.015	ppm	[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm
[2]Nb	<0.01	ppm	[2]Nd	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	0.017	ppm
[2]Re	<0.01	ppm	[2]S	<0.01	ppm	[2]Sb	<0.01	ppm
[2]Sc	<0.01	ppm	[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm
[2]Sn	<0.01	ppm	[2]Sr	0.277	ppm	[2]Ta	<0.01	ppm
[2]Tb	<0.01	ppm	[2]Te	<0.01	ppm	[2]Th	<0.01	ppm
[2]Ti	0.011	ppm	[2]Tl	<0.01	ppm	[2]Tm	<0.01	ppm
[2]U	<0.01	ppm	[2]W	<0.01	ppm	[2]Y	<0.01	ppm
[2]Yb	<0.01	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	30.4	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	94.2	mg/l	[1]NO3 as N	21.3	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	10.2	mg/l						

Method: [2]UIS-CP-T002(Ion Balance Error) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Sum of Cations	2.61	me/l	[2]Sum of Anions	3.13	me/l	[2]Ion Balance Error	-9.06	%

Request ID: 9125 **Sample ID:** 374378 **Received:** 2014-02-11 **Matrix:** Water **Page:** 2 / 4
Sample Number: KEN30-B24/11/2/14/09h20 **Revision Number:** 0

Method: [1]UIS-EA-T001(pH) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	7.86		[1]pH Temperature	22.4	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	20.1	mS/m	[1]TC Temperature	25	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	131	mg/l	[2]TDS by EC * 7	141	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2014-03-10

Parameter	Value	Unit
[1]Total Dissolved Solids	162	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2014-03-10

Parameter	Value	Unit
[2]TDS by Summation	147	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	94.7	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.05	mg/l	[2]Al	<0.05	mg/l	[2]As	<0.1	mg/l
[2]B	<0.05	mg/l	[2]Ba	0.25	mg/l	[2]Be	<0.05	mg/l
[2]Bi	0.16	mg/l	[2]Ca	18.5	mg/l	[2]Cd	<0.05	mg/l
[2]Co	<0.05	mg/l	[2]Cr	<0.05	mg/l	[2]Cu	<0.05	mg/l
[2]Fe	<0.05	mg/l	[2]K	1.82	mg/l	[2]Li	<0.05	mg/l
[2]Mg	14.6	mg/l	[2]Mn	<0.05	mg/l	[2]Mo	<0.05	mg/l
[2]Na	4.46	mg/l	[2]Ni	<0.05	mg/l	[2]P	<0.05	mg/l
[2]Pb	<0.05	mg/l	[2]S	0.65	mg/l	[2]Sb	<0.1	mg/l
[2]Se	<0.1	mg/l	[2]Si	16.4	mg/l	[2]Sn	<0.05	mg/l
[2]Sr	<0.05	mg/l	[2]Ti	<0.05	mg/l	[2]Tl	0.06	mg/l
[2]V	<0.05	mg/l	[2]Zn	0.06	mg/l			

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]As	<0.01	ppm	[2]Au	<0.01	ppm
[2]B	0.029	ppm	[2]Ba	0.303	ppm	[2]Be	<0.01	ppm
[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm	[2]Ce	<0.01	ppm
[2]Co	<0.01	ppm	[2]Cr	0.014	ppm	[2]Cs	<0.01	ppm
[2]Cu	<0.01	ppm	[2]Dy	<0.01	ppm	[2]Er	<0.01	ppm
[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm	[2]Gd	<0.01	ppm
[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm	[2]Hg	<0.01	ppm
[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm	[2]La	<0.01	ppm
[2]Li	<0.01	ppm	[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm
[2]Nb	<0.01	ppm	[2]Nd	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]S	<0.01	ppm	[2]Sb	<0.01	ppm
[2]Sc	<0.01	ppm	[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm
[2]Sn	<0.01	ppm	[2]Sr	0.093	ppm	[2]Ta	<0.01	ppm
[2]Tb	<0.01	ppm	[2]Te	<0.01	ppm	[2]Th	<0.01	ppm
[2]Ti	0.012	ppm	[2]Tl	<0.01	ppm	[2]Tm	<0.01	ppm
[2]U	<0.01	ppm	[2]W	<0.01	ppm	[2]Y	<0.01	ppm
[2]Yb	<0.01	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	1.54	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	20.5	mg/l	[1]NO3 as N	4.62	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	2.31	mg/l						

Method: [2]UIS-CP-T002(Ion Balance Error) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Sum of Cations	2.88	me/l	[2]Sum of Anions	3.17	me/l	[2]Ion Balance Error	-4.83	%

Request ID: 9125 **Sample ID:** 374379 **Received:** 2014-02-11 **Matrix:** Water **Page:** 3 / 4
Sample Number: KEN30-F12/11/2/14/09h50 **Revision Number:** 0

Method: [1]UIS-EA-T001(pH) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]pH	6.17		[1]pH Temperature	22.5	Deg C

Method: [1]UIS-EA-T001(Electrical Conductivity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]Total Conductivity	22.2	mS/m	[1]TC Temperature	25	Deg C

Method: [2]UIS-CP-T001(Calculated Total Dissolved Solids from EC) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[2]TDS by EC * 6.5	144	mg/l	[2]TDS by EC * 7	155	mg/l

Method: [1]UIS-EA-T005(Total Dissolved Solids) **Completed:** 2014-03-10

Parameter	Value	Unit
[1]Total Dissolved Solids	206	mg/l

Method: [2]UIS-CP-T003(Calculated Total Dissolved Solids by Summation) **Completed:** 2014-03-10

Parameter	Value	Unit
[2]TDS by Summation	158	mg/l

Method: [1]UIS-EA-T001(P and Total (M) Alkalinity) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit
[1]P Alkalinity	<0.6	mg/l CaCO3	[1]Total (M) Alkalinity	12.9	mg/l CaCO3

Method: [2]UIS-TEA-T001(Disolved Cations in Water by ICP-OES) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.05	mg/l	[2]Al	<0.05	mg/l	[2]As	<0.1	mg/l
[2]B	<0.05	mg/l	[2]Ba	0.27	mg/l	[2]Be	<0.05	mg/l
[2]Bi	0.11	mg/l	[2]Ca	16.3	mg/l	[2]Cd	<0.05	mg/l
[2]Co	<0.05	mg/l	[2]Cr	<0.05	mg/l	[2]Cu	<0.05	mg/l
[2]Fe	0.05	mg/l	[2]K	3.47	mg/l	[2]Li	<0.05	mg/l
[2]Mg	7.38	mg/l	[2]Mn	0.05	mg/l	[2]Mo	<0.05	mg/l
[2]Na	13.9	mg/l	[2]Ni	<0.05	mg/l	[2]P	<0.05	mg/l
[2]Pb	<0.05	mg/l	[2]S	8.26	mg/l	[2]Sb	<0.1	mg/l
[2]Se	<0.1	mg/l	[2]Si	9.78	mg/l	[2]Sn	<0.05	mg/l
[2]Sr	0.13	mg/l	[2]Ti	<0.05	mg/l	[2]Tl	<0.05	mg/l
[2]V	<0.05	mg/l	[2]Zn	0.05	mg/l			

Method: [2]UIS-AC-T103(ICP-MS Scan) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Ag	<0.01	ppm	[2]As	<0.01	ppm	[2]Au	<0.01	ppm
[2]B	0.041	ppm	[2]Ba	0.304	ppm	[2]Be	<0.01	ppm
[2]Bi	<0.01	ppm	[2]Cd	<0.01	ppm	[2]Ce	<0.01	ppm
[2]Co	<0.01	ppm	[2]Cr	<0.01	ppm	[2]Cs	<0.01	ppm
[2]Cu	<0.01	ppm	[2]Dy	<0.01	ppm	[2]Er	<0.01	ppm
[2]Eu	<0.01	ppm	[2]Ga	<0.01	ppm	[2]Gd	<0.01	ppm
[2]Ge	<0.01	ppm	[2]Hf	<0.01	ppm	[2]Hg	<0.01	ppm
[2]Ho	<0.01	ppm	[2]Ir	<0.01	ppm	[2]La	<0.01	ppm
[2]Li	<0.01	ppm	[2]Lu	<0.01	ppm	[2]Mo	<0.01	ppm
[2]Nb	<0.01	ppm	[2]Nd	<0.01	ppm	[2]Os	<0.01	ppm
[2]P	<0.8	ppm	[2]Pb	<0.01	ppm	[2]Pd	<0.01	ppm
[2]Pr	<0.01	ppm	[2]Pt	<0.01	ppm	[2]Rb	<0.01	ppm
[2]Re	<0.01	ppm	[2]S	<0.01	ppm	[2]Sb	<0.01	ppm
[2]Sc	<0.01	ppm	[2]Se	<0.01	ppm	[2]Sm	<0.01	ppm
[2]Sn	<0.01	ppm	[2]Sr	0.154	ppm	[2]Ta	<0.01	ppm
[2]Tb	<0.01	ppm	[2]Te	<0.01	ppm	[2]Th	<0.01	ppm
[2]Ti	0.015	ppm	[2]Tl	<0.01	ppm	[2]Tm	<0.01	ppm
[2]U	<0.01	ppm	[2]W	<0.01	ppm	[2]Y	<0.01	ppm
[2]Yb	<0.01	ppm	[2]Zr	<0.01	ppm			

Method: [2]UIS-EA-T008(Anions by Ion Chromatography) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[1]F	<0.1	mg/l	[1]Cl	14.3	mg/l	[1]NO2	<0.2	mg/l
[1]NO3	60.2	mg/l	[1]NO3 as N	13.6	mg/l	[2]PO4	<0.8	mg/l
[1]SO4	24.4	mg/l						

Method: [2]UIS-CP-T002(Ion Balance Error) **Completed:** 2014-03-10

Parameter	Value	Unit	Parameter	Value	Unit	Parameter	Value	Unit
[2]Sum of Cations	2.13	me/l	[2]Sum of Anions	2.79	me/l	[2]Ion Balance Error	-13.5	%

Ferdie van Niekerk
AUTHORISED SIGNATORY

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T0391

CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2016 - 04 - 14 **Date completed:** 2016 - 04 – 22

Project number: 159 **Report number: 58779** **Order number: 9460**

Client name: Golder Associates **Contact person: Mr. D. Brink**

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Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification: Kendal**			
		DS1	**DS2**	**DS4**	**DS5**
Sample Number		4170	4171	4172	4173
pH – Value at 25°C	WLAB001	6.9	6.9	6.8	6.6
Electrical Conductivity in mS/m at 25°C	WLAB002	22.5	8.3	13.9	15.9
Total Dissolved Solids at 180°C *	WLAB003	196	58	95	110
Total Alkalinity as $CaCO_3$	WLAB007	28	12	20	20
Chloride as Cl	WLAB046	16	5	8	5
Sulphate as SO_4	WLAB046	37	7	7	7
Fluoride as F	WLAB014	<0.2	<0.2	<0.2	<0.2
Nitrate as N	WLAB046	7.2	4.0	8.9	12
ICP-MS Scan *	WLAB050	See Attached Report: 58779-A			
% Balancing*	---	99.9	91.2	94.7	96.8

*** = Not SANAS Accredited**
Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory.

A. van de Wetering

Technical Signatory

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WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSIS

Project Number : **159**
Client : **Golder Assosiates**
Report Number : **58779-A**

Sample Origin	Sample ID	Ag (mg/L)	Al (mg/L)	As (mg/L)	Au (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Bi (mg/L)	Ca (mg/L)	Cd (mg/L)	Ce (mg/L)	Co (mg/L)
DS1	4170	<0.010	7.79	<0.010	<0.010	<0.010	0.128	<0.010	<0.010	12	<0.010	0.071	0.015
DS2	4171	<0.010	8.17	<0.010	<0.010	0.016	0.238	<0.010	<0.010	6	<0.010	0.107	0.014
DS4	4172	<0.010	3.58	<0.010	<0.010	0.010	0.200	<0.010	<0.010	7	<0.010	0.028	<0.010
DS5	4173	<0.010	7.00	<0.010	<0.010	0.017	0.189	<0.010	<0.010	16	<0.010	0.064	0.013

Sample Origin	Sample ID	Cr (mg/L)	Cs (mg/L)	Cu (mg/L)	Dy (mg/L)	Er (mg/L)	Eu (mg/L)	Fe (mg/L)	Ga (mg/L)	Gd (mg/L)	Ge (mg/L)	Hf (mg/L)	Hg (mg/L)
DS1	4170	<0.010	<0.010	0.026	0.011	<0.010	<0.010	4.77	0.033	0.014	<0.010	<0.010	<0.010
DS2	4171	0.010	<0.010	0.016	0.010	<0.010	<0.010	5.85	0.062	0.017	<0.010	<0.010	<0.010
DS4	4172	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	4.21	0.052	<0.010	<0.010	<0.010	<0.010
DS5	4173	0.014	<0.010	0.031	0.013	<0.010	<0.010	5.87	0.047	0.015	<0.010	<0.010	<0.010

Sample Origin	Sample ID	Ho (mg/L)	In (mg/L)	Ir (mg/L)	K (mg/L)	La (mg/L)	Li (mg/L)	Lu (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	Na (mg/L)	Nb (mg/L)
DS1	4170	<0.010	<0.010	<0.010	4.6	0.043	<0.010	<0.010	7	0.335	<0.010	23	<0.010
DS2	4171	<0.010	<0.010	<0.010	4.6	0.073	0.011	<0.010	3	0.695	<0.010	7	<0.010
DS4	4172	<0.010	<0.010	<0.010	7.5	0.017	<0.010	<0.010	3	0.446	<0.010	11	<0.010
DS5	4173	<0.010	<0.010	<0.010	5.1	0.026	0.013	<0.010	5	0.460	<0.010	7	<0.010

Sample Origin	Sample ID

WATERLAB (PTY) LTD

CERTIFICATE OF ANALYSIS

Project Number : **159**
Client : **Golder Assosiates**
Report Number : **58779-A**

		Nd (mg/L)	Ni (mg/L)	Os (mg/L)	P (mg/L)	Pb (mg/L)	Pd (mg/L)	Pr (mg/L)	Pt (mg/L)	Rb (mg/L)	Rh (mg/L)	Ru (mg/L)	S (mg/L)
DS1	4170	0.045	0.101	<0.010	0.119	0.020	<0.010	0.015	<0.010	0.011	<0.010	<0.010	15
DS2	4171	0.095	0.051	<0.010	0.092	0.025	<0.010	0.027	<0.010	0.020	<0.010	<0.010	2.54
DS4	4172	<0.010	0.030	<0.010	0.034	0.087	<0.010	<0.010	<0.010	0.015	<0.010	<0.010	2.81
DS5	4173	0.036	0.053	<0.010	0.165	0.020	<0.010	0.011	<0.010	0.010	<0.010	<0.010	2.60

Sample Origin	Sample ID	Sb (mg/L)	Sc (mg/L)	Se (mg/L)	Si (mg/L)	Sm (mg/L)	Sn (mg/L)	Sr (mg/L)	Ta (mg/L)	Tb (mg/L)	Te (mg/L)	Th (mg/L)	Ti (mg/L)
DS1	4170	<0.010	<0.010	0.017	24	0.014	<0.010	0.086	<0.010	<0.010	<0.010	<0.010	0.038
DS2	4171	<0.010	<0.010	0.068	25	0.021	<0.010	0.040	<0.010	<0.010	<0.010	<0.010	0.071
DS4	4172	<0.010	<0.010	0.030	26	0.004	<0.010	0.057	<0.010	<0.010	<0.010	<0.010	0.018
DS5	4173	<0.010	<0.010	0.045	26	0.015	<0.010	0.080	<0.010	<0.010	<0.010	<0.010	0.045

Sample Origin	Sample ID	Tl (mg/L)	Tm (mg/L)	U (mg/L)	V (mg/L)	W (mg/L)	Y (mg/L)	Yb (mg/L)	Zn (mg/L)	Zr (mg/L)
DS1	4170	<0.010	<0.010	<0.010	0.018	<0.010	0.053	<0.010	0.070	<0.010
DS2	4171	<0.010	<0.010	<0.010	0.025	<0.010	0.045	<0.010	0.094	<0.010
DS4	4172	<0.010	<0.010	<0.010	<0.010	<0.010	0.013	<0.010	0.078	<0.010
DS5	4173	<0.010	<0.010	<0.010	0.015	<0.010	0.061	<0.010	0.155	<0.010

APPENDIX C

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