DIGBY WELLS
ENVIRONMENTAL

Mutsho Power Project

Groundwater Scoping Report

Project Number:
SAV4689

Prepared for:
Savannah Environmental (Pty) Ltd

August 2017

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This document has been prepared by Digby Wells Environmental.

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Name	Responsibility	Signature	Date
Francis Kom	Reporting		August 2017
Andre van Coller	1st Review		August 2017
Graham Trusler	2nd Review		August 2017

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1 INTRODUCTION

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Savannah Environmental (Pty) Ltd (Savannah) to undertake a groundwater assessment for the proposed Mutsho Power Project near Makhado, in Limpopo Province.

The objective of this report is to provide current baseline groundwater conditions as a reference point against which potential power station impacts can be identified and compared for the EIA phase and in future. This report also details work that needs to be completed for the next phase of the project.

1.1 Project Description and Local Setting

The proposed project area is situated in the magisterial district of Vhembe, in the Limpopo Province, approximately 40 km north of the town Makhado and 7 km south of Mopane Town. The regional and local setting maps are shown on Figure 1-1 and Figure 1-2.

Once developed, the proposed plant would form part of the Department of Energy's (DoE's) Coal Baseload Independent Power Producer (IPP) Procurement Programme (CBIPPPP).

Due to lack of a detailed project description at this stage, it is assumed that the facility will comprise either a conventional Pulverised Coal (PC) (with Flue Gas Desulphurisation (FGD)), or Circulating Fluidised Bed (CFB) coal-fired power plant. The proposed project will have a generation capacity of up to 600MW.

The type of infrastructure required for the coal-fired power plant would ultimately be dependent on the type of technology selected for implementation. For the purposes of this report, it is assumed that a coal-fired power plant would typically consist of the following key components and associated infrastructure:

- Power generation units:
- Pulverised Coal (PC) with Flue Gas Desulphurisation (FGD); or Circulating Fluidised Bed (CFB).
- Coal crusher (for CFB) / coal crusher and screening plant (for PC).
- Coal stockpile.
- Limestone storage area (for use with CFB technology).
- Ash dump (dry ashing has been assumed for the plant in order to reduce the project's water requirements, which is in alignment with the recommendations of the National Development Plan (NDP) and Integrated Energy Plan (IEP)).
- Water infrastructure. This could include:
  - Water supply pipeline(s).
  - Bulk water storage dam.
  - Pollution control dams.

  - Water / Wastewater treatment plant (WWTP).
- Substation.
- Power lines.
- Office and administration buildings.
- Access roads.

A footprint of approximately 600 ha would be required for the power station and associated infrastructure. The type of technology selected for implementation would ultimately have influence on the project layout and development footprint (i.e. the area of land required for development). While the power generation components require limited space, supporting areas for the establishment of coal and other raw material stockpiles, and an ash dump increase the development footprint. The outcomes of the Site Screening Assessment are therefore expected to be applicable to the siting of a new CFB or PC (with FGD) power plant. The optimisation of the layout during the project design phase therefore presents the opportunity for impacts associated with the project on the receiving environment and sensitive receptors to be reduced.

Therefore, this will serve as preliminary groundwater scoping report and a detailed impact assessment will be conducted once the type of technology and infrastructure layout has been finalised.

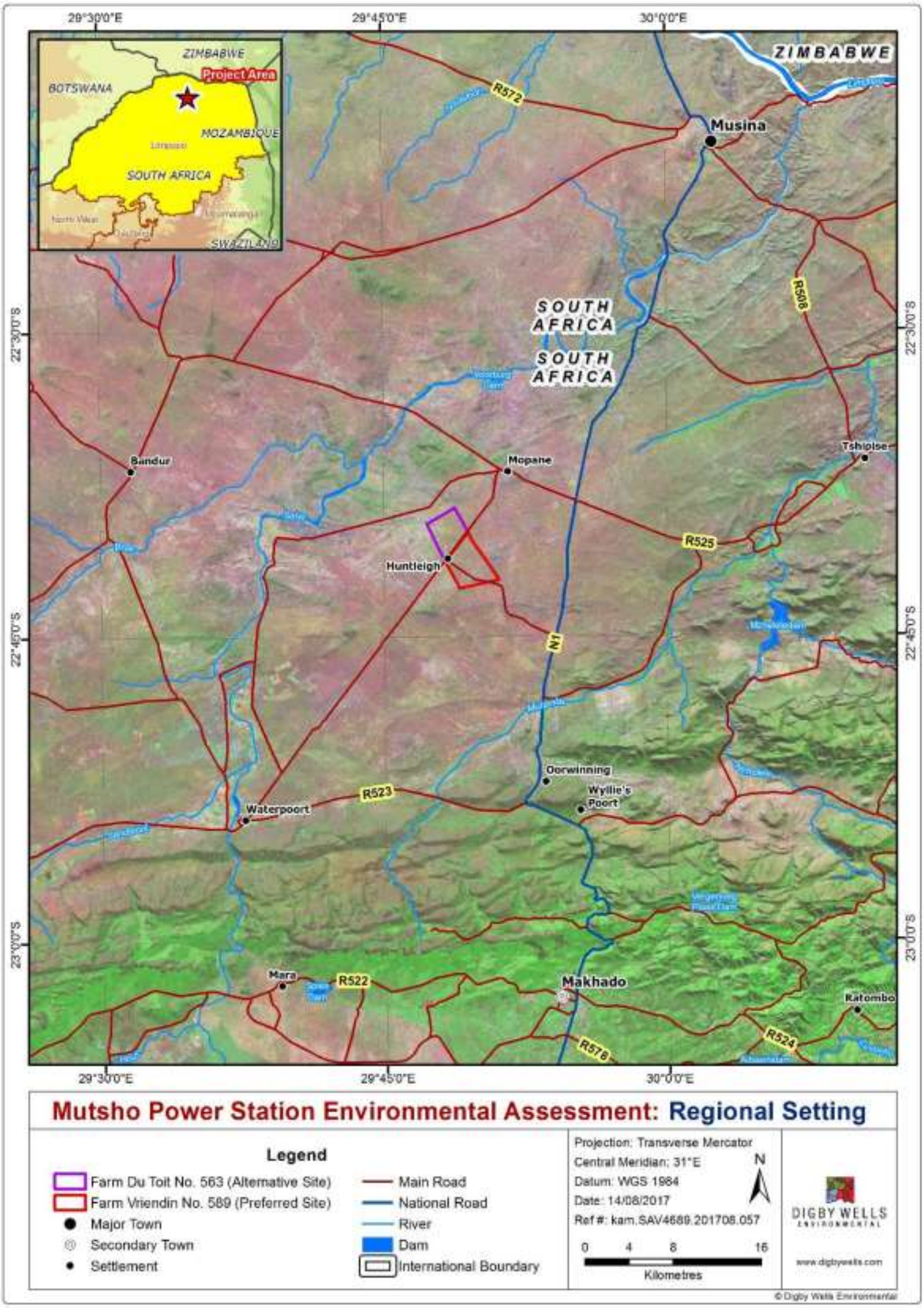

Figure 1-1: Regional Setting

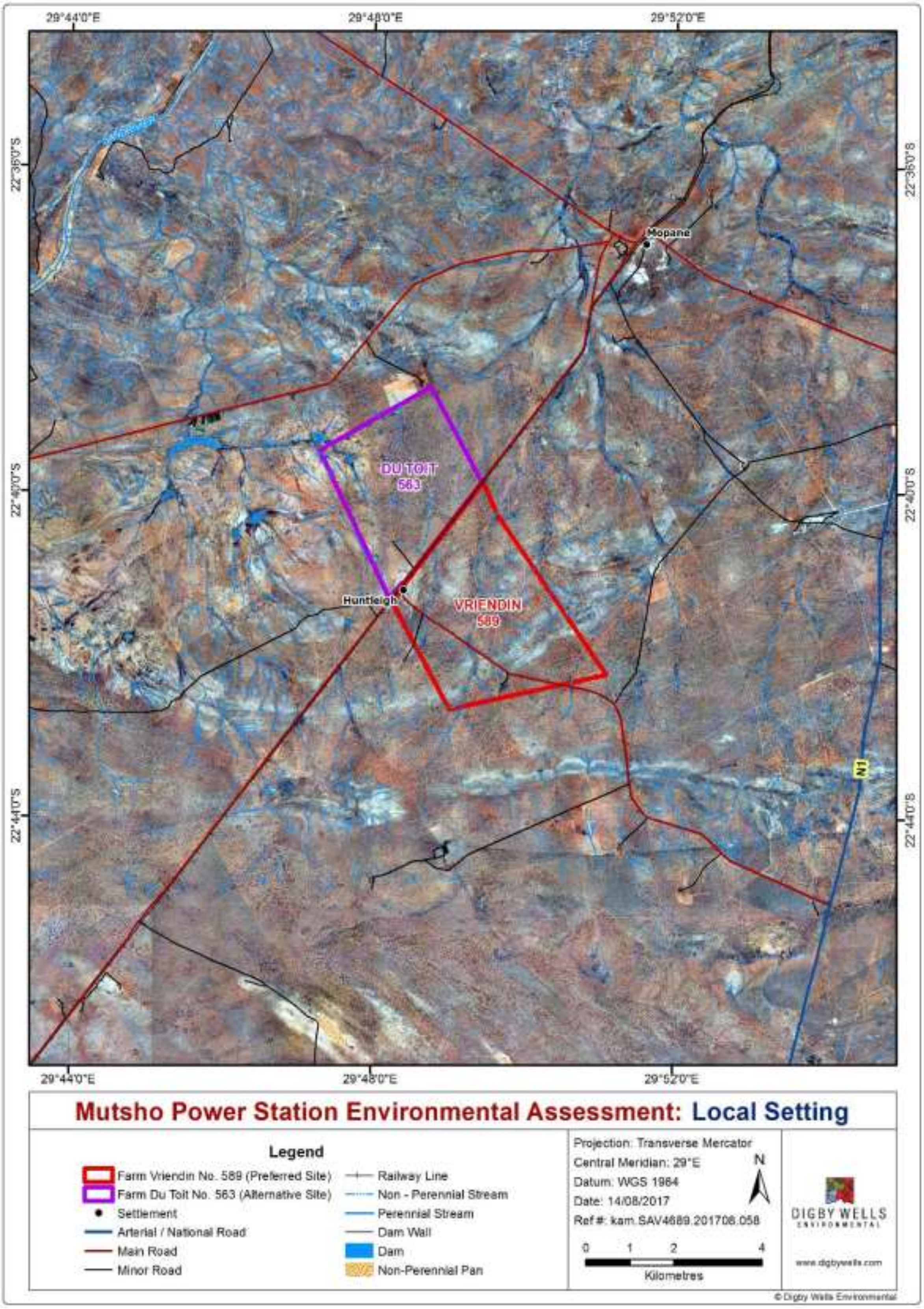

Figure 1-2: Local Setting

2 BASELINE ENVIRONMENT

2.1 Topography and Drainage

The project area is located in the A71K quaternary catchment of the Limpopo water management area (WMA) as revised in the 2012 water management area boundary descriptions (government gazette No. 35517); this is shown in Figure 2-2. The A71K quaternary catchment has a net area of 1668 km^2 which receives an average 305 mm of rainfall per annum with an average potential evaporation rate of 2000 mm per annum. The natural inflow and outflow from rainfall and evaporation mentioned above leads to a negative water balance for open water storage facilities.

The Sand River is the only major river within this quaternary catchment (approximately 8 km from the project area), it consists of several tributaries on both sides of the river and the Sands River flows into the Limpopo River which is 50 km away from the project area. Few drainage lines exist within the demarcated project area.

2.2 Climate

The project area is situated in a semi-arid zone to the north of the Soutpansberg. The regional climate is strongly influenced by the east-west orientated mountain range which represents an effective barrier between the south-easterly maritime climate influences from the Indian Ocean and the continental climate influences (predominantly the Inter-Tropical Convergence Zone and the Congo Air Mass) coming from the north.

The mountains give rise to wind patterns that play an important role in determining local climates. These wind effects include wind erosion, aridification and air warming (WSM LESHIKA, 2013)

This monthly climatic data conditions of the rainfall and evaporation zones in which the project area is located is provided below.

2.2.1.1 Rainfall

Table 2-1 present the average monthly rainfall for the quaternary catchments B31B and A71K. This is based on the averages of monthly rainfall data for the period 1920 to 2009.

Table 2-1: Summary of rainfall data extracted from the WR2012

Month	MAP (mm)
January	62.6
February	50.8
March	37.4
April	15.1

Month	MAP (mm)
May	5.7
June	3.9
July	1.8
August	0.9
September	7.8
October	21.4
November	45.8
December	52.0
MAP	**305**

From the rainfall data above, higher rainfall (52 mm, 62.6 mm and 50.8 mm) were recorded for the months of December, January and February respectively whilst the minimum or lowest rainfall was recorded in August. In general, this area receives a MAP of 305 mm.

2.2.1.2 Evaporation

Monthly evaporation data was obtained from the WR2012 manual. The evaporation data is based on Symons Pan evaporation measurements and needs to be converted to lake evaporation. This is due to the Symons Pan being located below the ground surface and painted black which results in the temperature in the water being higher than that of a natural open water body. The Symons Pan figure is then multiplied by a lake evaporation factor to obtain the adopted lake evaporation figure which presents the monthly evaporation rates of a natural open water body, this was calculated to be a MAP of 1681 mm per annum. Table 2-2 is a summary of the average monthly evaporation for the A71K quaternary catchment.

Table 2-2: Summary of evaporation data

Months	Lake Evaporation Factor	Lake Evaporation (mm)
January	0.84	175.2
February	0.9	149.4
March	0.9	149.4
April	0.9	122.1
May	0.9	114.0

Months	Lake Evaporation Factor	Lake Evaporation (mm)
June	0.9	91.8
July	0.8	100.9
August	0.8	120.2
September	0.8	146.3
October	0.8	169.5
November	0.82	164.5
December	0.83	177.3
Total	**N/A**	**1681**

Higher evaporation rates are experienced throughout the year with the highest being 177 mm during December.

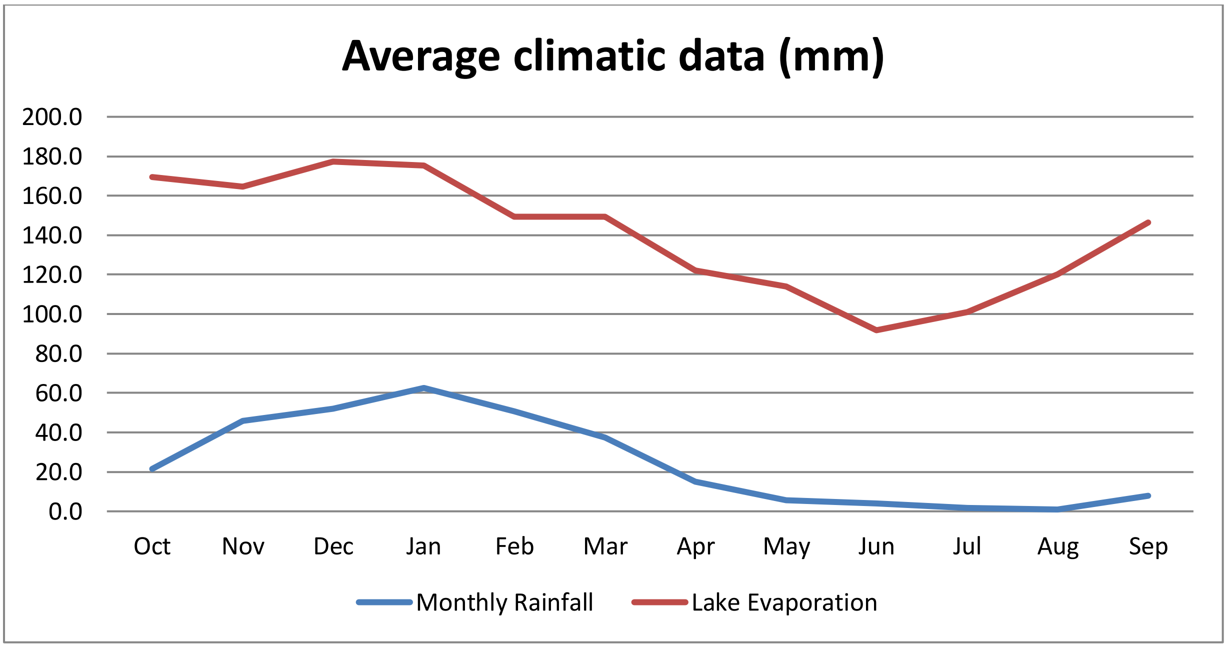

Figure 2-1: Summary of the average monthly climatic data for A71K quaternary catchment

Information reported in the regional geology and hydrogeology sections are sourced from:

- WSM LESHIKA CONSULTING (PTY) LTD, (December 2013). Groundwater Flow Impact Assessment Report For Generaal Coal Project.

2.3 Regional Geology

The regional geology is shown in Figure 2-3 and consists of 3 main lithological groups i.e. the Limpopo Mobile Belt, the Soutpansberg Group and the Karoo Sequence rocks:

- The Limpopo Mobile Belt (LMB); forms the gneissic basement on which the overlying strata (Soutpansberg Group and the Karoo Sequence) was deposited. The LMB rocks are the metamorphic expression of the collision and welding together of the Kaapvaal craton and the Zimbabwe craton. The LMB has a long and complex history of deformation occurring from 3200 Ma (million years ago) to 2000 Ma. The LMB gneisses are made up of inter-cratonic sediments and volcanics, deformed and metamorphosed to granulite facies and intruded by granite bodies which have themselves been metamorphosed to varying degrees. The rift fault systems controlling the various basins, in which the Soutpansberg and Karoo strata have been preserved, are major zones of crustal weakness preferentially re-activated during periods of tectonic instability over time.
- The Soutpansberg Group strata were deposited into rift basins controlled by these major fault systems between 1900 Ma and 1600 Ma. The strata consist of basaltic lavas, arenites and shales attaining a maximum preserved thickness of 5000 m. Dips can vary from 20° to 80° to the north.
- The Karoo Sequence strata were deposited on LMB basement and/or Soutpansberg Group strata between 300 – 180 Ma. Karoo deposits are preserved in rift basins and are often terminated against major east-west trending faults on their northern margins. The dips are between 3° and 20° to the north with coal located at the base of the sequence. The nature of the coal deposits changes from a multi-seam coal-mudstone association (7 seams) approximately 40m thick in the west (Mopane Coalfield), to two thick seams in the east (Pafuri Coalfield in the Tshikondeni area).

2.4 Hydrogeology

Regional groundwater flow is oriented northwest towards the Sand River. Flow volumes are extremely low due to the low permeabilities and low recharge, especially in the northern half of the catchment underlain by the Limpopo Mobile Belt and overlain by alluvium (Figure 2-4).

In the south, where the catchment is underlain by Karoo and Soutpansberg rocks, a local northward hydraulic gradient is present due to high recharge in the Soutpansberg Mountains with the groundwater following the topography down towards the Limpopo in the north.

A significant cone of depression exists around the Sand River directly north of the Soutpansberg Mountains due to the large scale irrigation from groundwater.

Under natural conditions, groundwater drains via localised springs, as baseflow to the perennial tributaries flowing from the Soutpansberg, and by evapotranspiration by riverine vegetation along the main river channels.

Groundwater is of good quality in the Soutpansberg rocks, which is the main recharge zone; however, increased salinity occurs northwards as groundwater flows through saline Karoo sediments, accumulating salts which mostly characterises the water facies as Na/Cl/Mg-Bicarbonate water. Low recharge rates in the drier terrain north of the Soutpansberg also results in low recharge rates to dilute these salts. The movement of groundwater passing through saline deposits of the Karoo rocks, and subsequent evapotranspiration by riverine vegetation, causes a rapid salt accumulation northward, with a peak salt load along the fringes of the channels lying over Karoo rocks, like the Mutamba, the Brak and Sand Rivers, resulting in poor natural water quality.

Groundwater is abstracted for irrigation on the farms Windhoek, Grootgeluk and Overwinning along the Kandanama, and irrigation boreholes along the Sand River on Sterkstroom, Sitapo, Sutherland and Waterpoort, or utilized by riparian vegetation. Very little surface runoff is believed to recharge the regional aquifers north of the Soutpansberg, since high salinity levels in the Karoo aquifers suggest it is not recharged by fresh water from the river. In comparison, groundwater is of good quality in the Karoo aquifer along the southern tributaries such as the Kandanama River, where river losses take place.

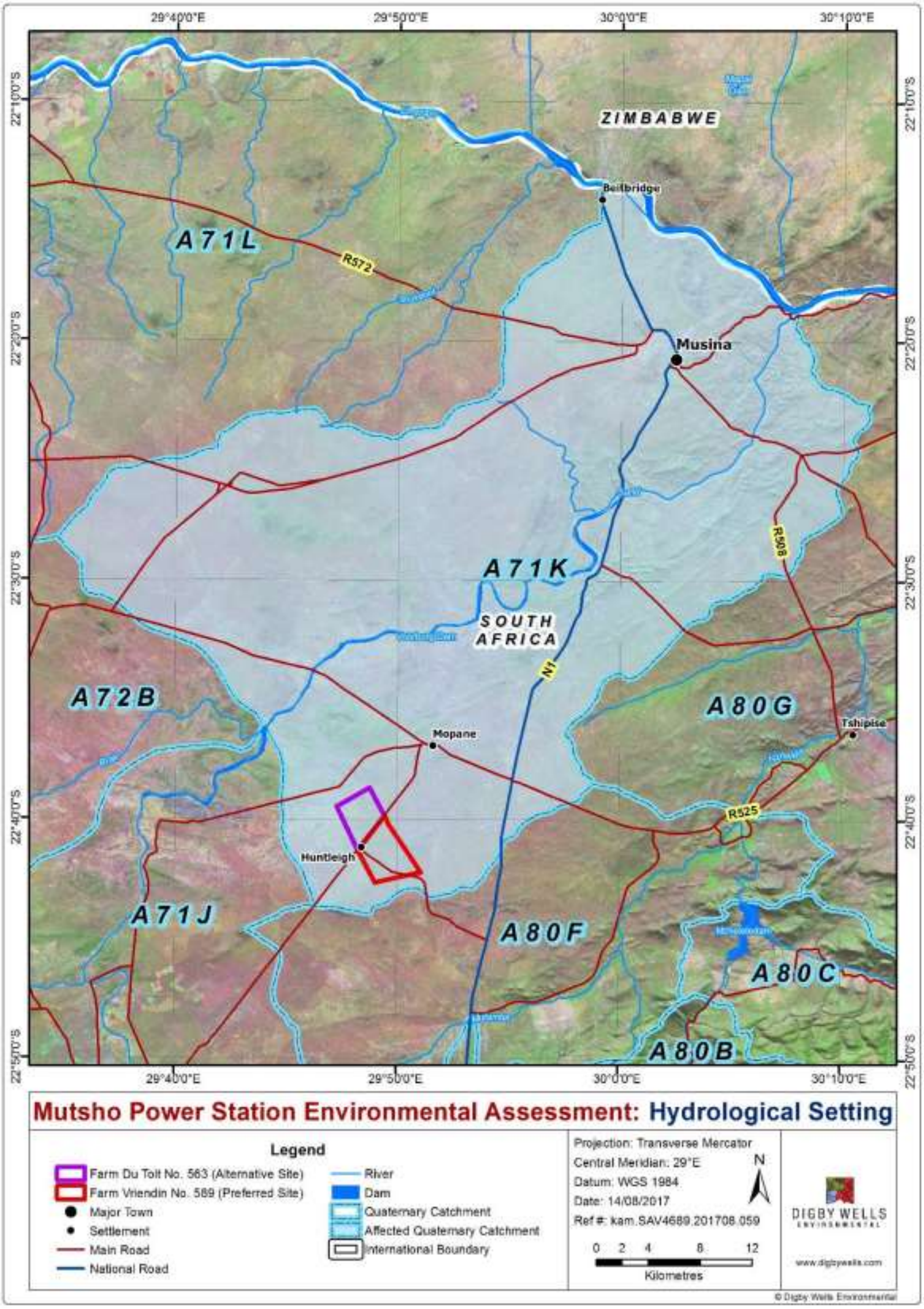

Figure 2-2: Catchment Area

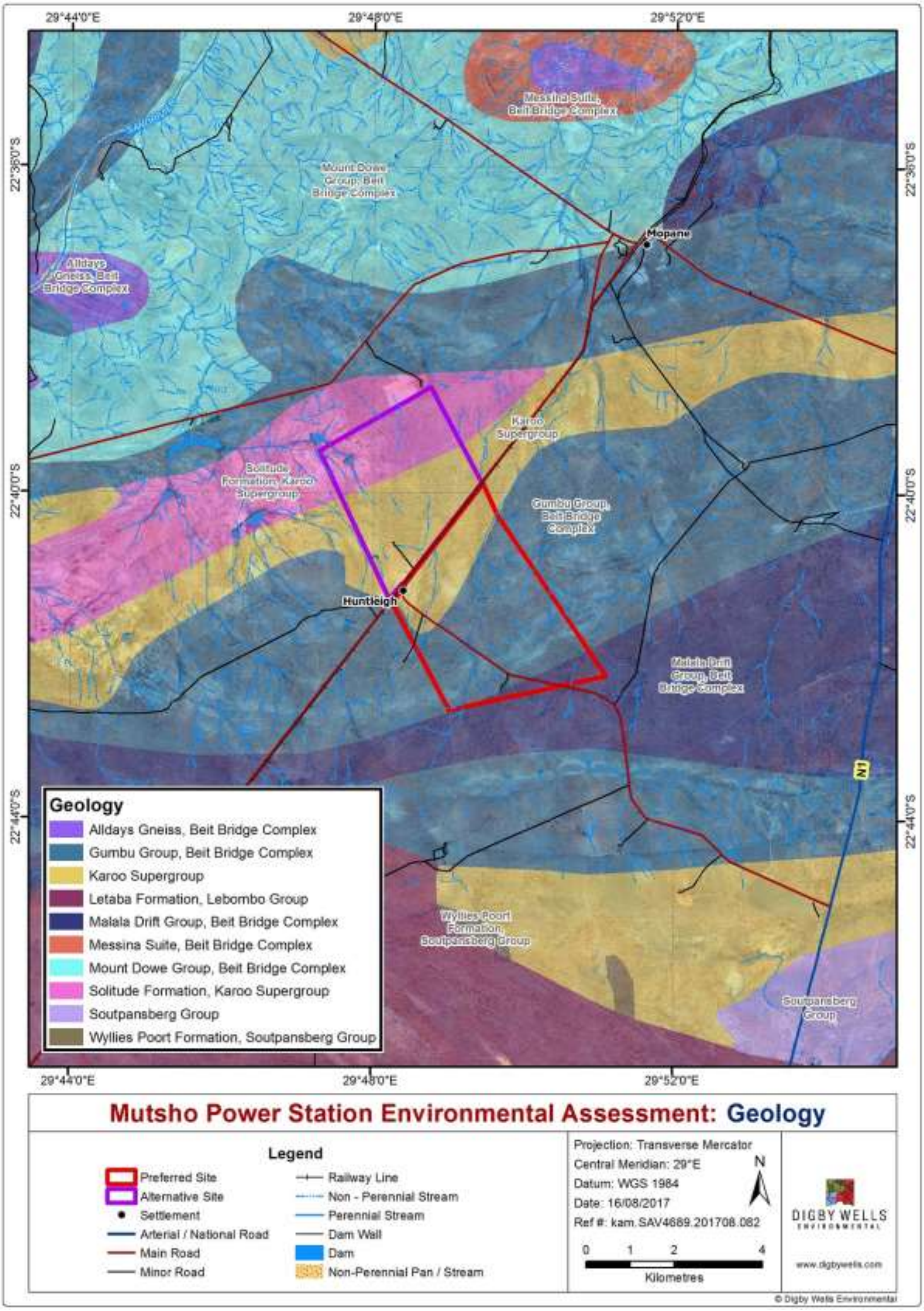

Figure 2-3: Regional Geology

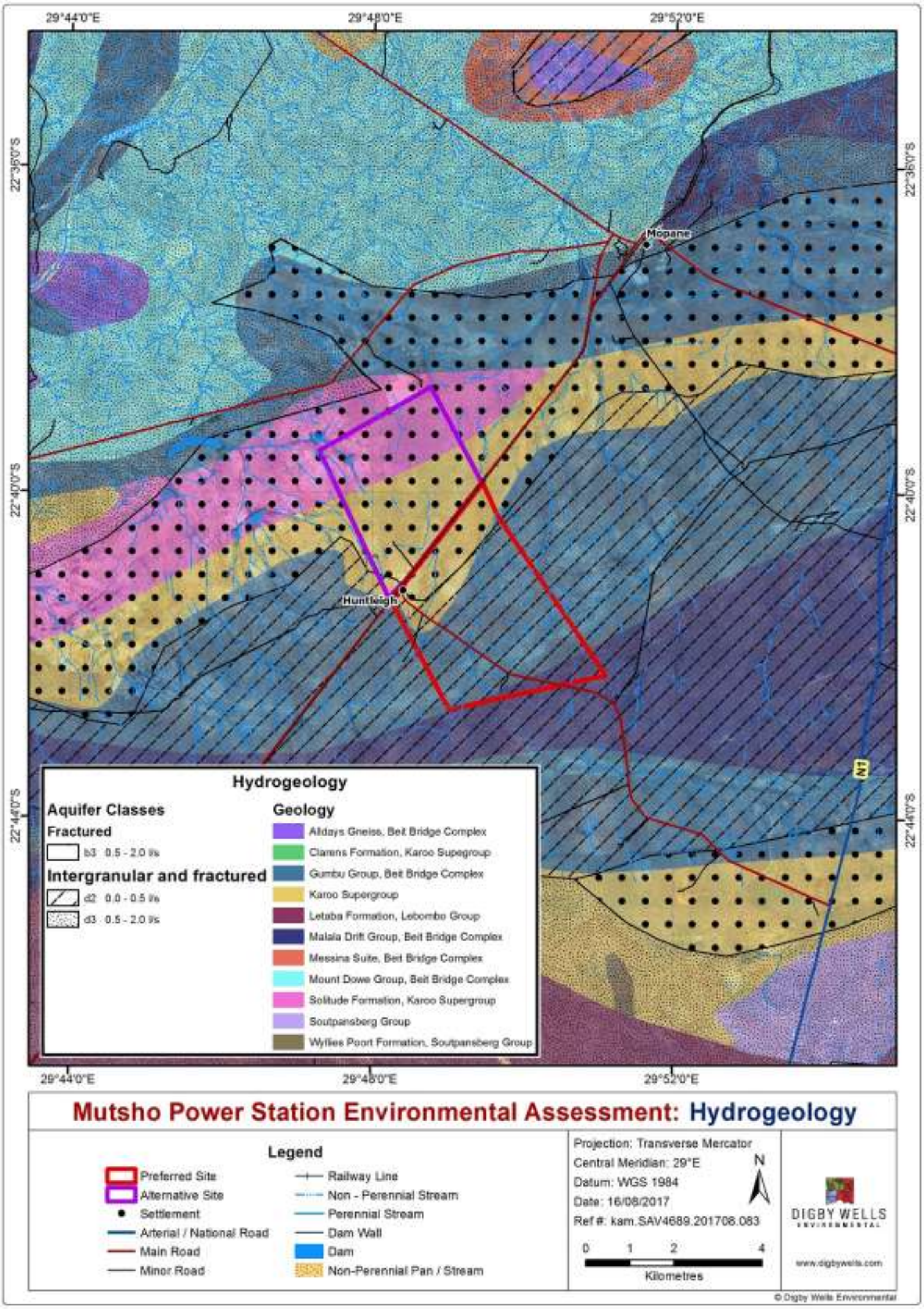

Figure 2-4: Site Hydrogeological Map

3 POTENTIAL GROUNDWATER IMPACTS

The potential groundwater impacts were assessed considering the three phases of the life of project: the construction, operation and decommissioning phases.

3.1 Construction Phase

The main activities during the construction phase that could result in groundwater impacts are associated with the site clearing and construction of the various parts of the power station infrastructure, including the pollution control dams, ash dump and coal stockpile.

The water table in the power station area is expected to be deeper than 5 m below the ground surface. All activities are expected to take place above this and no impact on the groundwater is envisaged as a result apart from spillages on surface. If any of the activities involve excavation to below the water table, there could be a potential impact on the groundwater quantity. Table 3-1 summarises potential groundwater impacts identified during the construction phase.

Table 3-1: Identified Potential Impacts during the construction phase

<table>
<tr><td colspan="4">Impact:
Lowering of the water table
Desktop Sensitivity Analysis of the Site:
Site clearing through the removal of the topsoil and weathered rocks could impact shallow water table</td></tr>
<tr><td>Issue</td><td>Nature of Impact</td><td>Extent Impact</td><td>Impacted Areas</td></tr>
<tr><td>Lowering of the water table</td><td>Groundwater quantity and quality</td><td>Local</td><td>Localised areas where infrastructure foundation has to be constructed below the water table</td></tr>
<tr><td colspan="4">Description of expected significance of impact
This impact is not expected to be significant depending on the depth of the water table. In areas where the foundation of structures is to be installed below the water level, dewatering of the aquifer to locally lower the water table will probably occur. The abstracted water can be utilised for dust suppression, vegetation or discharged to the stormwater dams.</td></tr>
</table>

Impact: Lowering of the water table **Desktop Sensitivity Analysis of the Site:** Site clearing through the removal of the topsoil and weathered rocks could impact shallow water table			
Issue	**Nature of Impact**	**Extent Impact**	**Impacted Areas**
Gaps in knowledge & recommendations for further study A hydrocensus has to be conducted to investigate how shallow the water table is. If sufficient boreholes are not present, monitoring boreholes should be drilled. Avoid constructing below the water table as far as possible. Install long term monitoring boreholes.			

Table 3-2: Identified Potential Impacts during the construction phase

Impact: Contamination of groundwater **Desktop Sensitivity Analysis of the Site:** If hydrocarbon spills had to occur from construction machinery or fuel and lubricant containing areas this could impact shallow water table			
Issue	**Nature of Impact**	**Extent Impact**	**Impacted Areas**
Contamination of the water table	Groundwater quality	Local	Localised areas near to areas of spills
***Description of expected significance of* impact** This impact could be locally significant of storage areas do leak and contaminate the groundwater below them. Generally spills from earthmoving equipment are fairly localised.			

3.2 Operational Phase

The activities associated with the power generation that could potentially impact the groundwater include: ash disposal, coal stockpiling, dirty water dams, domestic and other solid waste sites, chemical and fuel storage and sewage.

- The ash dump and associated stormwater dams will need to be lined and this is expected to significantly reduce seepage of contaminants to the subsurface. Dry ash disposal has been proposed for the project site, whereby the ash is partially wetted to contain approximately 15% moisture. This dry ashing has an advantage over wet ashing as it would minimise the infiltration of ash water to the subsurface.

- Coal stockyards, by virtue of the fact that the coal contains pyrite, probably have a far greater pollution potential than fly ash. The potential for the coal stockyard to generate acid drainage is, however, greatly reduced and expected to be insignificant due to the following assumptions:
  - The floor of the coal stockpile is expected to be a well-compacted or sealed flat surface. This would be designed for the ease of operation and coal recovery, but also to prevent seepage to the groundwater;
  - The stockpiles will be shaped to encourage surface water runoff; and
- No onsite domestic waste disposal facilities are proposed at the project site. Domestic waste will be collected by an independent contractor and disposed of offsite.
- Dirty Stormwater will be collected in lined pollution control dams and will be designed to contain a 1:24 hour 50 year rainfall event.
- Chemical and fuel storage areas will be on hard floors in areas which are bunded.
- If FGD technology is used then the sorbent will be stockpiled in an area but pollution from this source is not expected. However depending on the technology to be used the captured sulphur may be stored in the ash dam or in a separate disposal area which will consist mostly of gypsum material.

Table 3-3: Identified Potential Impacts during the operation phase

Impact:

Groundwater contamination

Desktop Sensitivity Analysis of the Site:

The main impact that a power generation may have is from ash disposal on the surface. The typical ash water chemistries within ash disposal sites include high pH (>12), and calcium, aluminium, sodium and sulphate in solution.

However, such impacts are expected to be negligible with the application of a liner, together with a dry ash disposal.

Coal stockpile areas can generate leachates due to the oxidation of the pyrites and produce water low in pH and high in calcium, aluminium, sodium and sulphate in solution

Issue	Nature of Impact	Extent Impact	Impacted Areas
Groundwater contamination as a result of seepage from the ash dump and coal stockpile	Groundwater quality deterioration	Contamination plume is expected to be within and immediately around the dump areas	Approximately 100 m radius from the ash dump and coal stockpile unless there is a

			preferential flow path.
***Description of expected significance of* impact** Groundwater is expected to feed the rivers in the project area. If the groundwater is contaminated, the plume can reach the local streams as base flow. With the implementation of a liner and dry deposition, however, such impacts are estimated to be negligible in the ash dump area. Seepage from the coal stockpile area needs to be contained and captured. Evaporation of the contaminated water in a lined pond is the best option in this region.			
Gaps in knowledge & recommendations for further study A geophysics survey has to be conducted to delineate fractures along which contaminates will migrate. Borehole drilling and aquifer testing is required to determine the rock permeability and groundwater flow speed. A geochemical study is required to determine the expected leachate quality from the ash material and coal stockpile. A numerical model is finally required to predict the size of the contamination plume and the risk of private borehole and rivers from contamination. These studies can help guide the placement of infrastructure to minimise the chances of contaminants entering the groundwater regime and being conducted away from site. The geochemical studies will also advise on the type of liner required.			

3.3 Decommissioning and Post-Closure Phase

The closure phase is characterised by the decommissioning of the power plant and associated infrastructure, including the coal stockpile and PCD. However the ash dump will remain on surface even after closure. Rain water seeping through the dump is expected to dissolve contaminants. However, this is unlikely to pollute the groundwater considering the proposed liner and post-closure dump rehabilitation.

At dry ash dams, carbon dioxide moves into the ash with the rain water. The carbon dioxide reacts with the calcium oxide in the ash and lime (CaCO3) precipitates forming a hard layer known as pozzolanic layer. Hodgson et al. (1998) reported that pozzolanic layer at a dry ash dump is typically up to 500 mm thick. As the crystallisation of lime continues, the top portion of the ash becomes less and less permeable. A stage should therefore be reached where the hydraulic conductivity of the pozzolanic layer has been reduced to such an extent, that rainwater can no longer effectively penetrate into the ash. The ability of pozzolanic ash to successfully act as a sealant, has also been demonstrated by Edil et al. (1992) in the US, in which they state that ash permeabilities are reduced to less than 10^{-7} m/s with time. The ash dam may also be sealed by the placement of soil over it and the planting of vegetation in order to reduce water ingression and to prevent erosion and the generation of dust.

It is possible that uses for the ash such as cement filler may be found and the dump is gradually removed.

Table 3-4: Identified Potential Impacts during the post-closure phase

Impact: Groundwater contamination **Desktop Sensitivity Analysis of the Site:** Rain water seeping through the ash dump is expected to dissolve contaminants and that would pollute the groundwater. Although the rain water infiltration rate can be minimised by the liner and rehabilitation of the dump, the amount of salt load reaching the groundwater could be significant over many years.			
Issue	**Nature of Impact**	**Extent Impact**	**Impacted Areas**
Groundwater contamination as a result of seepage from the ash dump and coal stockpile	Groundwater quality deterioration	Contamination plume is expected to be within and immediately around the dump area	Approximately 500 m radius of the ash dump
***Description of expected significance of* impact** The ash dump is expected to remain on ground surface long after the mine is closed. The amount of salt load released from the dump could be significant over time and pose risk to the groundwater receptors. Depending on the integrity of the liner and rehabilitation maintenance in the post-closure phase, the impact could be moderate.			
Gaps in knowledge & recommendations for further study Continuous post-closure monitoring is required to ensure that no drastic water quality changes are recorded. The numerical model needs to be updated and should be calibrated with the recorded monitoring data. Once the model is calibrated, it should be used to predict the shape and size of contamination plume up to 100 years after closure.			

4 TERMS OF REFERENCE AND PLAN OF STUDY FOR EIA

A detailed groundwater impact assessment will be conducted to identify and assess potential impacts that may arise from the proposed coal-fired power station and the associated activities. The impact assessment will make use of a rating system adopted by

Digby Wells that takes into consideration the intensity, duration, spatial scale and probability of the impacts.

The groundwater impact assessment will be conducted in line with the Department of Water and Sanitation (DWS) Best Practice Guideline for Impact Prediction and is guided by following legislative requirements:

National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
Regulation 636 under the National Environmental Management: Waste Act.
National Water Act (Act 36 of 1998) (NWA); and
NWA amendment of Regulation 704 (GN R 704) of 1999.

4.1 Objectives of the Study

The objectives include the assessment of the potential impact and mitigation plans of the proposed power station on the groundwater environment. The report will be compiled in support of obtaining the relevant environmental authorisations for the project to go ahead. Use will be made of the data gathered to assist in the placement and construction of infrastructure in order to minimise potential impacts.

4.2 Methodology for Groundwater Impact Assessment

The groundwater impact assessment, which is a detailed assessment of an area, will be carried out to define the groundwater system of the area and determine the extent of an impact on the groundwater resource. Tasks related to the site-specific geohydrological evaluation of the coal-fired power station project area will be included (as detailed in the sections which follow).

An impact assessment will be used to address the possible impacts of all power station related activities on the quantity and quality of the groundwater resources in the project area, according to the conceptual model and monitoring data available.

The methodology used to obtain quantitative and qualitative information will be site specific. The methodology will entail the acquisition of all relevant hydrogeological background information and data. This normally comprises site specific geotechnical and geophysical surveys, intrusive studies (drilling and aquifer testing), data interpretation, geochemical assessment, numerical flow and contamination modelling and reporting. Once completed, a specialist report will be compiled from all relevant data and will feed into the Environmental Impact Assessment report (EIA).

4.2.1 Field Surveys and Intrusive Work

This phase comprises detailed investigations to a definitive level to enable accurate project planning and to comply with regulatory requirements.

4.2.1.1 Hydrocensus

A hydrocensus will be conducted to get an understanding of the baseline hydrogeological environment in the area. In order to locate and access all known boreholes in the area, Digby Wells will contact and visit the property owners and/or occupants within a 1 km radius of the project area. The following information will be collected for each site:

- Borehole coordinates;
- The status of the surface water environment or borehole and equipment installed;
- Water level;
- Abstraction rates, if available;
- Field pH, EC and TDS values; and
- Borehole use.

A number of water samples (if available) will be taken during the hydrocensus and sent to a SANAS accredited laboratory for analysis. The number selected will be sufficient to characterise the baseline data in the area.

Water sample analysis will be for the constituents in Table 4-1.

Table 4-1: Inorganic constituents

pH	Sulphate (SO_4)
Electrical Conductivity (EC)	Ammonium (NH_4)
P-Alkalinity (PALK)	
Total Alkalinity (TALK)	Potassium (K)
Iron (Fe)	Nitrate (NO_3-N)
Manganese (Mn)	Chromium (Cr)
Chloride (Cl)	Phosphate (PO_4-P)
Magnesium (Mg)	Fluoride (F)
Sodium (Na)	Arsenic (As)
Aluminum (Al)	Cadmium (Cd)
Calcium (Ca)	Lead (Pb)
Zinc (Zn)	Copper (Cu)
Nickel (Ni)	Cobalt (Co)
Total cations	Total anions
Ionic balance	

4.2.1.2 Geophysical Survey

A ground geophysical survey will be conducted to delineate weathered zones and vertical to sub-vertical features.

The geophysical survey will be used to identify suitable position for the proposed new groundwater drilling sites, in combination with remote sensing lineament analysis and the geological analysis. A ground geophysical survey (magnetics and electromagnetic) would be employed to delineate weathered zones and identify possible linear structures that could act as preferred groundwater flow paths.

The magnetic method will be used to identify linear geological features, especially geological structures such as intrusive dykes and fractured fault zones. The electromagnetic method will then be applied to measure any geological feature with electrical anomaly. Fractured material or deep weathered material (geological structures/preferred groundwater flow paths) may be dry or filled with soil or water. In favourable circumstances, either type may offer a good resistivity contrast with the surrounding rock.

4.2.1.3 Drilling

Based on the targets identified during the geophysical survey, a number of boreholes will be drilled upon discussing with the client. Digby Wells proposes approximately 5 boreholes be drilled to gather geological, hydrogeological and water quality data at the project site. The proposed number of boreholes to be drilled is subject to change depending on site conditions and conclusions drawn from the site visit, client meeting and data review. These boreholes will be used to characterise the aquifer and determine its properties. They will later form part of the groundwater monitoring network.

Rotary air percussion drilling will be used to drill boreholes to a depth of about 30 m. The final depth will be confirmed following the desktop study and identification of local aquifer thickness.

4.2.1.4 Aquifer Testing

Boreholes drilled during this investigation will be aquifer tested to determine aquifer responses and to calculate the parameters presenting the aquifer hydro-dynamics underlying the investigation.

The following testing methodology is proposed:

- All boreholes will be step tested for 2 hours, followed by a 2 hour or 90% recovery test (whichever comes first). Each step will be 30 minutes long and the pumping rate will be increased depending on the borehole response;
- If, following the step test, the boreholes are found to be dry (or almost dry), they will either be slug tested or the step test data will be used for the sustainable yield estimation. No constant discharge test will be conducted in such boreholes;
- If, following the step test, the boreholes are found to be strong; they will be subjected to a constant discharge test at a rate that will be determined from the step test.
  - The boreholes will be tested for a maximum of 8 hours; and
  - This will be followed by a recovery test of 8 hours or 90% recovery of the static water level (whichever is shorter).

The aquifer test analysis will be conducted using the FC programme and Aquifer Test Pro software. The aquifer parameter results calculated from these programmes will assist in accurate characterisation of the aquifers present at the proposed site and used as input parameters in conceptual and analytical modelling.

Water samples will be taken at the aquifer tested boreholes and sent to a SANAS accredited laboratory for analysis. Sample analysis will be for the constituents in Table 4-1.

4.2.2 Geochemical and Waste Assessment

To fully understand the source of potential pollution and to define the liner requirements in terms of the guidelines provided by DWS and National Environmental Management Waste Act (NEM: WA) the following geochemistry and waste classification work is needed on the ash material.

If sufficient background data and geochemical tests work is available on the ash waste, no samples or laboratory test work will be needed.

During the kick-off meeting, a sampling program and methodology will be finalised. During the site visits samples will be collected if available. If not possible during the site visit the client will be advised on the sampling methodology and samples will be sent to Digby Wells.

Based on the current understanding of the site conditions a minimum of 6 ash samples will be required. No other waste material (such as coal discard dump) is assumed to exist at the proposed power plant sit and therefore only ash samples will be analysed. The number of samples is not final and will be discussed during the site visit.

The analysis to be performed includes Acid-Base Accounting (ABA), Sulphur speciation, XRD, XRF, Leachate test and aqua regia (for total element analysis).
Similar analyses will be conducted on coal samples. The number of coal samples to be analysed for will depend on the source of the coal and the variability expected.

4.2.3 Hydrogeological Modelling

4.2.3.1 <u>Conceptual Modelling</u>

This is a vital step in the impact assessment process, and the development of a good conceptual model will ensure reasonable results. The conceptual model will be constructed based on findings obtained in the geochemical assessment and field groundwater assessments. The conceptual model aims to describe the groundwater environment in terms of the following:

- The aquifer system:
  - Aquifer hydraulic parameters – this will be a description of the hydraulic conductivity, transmissivity and storativity;
  - Boundaries that result in the change or interruption of groundwater flow; and

  - Hydro-stratigraphic units - these are formations, parts of formations, or a group of formations displaying similar hydrologic characteristics that allow for a grouping into aquifers and associated confining layers;
- Groundwater sources:
  - The potential source of pollution will be described as part of the geochemical and waste classification assessment;
  - Precipitation and evapotranspiration will be studied to quantify groundwater recharge;
  - Baseflow, runoff, groundwater head data will be assessed to define the groundwater source;
  - Recharge and discharge areas will be evaluated with the intend of defining the groundwater and surface water interaction; and
  - Hydro-chemical data including major ions and metals will be analysed.
- Groundwater receptors (i.e. the groundwater users, streams and natural ecosystem that depend on the groundwater) will be defined.

4.2.3.2 Analytical Modelling

Once the conceptual model is formulated, it will be transformed into an analytical model. The model will be developed to evaluate the potential impact that the identified sources may have on the groundwater environment. Analytical models are formulated based on the fundamental groundwater principles of Darcy's Law.

4.2.3.3 Monitoring Network Design and/or Dewatering

Recommendations and methodology of the monitoring and dewatering will be provided based on the results of the groundwater study, latest power station plan and the analytical model results. Frequency of sampling and reporting will be a function of the EIA and the life of power station and its effect on the receiving environment.

4.2.4 Reporting

All information, data, maps and interpretations will be compiled into a detailed technical report that is the final deliverable of the hydrogeological specialist investigation of the project EIA, with conclusions and recommendations on risks, mitigation and monitoring requirements as stipulated by the authorities.

The site specific Groundwater Impact Assessment methodology and risk rating that will be used is the same as described in the EIA and is in accordance with the corresponding regulations.

A groundwater monitoring plan will be compiled based on the conditions and activities on site and will include the location of the monitoring boreholes, frequency of monitoring, list of chemical parameters to be monitored, sampling methodology, description of data capturing and reporting requirements.

5 REFERENCES

Department of Water and Sanitation notice 509 of 2016. General authorisation in terms of section 39 of the NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998) for water uses as defined in section 21(c) or section 21(i) National Water Act (NWA), 1998 (Act No. 36 of 1998);

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