Geohydrological Assessment for the proposed development of the Richards Bay Combined Cycle Power Plant (CCPP) and associated infrastructure on a site near Richards Bay, KwaZulu-Natal Province

Report Reference: GET08_102016
Date: 02 May 2017

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Declaration

I, the undersigned, declare that I am an independent Consultant with no interest in this application. I has over 20 years of fieldwork and project management experience in the research, mining, oil and gas sectors, firstly as a geologist and following completion of my Masters degree in Geohydrology at the University of the Free State. I am registered to SACNASP (Water Resources Science). I have extensive experience in developing geological and hydrogeological conceptual models for groundwater modeling. I managed various hydrogeological investigations for contaminated sites and as part of environmental impact assessments (EIA), Environmental management plan (EMP), water use licence application (WULA) and waste management licence application (WMLA), mining water management studies.

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I am appointed by AFZELIA (Pty) Ltd (on the behalf of the department of ESKOM).

Executive Summary

Geo Hydraulic and Environmental Technology (Pty) Ltd (hereafter referred to as "GET") was appointed by Afzelia (Pty) Ltd to perform a geohydrological specialist assessment as part of the Environmental Impact Assessment (EIA) for the proposed Combined Cycle Power Plant (CCPP) near Richards Bay on Erf 2/11376 and Erf 4/11376 (hereafter referred to as "site"), in KwaZulu-Natal Province.

The focus of the investigation is to review and assess the baseline groundwater conditions at the proposed site and to identify potential sensitive environments and receptors that may be impacted by the CCPP. Types of potential impacts and mitigation measures as part of the EIA process will also form part of the investigation.

The site is underlain by quaternary yellowish distributed sand which overlays the mudstone, shale, sandstone, lignite and sand of the Port Durnford formation. Groundwater occurs within the inter-granular primary aquifer in the semi consolidated and unconsolidated materials deposited during the Tertiary and Quaternary periods.

Available data reviewed indicated no abstraction boreholes in the vicinity of the site and surface water bodies are used as a source of water supply to industries and mines.

Groundwater levels data was not available from the National Groundwater Achieve (NGA). It was understood that groundwater flow mimic the topography. The topography slopes towards the Nseleni River valley. It is likely to follow the Nseleni River drainage which flows southerly.

The following potential impacts were identified within the site:

- During the construction phase, there is a potential impact on groundwater and surface water bodies including Nseleni river, Nsezi dam, Voor river and Bhizolo stream (Receptors) as a results of on-site accidental fuel spills and leaks (sources) from construction vehicles and/or fuel storage areas. Fuel spills can either migrate off-site to surrounding surface water bodies by means of rain surface runoff or seep into groundwater by means of rain water seepage (pathways).
- During the construction phase, there is a potential impact on groundwater and surface water bodies (receptors) as a result of leachate from construction waste disposal areas and infiltration through soil (pathway) of dirty water from ablution facilities (sources).

- During the operation phase, there is a potential impact on locale groundwater and surface water bodies including Nseleni River, Nsezi dam, Voor River and Bhizolo stream (Receptors) due to possible leakage of diesel and/or chemicals from storage facilities and/or pipelines and Emergency backup generators (sources). With rain water seepage, hydrocarbon products (diesel) can migrate through unconsolidated formations and reach the groundwater table or migrate off-site to surface water bodies by means of rain water runoff (Pathways).
- During the operation phase, there is a potential impact on groundwater and/or surface water bodies due to waste water discharges from the proposed waste water treatment plant and pond (sources) by means of water seepage and/or rain surface runoff (pathways).

A monitoring plan is recommended to prevent the CCPP activities from negatively impacting the groundwater quality. The following actions are required:

- To drill at least three monitoring boreholes at the site within EIA phase. This is critical for the site as soil profiles, borehole logs and local static water levels are data gaps required to assess groundwater vulnerability and to discuss site alternatives if applicable.
- The three monitoring boreholes will form a groundwater monitoring network including a background monitoring borehole, impact monitoring borehole as early warning of groundwater contamination and an interception monitoring borehole for plume off-site migration.
- Groundwater levels should be monitored from the monitoring boreholes in order to determine the local groundwater flow direction and the hydraulic gradient.
- Groundwater samples should be collected for groundwater quality assessment twice a year as well as a visual or olfactory inspection of boreholes.
- It is also suggested that surface water monitoring of the Nsezi dam, Nseleni River, Voor River and Bhizolo stream in the vicinity of the CCPP is undertaken to assess any impact during the construction and operation phases of the CCPP.
- Regular integrity tests on fuel storage tanks and pipelines are recommended to prevent leak occurrence.
- It is recommended that solid waste be collected and disposed of at an appropriate municipal waste disposal site.
- The pond needs to be lined to prevent any seepage of waste water.
- It is recommended to conduct aquifer testing at the site within the EIA phase to determine the aquifer transmissivity.

Based on the desktop geohydrological impact assessment, the following can be concluded:

- The site is essentially underlain by quaternary yellowish distributed sand which overlays the granite, conglomerate, sandstone as well as lignite and sand of the Port Durnford formation.
- Groundwater is likely to occur either within the inter-granular primary aquifer in the consolidated or in unconsolidated materials deposited during the Tertiary and Quaternary periods.
- The groundwater table is assumed to mimic the topographic levels and surface water. Groundwater interaction is likely to occurr.
- Regional groundwater quality indicates that Electrical Conductivity (EC) ranges from 0 to 70mS/m.
- Data gaps identified are related to soil profiles, borehole logs, baseline water quality and local static water levels.
- Monitoring boreholes installation are recommended during the EIA phase.
- Groundwater and surface water monitoring are recommended during the EIA phase and during operation phase of the CCPP.

Without the implementation of any mitigation measures the significance of the potential impacts to groundwater and surface water bodies at the site will be high. The implementation of mitigation measures reduces the significance rating to low.

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1 Introduction and Background

Geo Hydraulic and Environmental Technology (Pty) Ltd (hereafter referred to as "GET") was appointed by Afzelia (Pty) Ltd to perform a desktop geohydrological study at the preferred project site on Erf 2/11376 and Erf 4/11376 (hereafter referred to as "the site") as a component of the Scoping Report Impact Assessment. The site is located approximately 5 km from Richards Bay Central, in the City of uMhlathuze Local Municipality, northern Kwazulu Natal.

2 Objective and Scope of Work

2.1 Objectives

The objective of the desktop geohydrological assessment is to determine, through the use of existing information, the main potential issues and impacts of the proposed CCPP, on the receiving groundwater environment.

2.2 Scope of Work

The scope of work applicable to the desktop geohydrological assessment includes the following:

- Desktop review and description of baseline geological and hydrogeological characteristics of the site.
- Desktop hydrocensus investigation of existing registered boreholes within 1 km radius of the site, using the National Groundwater Archive (NGA).
- Assessment of the baseline groundwater quality using the Water Management System (WMS) which contains hydrochemical data.
- Identifying data gaps related to groundwater condition in the vicinity of the site.
- Identifying the potential impacts the CCPP would have on the receiving groundwater environment based upon the findings of the investigation.
- Completion of a impact assessment, including mitigation measure, monitoring plan and recommendations.
- Compile a scoping report incorporating all of the above.

2.3 Available data Sources

The following data sources were reviewed for the study:

- 1:25000 Hydrogeological map, 2830 Dundee from the Department of Water and Sanitation;
- 1:250 000 Geological series 2830 Dundee from the Department of Mineral and Energy Affairs;
- 1:250 000 Geological series 28(1/2)30 St Lucia from Department of Mineral and Energy Affairs;
- The National Groundwater Archive (NGA) which listed records of registered boreholes;
- The Water Management System (WMS) which contains hydrochemical data;
- Water Authorisation Registration Management System (WARMS) for registered and licensed groundwater use;
- CSIR (2006), A Conservation Vision for the Freshwater Biodiversity of the Olifants, Inkomati and Usutu-Mhlathuze Water management Areas, Directorate: Resource Directed Measures, DWA;
- Golder Associates (2014), Zulti South-Phase I Groundwater report, Hydrocensus and information review;
- Germishuyse T, (1999), A Geohydrological Study of the Richards Bay Area, Msc Thesis.
- SRK (2008) Groundwater Baseline and Impact Assessment for the Establishment of Servitudes for the Inhlansi Project, Richards Bay; and
- All information made available by the Client.

2.4 Legal Framework

Surface water and groundwater management is regulated by the following legal framework:

- National Water Act (No 36 of 1998);
- National Environmental Management Act, NEMA, Act 107 of 1998, under Regulations R324 to 327, of 07 April 2014; and
- Mhlathuze Water Service Bylaw, Section 64.

3 Project Description

3.1 Location of the Proposed Site

The site is situated within the quaternary catchments W12F, in the City of uMhlathuze, northern KwaZulu-Natal Province. The site is located at the approximate geographical coordinates of 28°46'04.54"S, 31° 58'54.74"E. The site location is indicated in *Figure 3-1* and *Figure 3-2*.

3.1.1 Surrounding Land Use

Table 3-1: Surrounding land use

Preferred project site		
Direction from Site	Land Use	Other Information
North	Farming land	Railway-line, Natural forest and Nsezi Dam
East	Industrial	Railway-line and Industrial Building
South	Vacant land	Private houses and vacant land
West	Farming land	Natural forest, Railway-line and plantation

3.2 Proposed Project Infrastructure Components

The project infrastructure components for the proposed the CCPP power plant consist of the following (information provided by Eskom):

- Fuel/gas/diesel storage facilities;
- Steam and gas turbines;
- Natural gas supply pipeline;
- Water pipeline;
- Security and visitor centre;
- Water treatment Plant and water tank;
- Workshop;
- Air cooled condenser;
- Transmission yard;
- Heat Recovery Steam Generator (HRSG) and Exhaust stack;
- Water pond or dam;
- Access road to site;

- Chemical storage facilities;
- Control and electrical building and 132kV and 400kV switchyard;
- Central control room, warehouse and administrative buildings;
- Emergency backup generators (diesel or LPG); and
- Firefighting systems.

3.3 Proposed Project Operation

Diesel or natural gas will be used to operate the CCPP to generate electricity of 3000 MW. The following steps are designed for the CCPP operation as per Eskom's data:

- A Gas turbine burns fuel together with compressed air to produce very high temperature combustion gas;
- The hot combustion gas produced causes the gas turbine blades to spin;
- The spinning energy is converted into electricity by means of a connected generator;
- The exhaust waste heat from the gas turbine is captured by the HRSG and used to generate high temperature and pressure steam; and
- The steam turbine uses the hot steam to generate additional electricity.

It is anticipated that the natural gas will be supplied from the gas supply take-off point at the Richards bay harbour to the power station using gas pipeline. The natural gas will pass through a supply conditioning system before it is used in the gas turbine. Waste water produced on site will be temporary retained at a water pond for treatment.

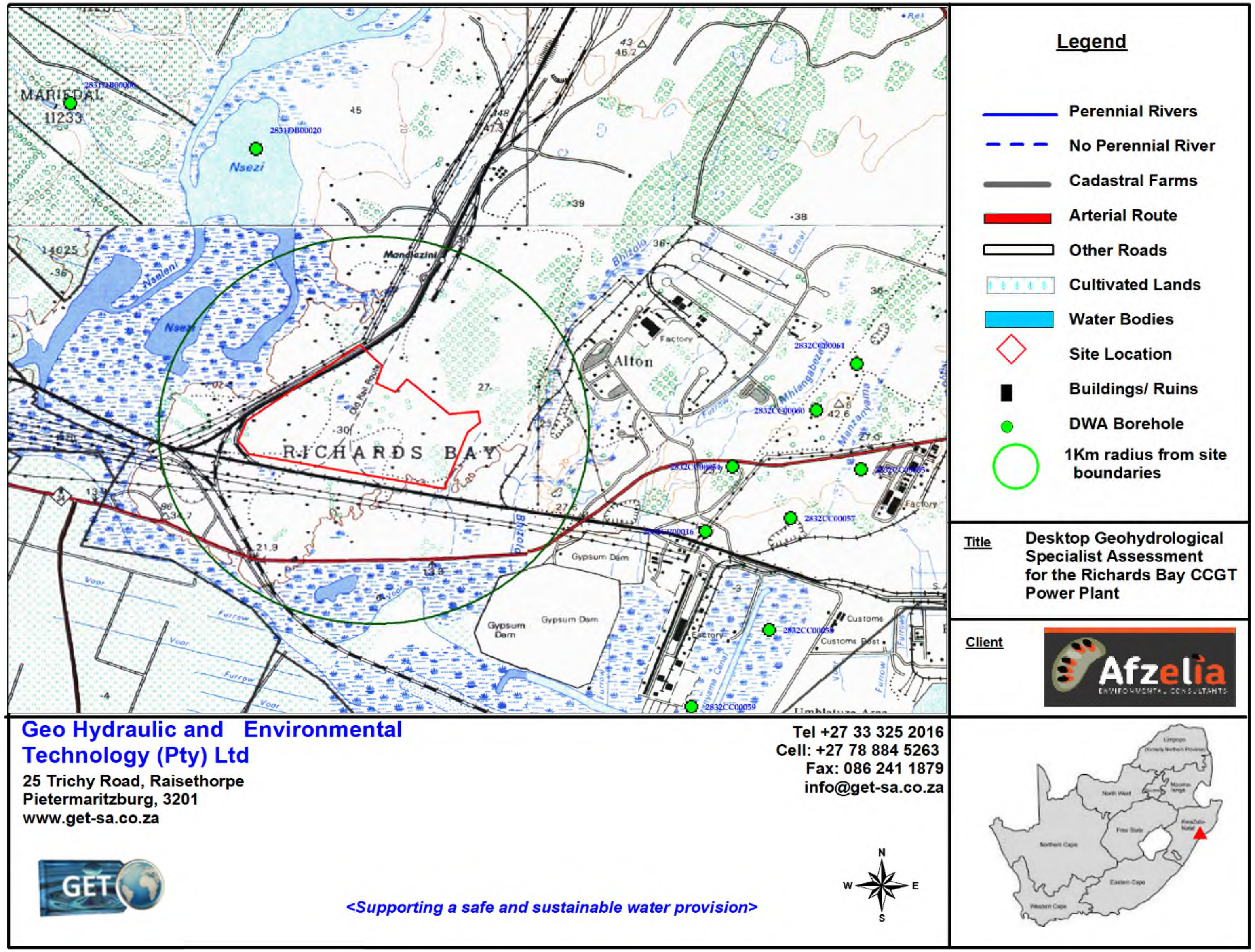

Figure 3-1 Topographic map showing the location of the site and surroundings

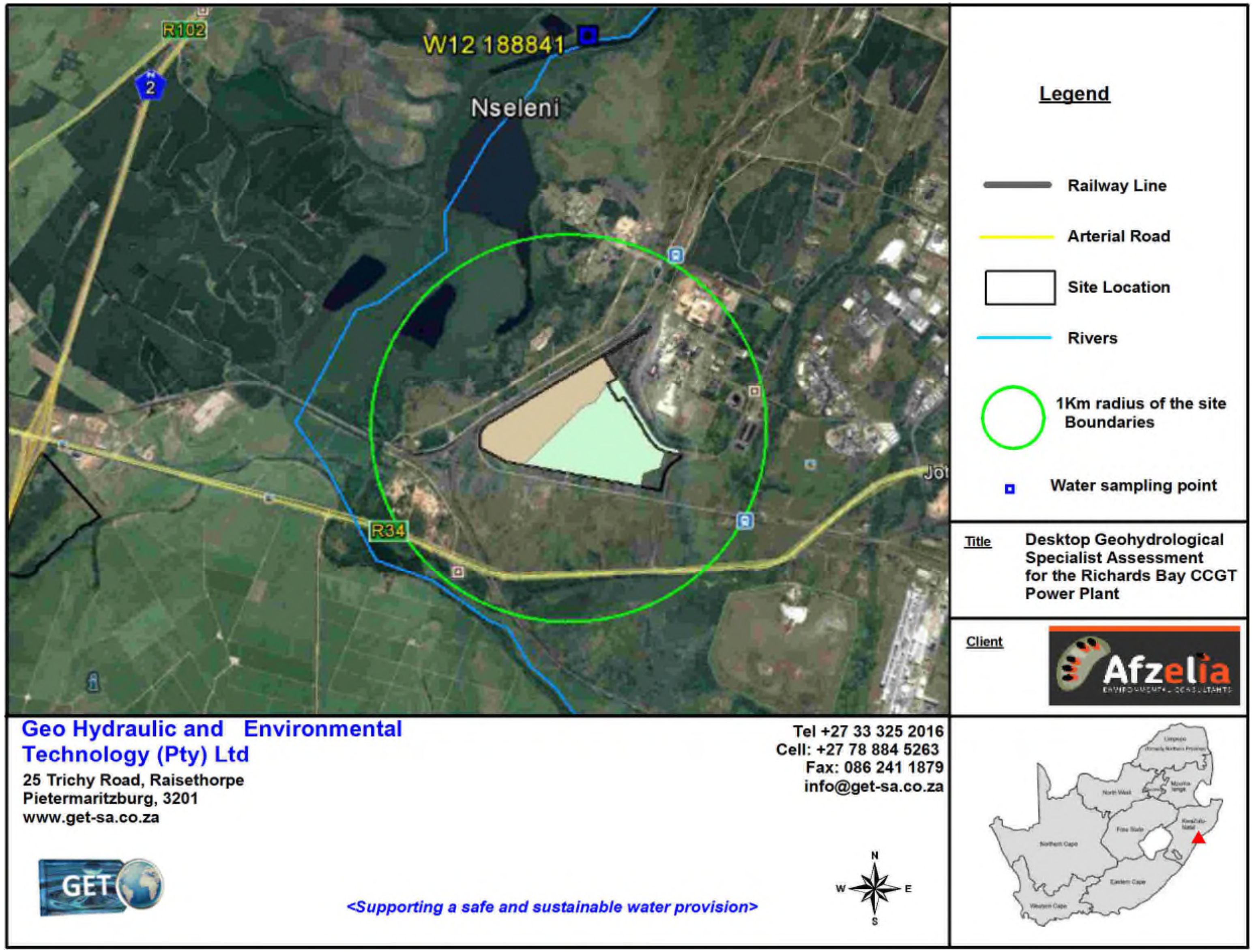

Figure 3-2 Orthographic map showing the location of the site and surroundings

3.4 Topography and Drainage

The site area lies at an elevation ranging approximately from 20 to 30 meters above mean sea level meters (m amsl). The topography slopes towards the Nseleni River valley. The main rivers and drainage identified included perennial rivers such as Nseleni River flowing in the valley southerly toward the Mhlathuze River, Voor River flowing southerly into Nseleni River and two non-perennial stream located west of the site including Bhizolo and an unnamed stream as shown in *Figure 3-2*. Wetlands are also present within site and the surroundings. Surface water bodies are found north west of the site including Lake Nsezi and an unnamed lake located south of the site.

3.5 Geology

According to the 1:250 000 Geological series 28(1/2)30 St Lucia (Map sheet 2830) and 1:250 000 Geological series 2830 Dundee, the site is underlain mainly by quaternary formations Qs (yellowish redistributed sand) as shown in *Figure 3-3*.

The regional geology of the Richards Bay area consists of siltstone and sandstone of the St Lucia formation which is the upper part of the Zululand group. The Zululand group is overlain by red sand, red calcarenite, coquina and calcareous sandstone of Uloa formation. The Uloa formation is overlain by mudstone, shale, sandstone, lignite and sand of the Port Durnford formation. The latest is finally overlain by quaternary yellowish distributed sand. A simplified regional lithostratigrapy is shown in *Table 3-2* below.

Table 3-2: Simplified lithostratigrapy of the site

Period	Series	Stage	Group	Formation	Lithology
Quaternary	Holocene (Recent)				Alluvium, dune, aeolian and beach sands
	Pleistocene	Upper Pleistocene		Kwambonambi	Sand and aeolianite, dune and beach sand
		Middle Upper Pleistocene		Bluff	Calcareous sandstone
		Lower Pleistocene		Upper Port Dunford	Sand and sandstone
					Lignite
				Lower Port Dunford	Mudstone, clay rich sandstone
Tertiary	Late Miocene to Pleistocene			Uloa	Calcareous sandstone and coquina

	Miocene		Zululand	Richards Bay	Siltstone and sandstone
Cretaceous		Senonian		St. Lucia	Siltstone and sandstone

The two geological maps reviewed do not indicate any geological structures including faults, joints and lineaments within the study area (Refer to *Figure 3-3)*. According to Golder (2004) the more recent thick sedimentary rock post-date and cover the geological structures.

A desktop hydrocensus conducted using National Groundwater Archive (NGA) reveals the lithostratigraphy data from three boreholes namely 2832CC00016, 2831DB00020 and 2831DB00006 identified within 5km radius of the site. The borehole 2832CC00016 indicates shallow granite located at 2.44mbgl overlain by a thin layer of soil, borehole 2831DB00006 indicates shallow consolidated sandstone located at 0.30mbgl underlain by conglomerate and dolerite. The borehole 2831DB00020 reveals 30m thick soil underlain by sandstone and dolerite. Referring to the position of each borehole, shallow consolidated rocks (granite and/or sandstone) are likely to be underlying the site.

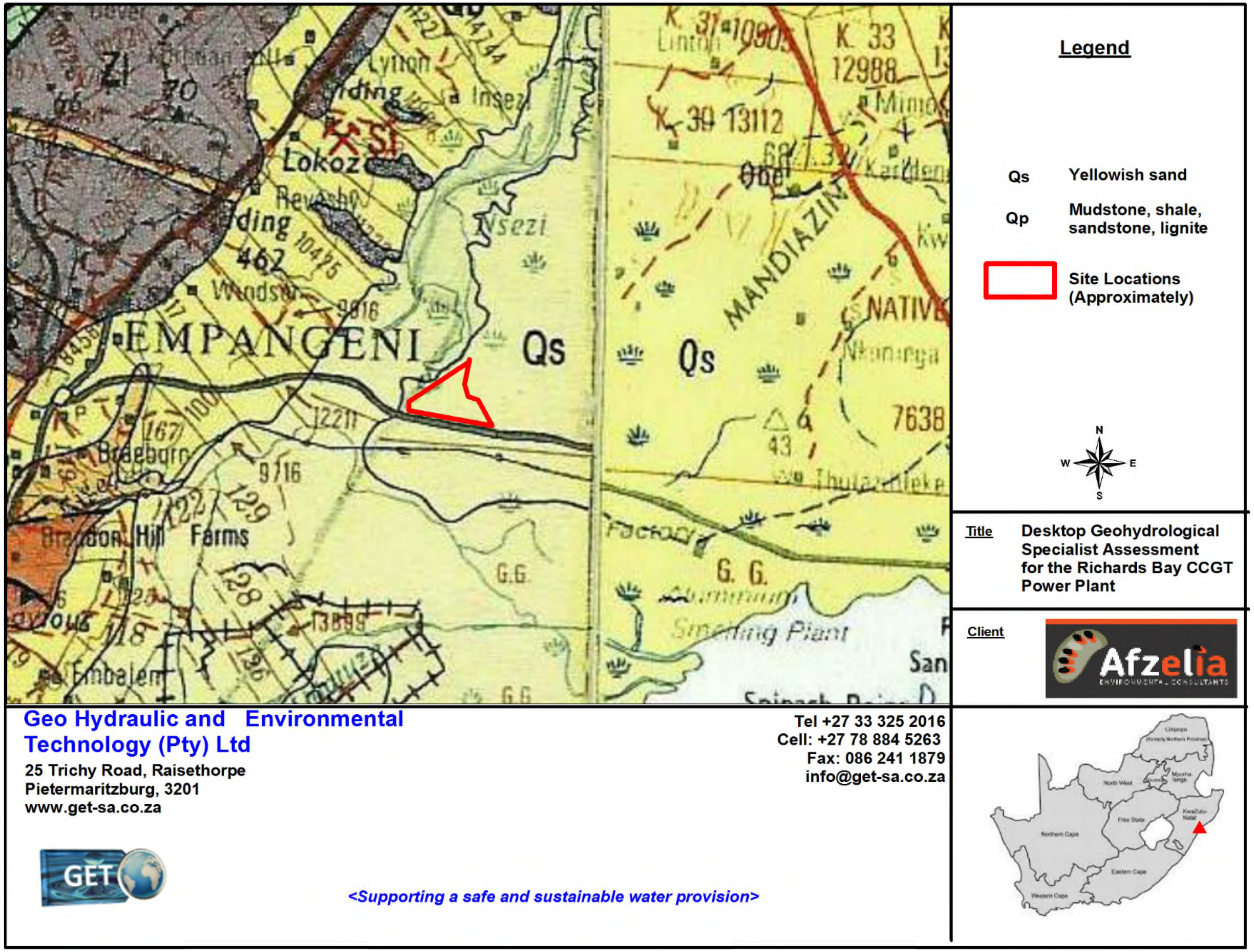

Figure 3-3 1:250 000 scale geological map for St Lucia and Dundee (Map sheet 2830)

3.6 Geohydrology

3.6.1 Aquifer Characteristics

According to the 1:500 000 scale hydrogeological map series (Vryheid, Map sheet 2730) and from available hydrogeological information, Richards Bay groundwater occurs within the inter-granular primary aquifer in the semi consolidated and unconsolidated materials deposited during the Tertiary and Quaternary periods.

According to Golder (2014) the depths of boreholes measured within the Richards Bay area varies from 30 and 45 metres below ground level (mbgl) and the aquifer testing conducted indicated the hydraulic conductivity ranging from 0.5 to 5 m/d.

It was also indicated that mean annual rainfall in the Richards Bay area ranges between 994 and 1500 millimetres per year (mm/year) and the mean annual evaporation ranges from 1410 to 1923 mm/year, Germishuyse (1999). The effective groundwater recharge is estimated to range from 450 to 750mm/year. Generally, it is expected that the groundwater table mimics the surface topography. According to SRK (2008) the static water level estimated along the servitude route in the vicinity of the site varies from <2mbgl to 4mbgl.
Geohydrological data shown in Table 3-3 was retrieved from NGA database for three boreholes located within 5km radius from the site.

Table 3-3: NGA geohydrological data

NGA Borehole	Latitude	Longitude	Water Strike depth to top (mbgl)	Total Blow Yield (L/s)	Aquifer Lithology
2832CC00016	-28.77825	32.01648	24.38	1.63	Granite (Highly weathered)
2831DB00020	-28.74351	31.97477	28.96	0.44	Sand
2831DB00006	-28.73935	31.95755	37.80	0.13	Dolerite

Table 3-3 geohydrological data can only indicate the likelihood of the aquifer undelaying the site to be located at more than 20 mbgl. This data does not excluded the geohydrolocal data gap identified on site and within 1km radius of the site.

3.6.2 Groundwater Usage

Germishuyse (1997) indicated that there were no groundwater extractions in the Richards Bay area, since private boreholes were prohibited by the uMhlathuze Municipality by-laws. The uMhlathuze Local Municipality Water Services By-laws 2010 allowed the sinking of abstraction boreholes only above the 50m mean sea level contour line. The recorded NGA data reviewed within 5 km radius of the site do not indicate groundwater abstractions.

The interaction between surface water and groundwater needs to be considered in assessing baseline geohydrological conditions during EIA phase. Surface water such as Lake Nsezi is used as main water supply reservoirs under the jurisdiction of Mhlathuze water for the region, Germishuyse (1997). Besides river drainage and rainfall, lakes around the site are also replenished by groundwater seepages from the local primary aquifer, Germishuyse (1997).

3.6.3 Groundwater Flow Direction

Generally the groundwater levels mimic topographic levels, groundwater is likely flowing towards the valley in which the Nseleni River is flowing. According to SRK (2008) groundwater flow direction is southwest in the vicinity of the site.

3.6.4 Groundwater Quality

The 1:500 000 scale hydrogeological map (Vryheid, Map sheet 2730) indicates that electrical conductivity (EC) ranges from 0 to 70mS/m. No recent groundwater quality data was available for the site in the WMS database but recent surface water quality data is available within a 1km radius of the site. Water quality analysis data from a water sample W12 188841 collected upstream of Nseleni River (Refer to *Figure 3-2*) was compared to SANS 241-1:2015 drinking water guideline as shown in *Table 3-4*.

Table 3-4: Water Quality data from DWA Water Management System

	Units	Sans 241-1:2015 drinking water standard limits	W12 188841
Latitude			-28.7325
Longitude			31.98389
Date Time			2/3/2014 7:10

Calcium, Ca	mg/L	≤150	13.921
Chloride, Cl	mg/L	≤300	181.856
Conductivity, EC	mS/m	≤170	73.293
Fluoride, F	mg/L	≤1.5	0.488
Potassium, K	mg/L	≤50	N/A
Manganese, Mg	mg/L	≤50	16.195
Sodium, Na	mg/L	≤200	N/A
Ammonium, NH4	mg/L	NS	0.025
Nitrate, NO3 Nitrite, NO2	mg/L	≤11 ≤0.9	0.025
pH		≥ 5 to ≤9.7	8.313
Phosphate, PO4	mg/L	NS	0.005
Silicon ,Si	mg/L	Ns	8.437
Sulphate, SO4	mg/L	≤250	1.5
Total Alkalinity	mg/L	NS	202.906

Note: NS: Note Specified

The results indicate that the surface water quality at these locations are compliant with the SANS 241-1:2015 drinking water guideline.

4 Impact Identification

This impact assessment was undertaken based on the proposed project infrastructure components listed in section 3.2 and project operation described in section 3.3 above.

4.1 Limitations and Data Gaps

The following data gaps were identified:

1. No local geotechnical data and/or geological logs related to the site are available, therefore soil profiles and types and shallow consolidated rocks types are not known at this stage.
2. Groundwater static level is not known at the site level as no borehole exist within 1km radius.
3. Groundwater water quality data are not available on site and within 1km radius.
4. Aquifer parameters including the transmissivity are not available within the 1km radius of the site. This parameter indicates how fast a potential contaminant of concern will reach the identified receptors (groundwater and surface water bodies).

4.2 Identification of Potential Impacts

The following potential impacts were identified from the desktop risk assessment within the site area:

- During the construction phase, a potential impact exists on groundwater and surface water bodies including the Nseleni River, Nsezi dam, Voor River and Bhizolo Stream and an unnamed dam (receptors) as a result of on-site accidental fuel spills and leaks (sources) from construction vehicles and/or fuel storage areas. Fuel spills can either migrate off-site to surrounding surface water bodies by means of rain surface runoff or seep into the groundwater by means of rain water seepage (pathways).
- During the construction phase, a potential impact exists for identified receptors as a result of leachate from construction waste disposal areas (sources) and infiltration through soil (pathway) of dirty water from ablution facilities (sources).
- During the operation phase, a potential impact exists on groundwater and surface water bodies including the Nseleni River, Nsezi dam, Voor River, Bhizolo Stream and an unnamed dam (receptors) due to possible leakage of diesel and/or chemicals from storage facilities and/or pipelines and form emergency backup generators leaks (sources). With rain water seepage, hydrocarbon products (diesel) can migrate through unconsolidated formations and the reach groundwater table or migrate off-site to surface water bodies by means of rain water runoff (pathways).
- During the operation phase, a potential impact exists on identified receptors due to waste water discharges from the waste water treatment plant and pond (sources) by means of water seepage and/or rain surface runoff (pathways).

4.3 Impact Risk Rating

The impact risk rating below is used in accordance with the National Environmental Management Act (Act 107 of 1998) (NEMA).

The maximum value of the environmental significant of any impact is 100.

The following scales (*Table 4-1*) is applied to each identified potential impact in section 4.3 above.

Table 4-1: Scales for potential impact rating

Extent: spatial scale	Duration: Temporal scale
0- None 1- Site only 2- Local 3- Regional 4- National 5- International	1- Immediate 2- Short term: 0 to 5 years 3- Medium term 4- Long term: 50 to 15 years 5- Permanent: Operational life time.
Magnitude: severity	**Probability: likelihood of occurring**
2- Minor 4- Low 6- Moderate 8- High 10- Very high	0- None 1- Improbable 2- Low probable 3- Medium probable 4- High probable 5- Definite

The environmental significance of each identified potential impacts can be calculated using the following formula:

Significance = (duration + extent + magnitude) x probability

The identified potential impacts will need to be assess twice, before and after the implementation of any mitigation and management measures to ascertain the degree to which the potential impact can be mitigated or cause loss.

According to the potential impacts identified in Section 4.2, an impact rating is provided in *Table 4-2* below.

Table 4-2: Significance of potential impact before mitigations

Construction Phase				
Nature of Impact	Potential impact on surface water bodies due to on-site accidental fuel spills and leaks/leachate and infiltration of dirty water.		Potential impact on groundwater due to on-site accidental fuel spills and leaks/ leachate and infiltration of dirty water.	
Duration	4		4	
Extent	3		3	
Magnitude	8		8	
Probability	4		4	
Significance	60 / High		60 / High	
Operational Phase				
Nature of Impact	Potential impact on locale groundwater due to possible leakage of diesel from storage facilities and/or pipelines and Emergency backup generators.	Potential impact on locale surface water bodies due to possible leakage of diesel from storage facilities and/or pipelines and Emergency backup generators.	Potential impact on groundwater due to waste water and solid waste discharges.	Potential impact on surface water bodies due to waste water and solid waste discharges.
Duration	2	2	2	2
Extent	2	2	2	2
Magnitude	8	8	6	6
Probability	4	4	4	4
Significance	48 / Moderate	48 / Moderate	40 / Moderate	40 / Moderate

Table 4-3: Mitigation Measures

<table>
<tr><th colspan="5">Construction Phase</th></tr>
<tr><td>Nature of Impact</td><td colspan="2">Potential impact on surface water bodies due to on-site accidental fuel spills and leaks/ leachate and infiltration of dirty water.</td><td colspan="2">Potential impact on groundwater due to on-site accidental fuel spills and leaks/ leachate and infiltration of dirty water.</td></tr>
<tr><td>Mitigation Measures</td><td colspan="2">➢ Surface and storm water run-off needs to be diverted through an oil/water separator before leaving the site.
➢ Emergency spill kits should always be present at strategic locations.
➢ Good housekeeping practices are to be implemented.
➢ Immediate reporting of significant spillages and initiate an environmental site assessment for risk assessment and remediation if necessary.
➢ Construction waste on an impermeable base, keep away from drains.
➢ Use of temporal toilets.</td><td colspan="2">➢ Storage of fuel, oils and chemicals on an impermeable base, keep away from drains.
➢ Emergency spill kits should always be present at strategic locations to be used.
➢ Good housekeeping practices are to be implemented.
➢ Report significant spillages and initiate an environmental site assessment for risk assessment and remediation if necessary.
➢ Construction waste on an impermeable base, away from drains.
➢ Use of temporal toilets.</td></tr>
<tr><th colspan="5">Operational Phase</th></tr>
<tr><td>Nature of Impact</td><td>Potential impact on locale groundwater due to possible leakage of diesel from storage facilities and/or pipelines and Emergency backup generators.</td><td>Potential impact on locale surface water bodies due to possible leakage of diesel from storage facilities and/or pipelines and Emergency backup generators.</td><td>Potential impact on groundwater due to waste water and solid waste discharges.</td><td>Potential impact on surface water bodies due to waste water and solid waste discharges.</td></tr>
<tr><td>Mitigation Measures</td><td>➢ The site should be paved to avoid direct contact with impacted soils.
➢ Good housekeeping practices are to be implemented.</td><td>➢ Good housekeeping practices are to be implemented.
➢ Immediately report significant spillages and initiate an environmental site assessment for risk</td><td>➢ Regular quality monitoring of waste before discharge.
➢ Compliance to appropriate construction standards of the</td><td>➢ Regular quality monitoring of waste before discharge.
➢ Compliance to appropriate construction standards of the waste storing and drainage systems.</td></tr>
</table>

	➢ Immediately report significant spillages and initiate an environmental site assessment for risk assessment and remediation if necessary.	assessment and remediation if necessary. ➢ Surface and storm water run-off need to be diverted through an oil/water separator before leaving the site. ➢ Regular integrity tests on fuel storage tanks and pipelines to prevent leak occurrence	waste storing and drainage systems. ➢ Implementation of procedures for storage and handling hazardous substances. ➢ Solid waste must be collected and disposed of at an appropriate municipal waste disposal site. ➢ The pond needs to be lined to prevent any seepage of waste water.	➢ Implementing of procedures for storage and handling hazardous substances. ➢ Solid waste must be collected and disposed of at an appropriate municipal waste disposal site.

Table 4-4: Significance of potential impact after mitigations

Construction Phase				
Nature of Impact	Potential impact on surface water bodies due to on-site accidental fuel spills and leaks/leachate and infiltration of dirty water.		Potential impact on groundwater due to on-site accidental fuel spills and leaks/ leachate and infiltration of dirty water.	
Duration	2		2	
Extent	1		1	
Magnitude	2		2	
Probability	2		3	
Significance	10 / Low		15 / Low	
Operational Phase				
Nature of Impact	Potential impact on locale groundwater due to possible leakage of diesel from storage facilities	Potential impact on locale surface water bodies due to possible leakage of diesel from storage facilities and/or	Potential impact on groundwater due to waste water and solid waste discharges.	Potential impact on surface water bodies due to waste water and solid waste discharges.

	and/or pipelines and Emergency backup generators.	pipelines and Emergency backup generators.		
Duration	2	2	2	2
Extent	1	2	1	2
Magnitude	6	2	4	2
Probability	2	2	2	2
Significance	18 / Low	12 / Low	14 / Low	12 / Low

5 Proposed Monitoring Plan and Recommendations

A groundwater monitoring plan is required to prevent the CCPP activities from negatively impacting the groundwater quality. As part of the monitoring plan the following actions are required:

- Drill at least three monitoring boreholes at the site within EIA phase. This is critical as soil profiles, borehole logs and local static water level are data gaps required to assess groundwater vulnerability and to discuss alternatives if applicable.
- The three monitoring boreholes will form a groundwater monitoring network including a background monitoring borehole, impact monitoring borehole as early warning of groundwater contamination and an interception monitoring borehole for plume off-site migration.
- Groundwater levels should be monitored from monitoring boreholes in order to determine the local groundwater flow direction and the hydraulic gradient.
- It is also suggested that surface water monitoring of the Nsezi dam, Nseleni River, Voor River and Bhizolo stream in the vicinity of the CCPP is undertaken to assess any impact during the construction phase and when the CCPP is operational.
- It is recommended that solid waste be collected and disposed of at an appropriate municipal waste disposal site.
- The pond needs to be lined to prevent any seepage of waste water.
- It is recommended to conduct aquifer testing at the site within EIA phase to determine the aquifer transmissivity.

If the monitoring data indicates that leakages occurred and that the groundwater system is impacted an environmental site assessment needs to be undertaken by an appropriately qualified and experienced specialist and the necessary mitigation measures taken based on the magnitude of the impact.

6 Conclusions

Based on the desktop geohydrological impact assessment, the following can be concluded:

- The site is essentially underlain by quaternary yellowish distributed sand which overlays the granite, conglomerate, sandstone as well as lignite and sand of the Port Durnford formation.
- Groundwater is likely to occur either within the inter-granular primary aquifer in the consolidated or in unconsolidated materials deposited during the Tertiary and Quaternary periods.
- Groundwater table is assumed to mimic the topographic levels and surface water and groundwater interaction likely occurrs.
- Regional groundwater quality indicates that EC ranges from 0 to 70mS/m.
- Data gaps identified are related to soil profiles, borehole logs, baseline water quality and local static water levels.
- Monitoring of borehole installation are recommended during the EIA phase.
- Groundwater and surface water monitoring are recommended during the EIA phase and during the operation phase.
- Without the implementation of any mitigation measures the significance of potential impacts to groundwater and surface water bodies at the site is high. The implementation of the mitigation measures reduces the significance rating to low.

7 References

DEAT (2002) Impact Significance, Integrated Environmental Management, Information Series 5, Department of Environmental Affairs and Tourism (DEAT), Pretoria.

SRK (2008), Groundwater Baseline and Impact Assessment for Establishment of Servitudes for the Inhlansi Project, Richard Bay, Report prepared for Nozalela Mineral Sands Pty (Ltd) by SRK.

CSIR (2006), A Conservation Vision for the Freshwater Biodiversity of the Olifants, Inkomati and Usutu-Mhlathuze Water management Areas, Directorate: Resource Directed Measures, DWA.

Golder Associates (2014), Zulti South-Phase I Groundwater report, Hydrocensus and information review.

Germishuyse T, (1999), A Geohydrological Study of the Richards Bay Area, Msc Thesis.