Groundwater Impact Assessment for a Proposed Housing Development on Erf 6482, Grassy Park, Cape Town

Prepared by

GEOSS

14 November 2024

GROUNDWATER AND EARTH SCIENCES

GEOSS

SOUTH AFRICA (Pty) Ltd

Executive Summary

GEOSS was appointed by Michelle Lee of Chand Consultants (Pty) Ltd to complete a groundwater impact assessment for a proposed housing development in Grassy Park. The proposed development is to take place on Erf 6482, located in the residential area between Lotus River and Ottery. The study aims to assess the potential impact of the housing development on groundwater in the area surrounding the site. There is the potential for soil and groundwater contamination to occur as a result of construction and related activities, which could have indirect impacts to surrounding groundwater users

The study included a desktop assessment of various groundwater databases, a review of hydrogeological and geological maps and reports for the study area, and a field visit to determine the potential impact on the existing groundwater resources and users. The field visit entailed the installation of piezometers to understand the subsurface.

The proposed development overlies thick and laterally extensive intergranular cover which forms the regional Cape Flats Aquifer, a Major Aquifer System due to its high-yielding potential and good water quality. Due to the highly permeable nature of the geology and the shallow water table, localised contamination of the aquifer is likely. The yield of an average borehole in the vicinity of the site, is in the range of 2.0 – 5.0 L/s. Good to marginal quality groundwater (70 – 300 mS/m) is mapped for the area, and assessment of the available information indicates that within the 1-km surrounding the study site, EC ranges from 58 – 254 mS/m.

Although the aquifer beneath the site is considered to have a very high vulnerability to point-source contamination, the proposed land use is assessed to have a has a relatively low risk. Despite a housing development being associated with a lowered risk, mitigation measures should still be implemented. With sufficient mitigation measures in place, the development may proceed. It must be noted, however, that at the time of report preparation, no proposed site development plan was available for the site which may affect the final risk assessment of the site. Based on the findings of the report, the following recommendations are made:

- It is recommended that the extent of the existing waste observed on site, be investigated. Should the waste be superficial, the waste can be cleared and the development should proceed. Should the waste layer prove to be extensive, it is recommended that a soil study be conducted to assess whether soil contamination has occurred and whether there is a risk to future construction workers and inhabitants of the development. This will also provide insight into whether there is a risk of leaching of contaminants into the groundwater. Should any hazardous types of waste be encountered during the excavation, a soil sampling study will be necessary.
- It is strongly recommended that should the proposed development be approved, that a hydrogeologist review the final site development plan. If necessary, the report will then be revised to:
    - Identify any high risk activities;
    - Update the risk assessment and provide additional mitigation measures where necessary;
    - Compile a groundwater monitoring plan based on the site layout; this may include monitoring during both the construction and operational phases

  - Provide comment on stormwater management design
- Appropriate stormwater management systems must be designed to ensure that clean run-off water is appropriately directed off-site and does not cause flooding of low-lying or clay lined areas nearby. Ideally, clean stormwater should be allowed to infiltrate into the underlying aquifer. The stormwater management system must ensure that potentially contaminated stormwater originating on site is captured. The system must be continually monitored to ensure that no potentially contaminated run-off water flows off-site.
- Appropriate spill and leak detection must be enforced for contaminated stormwater and sewage systems. Additionally, all areas where any potentially hazardous activities will take place, must be appropriately lined and/or bunded.

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Abbreviations

BH	Borehole
CFA	Cape Flats Aquifer
CoCT	City of Cape Town
CGS	Council for Geoscience
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water Affairs and Sanitation
EC	electrical conductivity
GA	General Authorisation
L/s	litres per second
m	metres
m^3/ha/a	cubic metres per hectare per annum
mamsl	metres above mean sea level
mbch	metres below collar height
mbgl	metres below ground level
mm	millimetre
mm/a	millimetres per annum
mS/m	milli-Siemens per metre
NEFPA	National Freshwater Ecosystem Priority Areas
NWM5	National Wetland Map 5
NGA	National Groundwater Archive
ORP	oxidation-reduction potential
SDP	site development plan
TDS	total dissolved solids
TOC	total organic carbon
WARMS	Water Authorisation and Registration Management System

Glossary of Terms

aquifer	a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].
borehole	includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].
electrical conductivity	the ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).
fractured aquifer	Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.
intergranular aquifer	An aquifer in which groundwater is stored in and flows through open pore spaces in the unconsolidated Quaternary deposits.
groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e., the water table marks the upper surface of groundwater systems.
vlei	a natural, shallow pool of water, mostly of a seasonal or intermittent nature; low-lying grassy or marshy wetland.

SPECIALIST EXPERTISE

CURRICULUM VITAE – Zita Harilall

GENERAL

Nationality:	South African
Profession:	Hydrogeologist
Specialization:	Groundwater impact and contamination assessments, groundwater management and monitoring including stable and radioisotope analysis.
Position in firm:	Hydrogeologist at GEOSS South Africa (Pty) Ltd
Date commenced:	November 2018
Language skills:	English (mother tongue), Afrikaans (average)

KEY SKILLS

- Groundwater impact and contamination – investigation and assessment of industrial activities on groundwater resources.
- Groundwater sampling and monitoring – development and implementation of groundwater monitoring and management programmes; analysis of groundwater level and quality (chemistry) data.
- Advanced chemistry monitoring and residence time determination – stable and radioisotope analysis.
- Writing of hydrogeological reports
- Conducting hydrocensus studies
- ArcMap / Geochemist's Workbench / WISH and typical software skills.

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2020	M.Sc. (Geology)	Stellenbosch University, South Africa
2017	B.Sc. (Hons) Earth Science	Stellenbosch University, South Africa
2016	B.Sc. Earth Science	Stellenbosch University, South Africa

Courses and symposiums

2016	Introduction to C++ (US)
2017	Introduction to Micromine (US)
2018	Introduction to R (AEON – NMU)
2018	ArcGIS and Spatial Statistics (AEON – NMU)
2019	International Symposium of Isotope Hydrology (IAEA) [poster]
2019	Groundwater Age Dating using Noble Gas Concentrations (US)
2020	International Association of Hydrogeologists (IAH)
2022	NICOLA: Resiliency, Nature and Climate Solutions: Striving for Sustainable Land Management
2023	International Association of Hydrogeologists (IAH) – 50th Annual Congress
2024	Water Governance in South Africa
2024	NICOLA: Knowledge Based Solutions and International Drivers

Memberships/Organisations

- South African Council for National Scientific Professions (SACNASP) – Mem. No. 134005 (Pr.Sci. Nat)
- Groundwater Division (GWD) of the GSSA – Mem No. 2742/22
- Network for Industrially Contaminated Land in Africa (NICOLA) – Mem No. NM60b/2022
- Golden Key Honours Society

EMPLOYMENT RECORD

January 2023 – present:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist: Impact and Contamination Business Unit Leader*
January 2020 – December 2022:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist*
November 2018 – December 2019:	GEOSS – Geohydrological and Spatial Solutions International (Pty) Ltd, Stellenbosch *Student Hydrogeologist*

SPECIALIST DECLARATION

I / we, Zita Harilall and Julian Conrad, as the appointed independent specialist(s) hereby declare that we:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to our specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- are fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- are aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Zita Harilall	Julian Conrad
GEOSS South Africa (Pty) Ltd	GEOSS South Africa (Pty) Ltd
SACNASP – Pr.Sci.Nat	SACNASP – Pr.Sci.Nat
14 November 2024	14 November 2024

1 Introduction

GEOSS was appointed by Michelle Lee of Chand Consultants (Pty) Ltd to complete a groundwater impact assessment for a proposed housing development in Grassy Park. The proposed development is to take place on Erf 6482, located in the residential area between Lotus River and Ottery. The study aims to assess the potential impact of the housing development on groundwater in the area surrounding the site. There is the potential for soil and groundwater contamination to occur during the construction and operational phases of the development which could have indirect impacts on surrounding groundwater users.

The study included a desktop assessment of various groundwater databases and a review of hydrogeological and geological maps and reports for the study area. Thereafter, a field visit was conducted to determine the potential impact on the existing groundwater resources and their users. The field visit entailed the installation of a piezometer to understand the subsurface.

2 Scope of Work

The scope of work is to provide groundwater specialist services, including the tasks outlined below:

- Review of available literature and other specialist studies pertaining to the study site.
- Assess the presence and quality of groundwater in the study area.
- Assess the potential impact of the proposed development on hydrogeological resources.
- Provide recommendations and mitigation measures to minimize the risk and impacts from on-site operations.

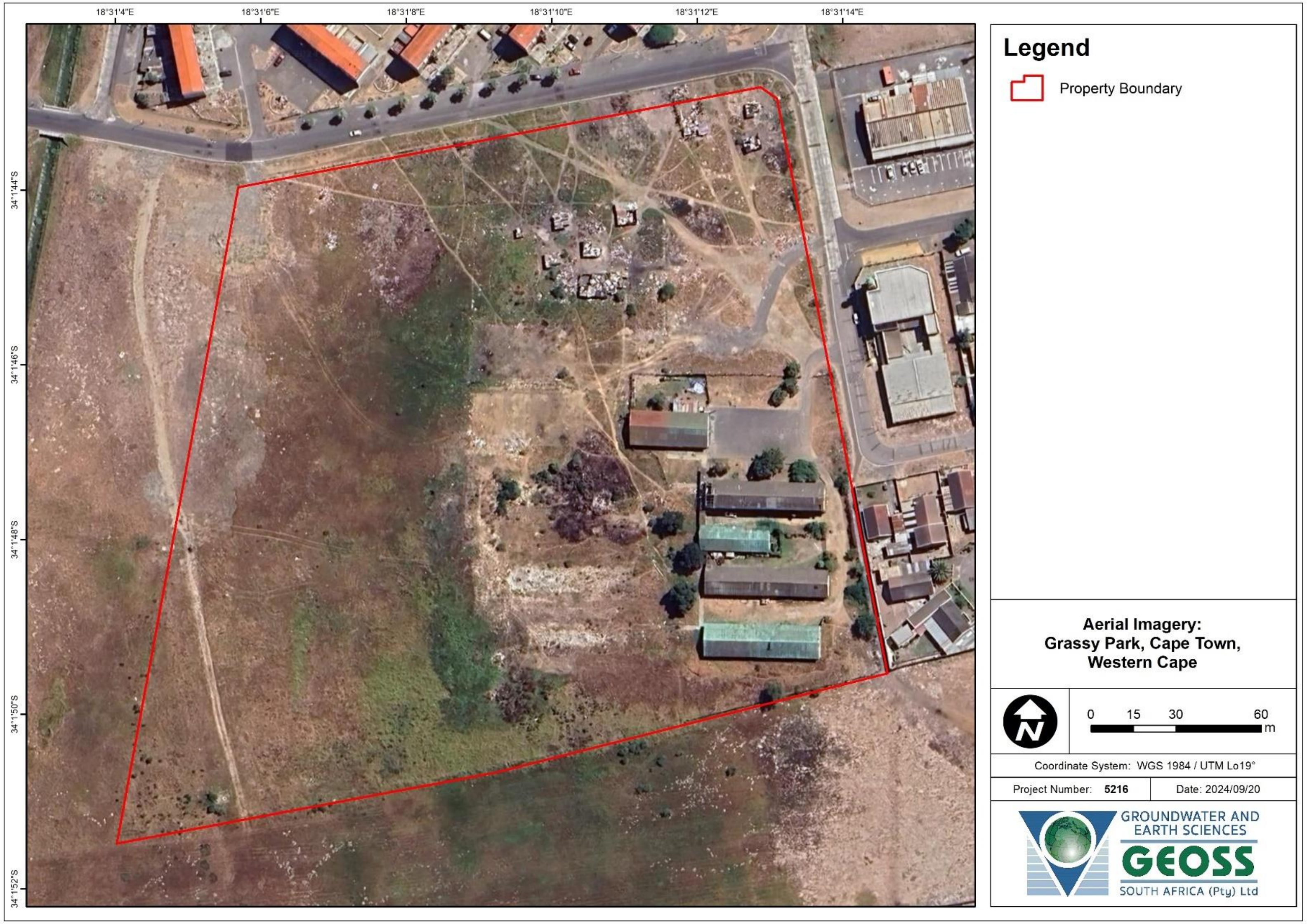
The assessment has been conducted in accordance with accepted best practice principles, particularly DEA&DP Guidelines for involving Hydrogeologists in the EIA Process (June 2005).

3 Methodology

The procedure adopted for this study involved a desktop study followed by field work. The initial desktop study involved obtaining and reviewing all relevant data for the project. This included reviewing relevant site plans, reports and geological maps of the area, and analysing data from multiple groundwater databases which included information on groundwater yield and quality.

A site visit was then conducted to collect additional data and verify as much of the existing data as possible. This included the installation of piezometers, groundwater sampling and noting any subsurface conditions where possible. All collected data was analysed and interpreted to assess the potential risks associated with the intended site development as they pertain to groundwater.

Map 1: Locality map of the proposed development located on Erf 6482, Grassy Park, Cape Town.



Map 2: Enlarged aerial imagery illustrating the property demarcated for the proposed development, Grassy Park.

4 Regional Setting

4.1 Site Context

The study area is located in a residential suburb between Lotus River and Ottery. The site is located in the Cape Flats region of Cape Town, approximately 15 km southeast of Cape Town city centre. The proposed housing development is to take place on Erf 6482. The study area is bound by residential properties in all directions with Strandfontein Road (M17) located to the east. The site falls within the City of Cape Town Metropolitan Municipality and is located within quaternary catchment G22D, which has a General Authorisation (GA) of 400 m^3/ha/a for groundwater use and forms part of the Berg-Olifants Management Area. The general relief of the area is gentle, sloping south towards Zeekoevlei. The elevation range of the entire property is small, ranging between 10 – 15 metres above mean sea level (mamsl).

Notable features in the vicinity include Zeekoevlei, a naturally occurring wetland located approximately 2.4 km south of the proposed development site. The Big Lotus River Canal is located approximately 65 metres west from the western border of the property. This canal feeds Zeekoevlei and discharges drainage from various water sources including general urban run-off, stormwater drainage pipes, and potentially minor industrial run-off. The water from Zeekoevlei flows south towards False Bay via the Zeekoevlei Canal, finally discharging into the ocean at Strandfontein.

4.2 Climate

The study area experiences a Mediterranean climate with cool wet winters and warm dry summers. **Figure 1** illustrates the monthly average minimum and maximum air temperatures, and **Figure 2** illustrates the monthly mean rainfall and evaporation distribution for the study area (Schulze, 2009). The study area receives a mean annual precipitation of 767 mm/a. Rainfall volumes exceed evaporation rates during the rainfall season during the months of May to September. The peak groundwater recharge period is therefore during the winter.

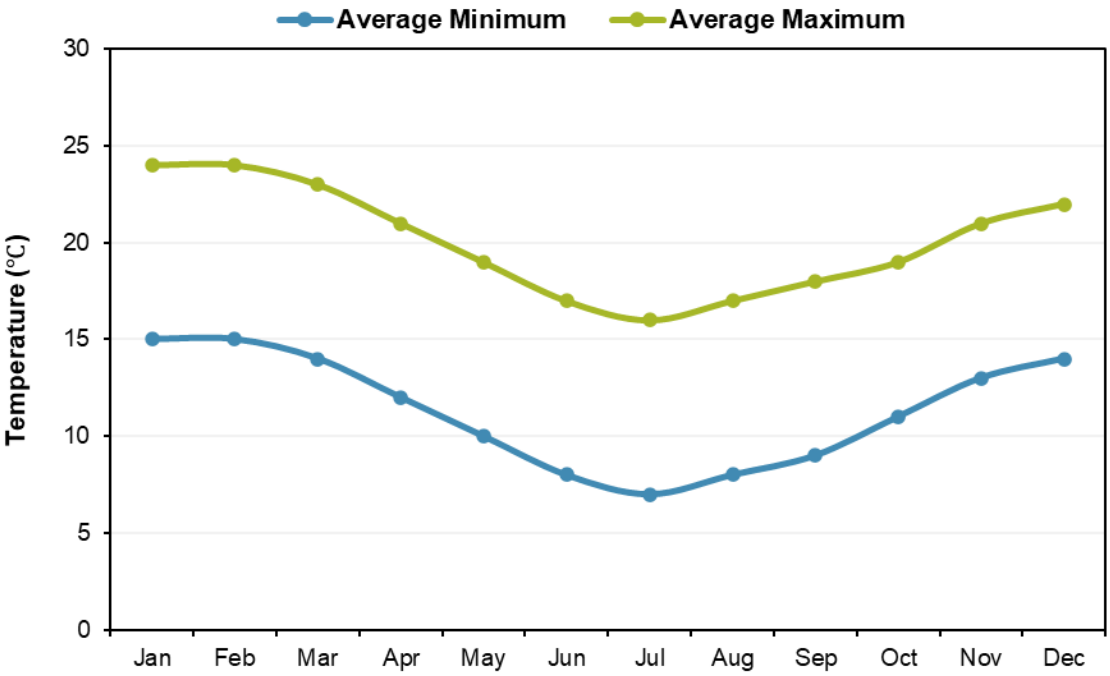


Figure 1: Monthly average minimum and maximum air temperatures for the study area (Schulze, 2009).

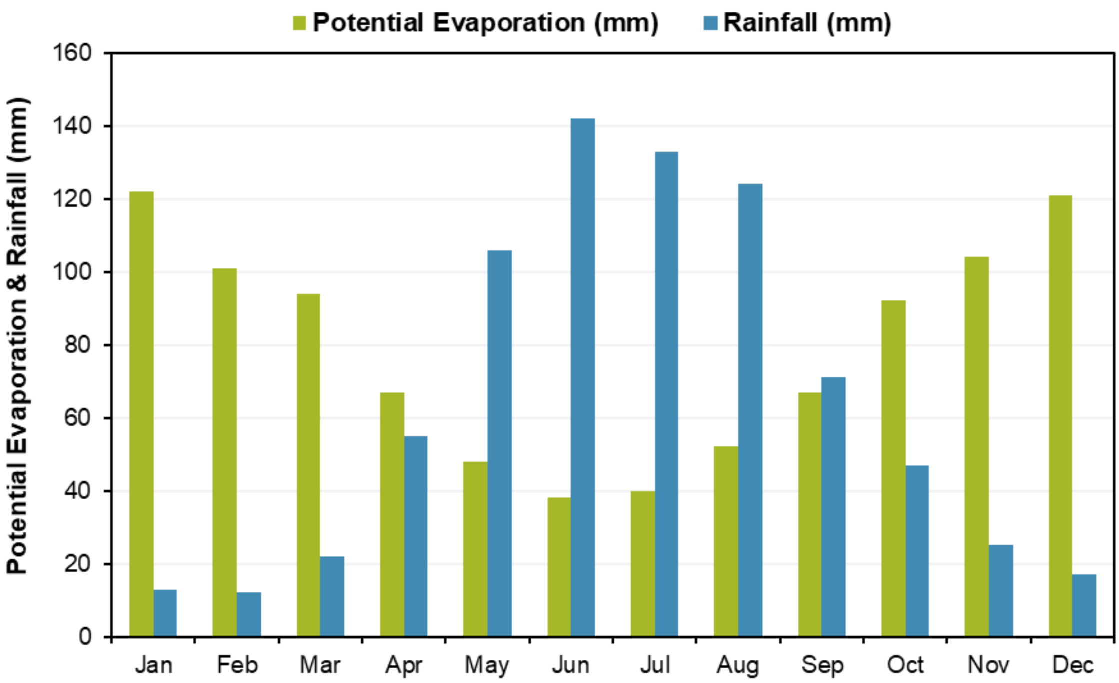


Figure 2: Monthly average rainfall and evaporation distribution for the study area (Schulze, 2009).

5 Regional Geology

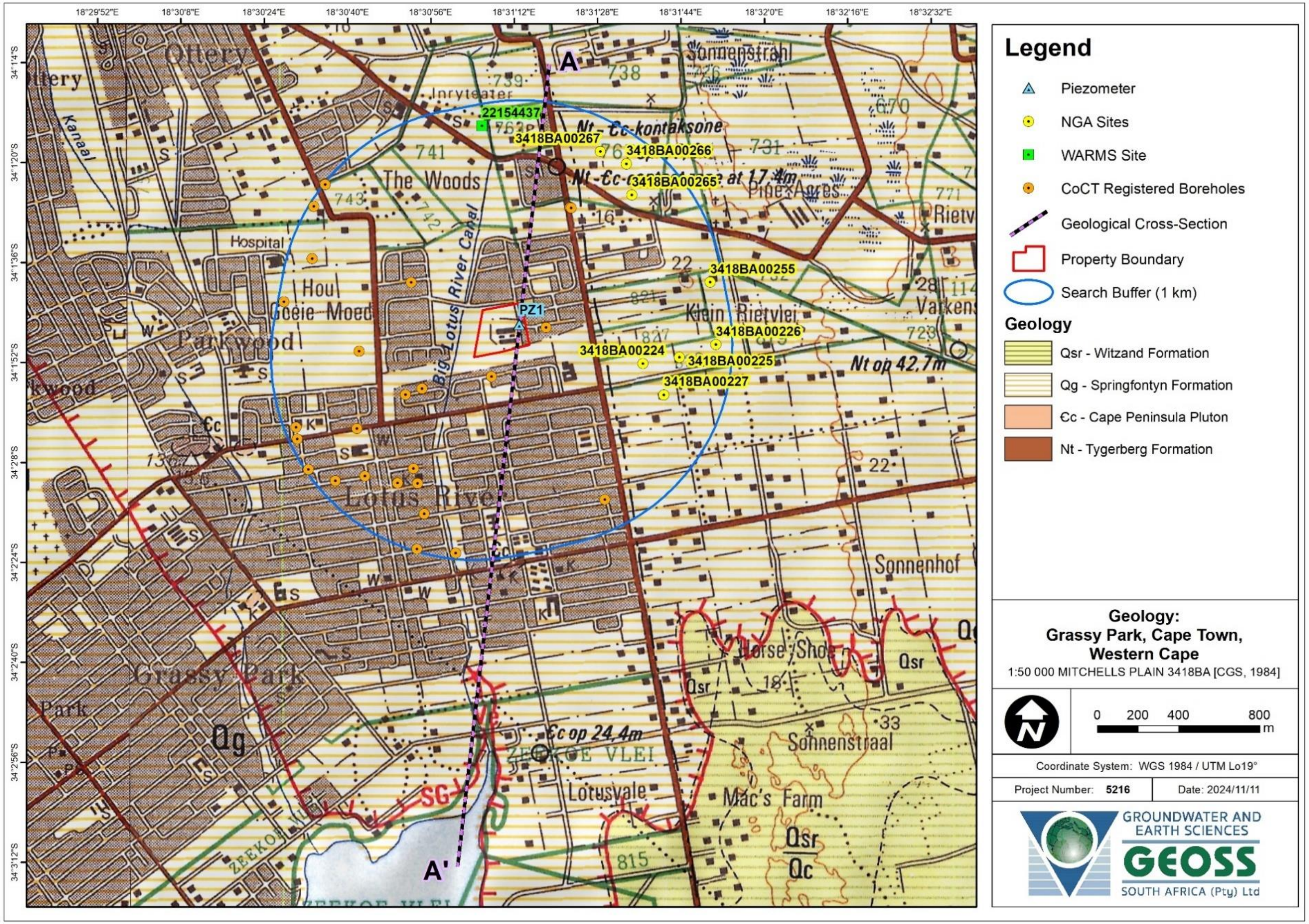
The Geological Survey of South Africa (now the Council for Geoscience (CGS)) has mapped the area at 1:50 000 scale (3318AB and 3318AD (CGS, 1984)). The geological setting is shown in **Map 3** and the main geology of the area is listed in **Table 1.**

Table 1: Geological formations within the study area

Code	Formation	Group	Lithology
Qsr	Witzand	Sandveld	White sand with finely crushed shell; pebbles and shells in places along the beach
Qg	Springfontyn		Light-grey to pale red sandy soil
Qc	Langebaan		Limestone and calcrete
Єc	Cape Peninsula Pluton	Cape Granite Suite	Coarse-porphyritic granite
Nt	Tygerberg Formation	Malmesbury Group	Phyllite, greywacke and sandstone

The site is directly underlain by Quaternary-age sedimentary deposits of the Springfontyn Formation, primarily comprised of light-grey to pale red sandy soil. To the south east of the study site, the geology of the Witzand Formation is encountered. The Witzand Formation is comprised of white sand with finely crushed shells. The Witzand Formation often overlies limestone and calcrete deposits of the Langebaan Formation. These sedimentary formations form part of the Sandveld Group, which overlie the basement rocks of the Malmesbury Group, which have been intruded by batholiths of the Cape Granite Suite. In the area, the bedrock is noted to be between 17.4 m – 42.7 m beneath the surface. A contact zone between the Malmesbury Group and the Cape Granite Suite is mapped a few hundred metres from the eastern border of the property. The Sandveld Group sediments originate from two sources: the weathering of the quartzites and sandstones of the Malmesbury Group and the Table Mountain Group (TMG) which was deposited under marine conditions; as well as from the beaches in the areas, from where aeolian sand was deposited as dunes on the top of the marine sands (Adelana, Xu and Vbrka, 2010).

Sediments of the Springfontyn Formation have been classified as SP (poorly graded sand), SP-SM (poorly graded, silty sands, sand-silt mixtures), or SC (clayey sands, sand-clay mixtures) in terms of the Unified Soil Classification System (USCS) (Fouche, 2021). Further, materials including clayey or silty sands, fine uniform sands and well-graded sands from the Cape Flats have recorded densities between 1 350 and 1 750 kg/m^3, peak friction angles of between 30° and 40°, and cohesion values of up to 13 kPa (Fouche, 2019). Test pit sidewalls excavated within Cape Flats sands typically collapse beneath 2 metres below ground level and this can often be ascribed to shallow groundwater conditions (Fouche, 2021). Finally, Springfontyn Formation sediments were found to have a permeability of 2.8 x 10^{-5} m/s by means of a constant head test undertaken at a density of 1 560 kg/m^3 (Fouche, 2021).



Map 3: Geological setting of the study area displaying the positions of auger holes and database boreholes (1:50 000 scale Mitchells Plain 3418BA (CGS, 1984).

6 Regional Hydrogeology

The site is located on a major unconfined aquifer system, the Cape Flats Aquifer (CFA) which is defined by unconsolidated Quaternary sands (**Map 4**). The CFA covers an area exceeding 400 km^2, extending from False Bay in the south to the Tygerberg Hills in the northeast and Milnerton in the northwest (Hay, 1981, DWAF; 2005a; DWAF, 2008). The aquifer yield and aquifer quality classifications are based on regional datasets, and therefore, only provide an indication of conditions to be expected.

6.1 Aquifer Yield

According to the 1:500 000 scale groundwater map of Cape Town (3318), the study area hosts an **intergranular aquifer** of varying yield (**Map 5**) (DWAF, 2005b). Directly beneath the study site, the average **borehole yield is in the range of 2.0 – 5.0 L/s**. To the northwest, the average borehole yield ranges between 0.5 - 2.0 L/s. The unconsolidated Quaternary deposits form the primary aquifer directly beneath the site. The intergranular aquifer is described as an aquifer in which groundwater is stored within, and flows through open pore spaces in the unconsolidated Quaternary deposits.

6.2 Aquifer Quality

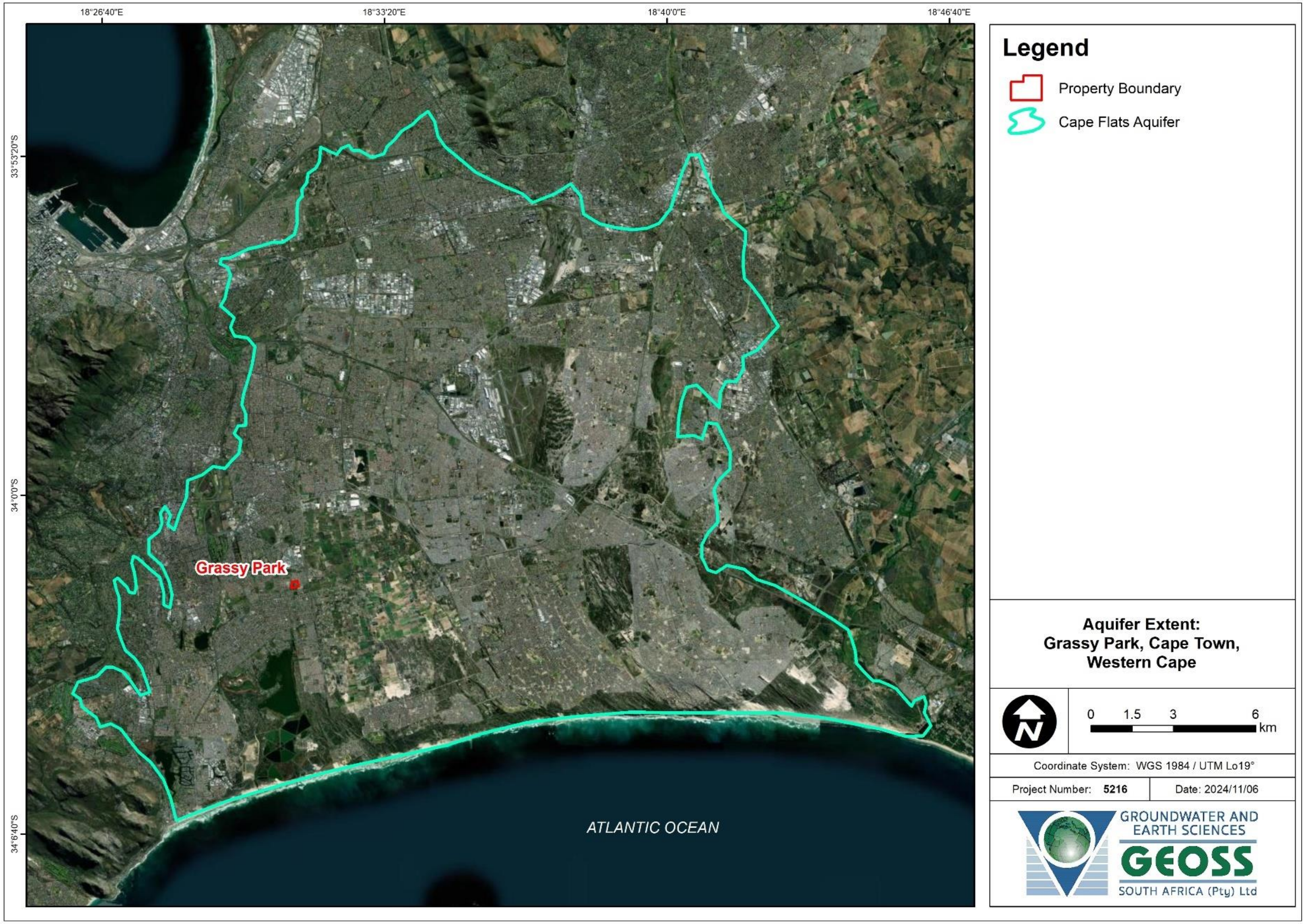
Electrical conductivity (EC) is a measure of the ability of the groundwater to conduct electricity. EC is directly related to the concentration of dissolved ions in the water and this parameter is used as an indication of groundwater quality. The groundwater map indicates that the aquifer has electrical conductivity values in the range of 70 – 300 mS/m (**Map 6**) (DWAF, 2005b). In terms of domestic water standards (DWAF, 1998), water quality in the area ranges from **good** (Class I) (70 – 150 mS/m) to **marginal** (Class II) (150 – 370 mS/m).

6.3 Aquifer Vulnerability Classification

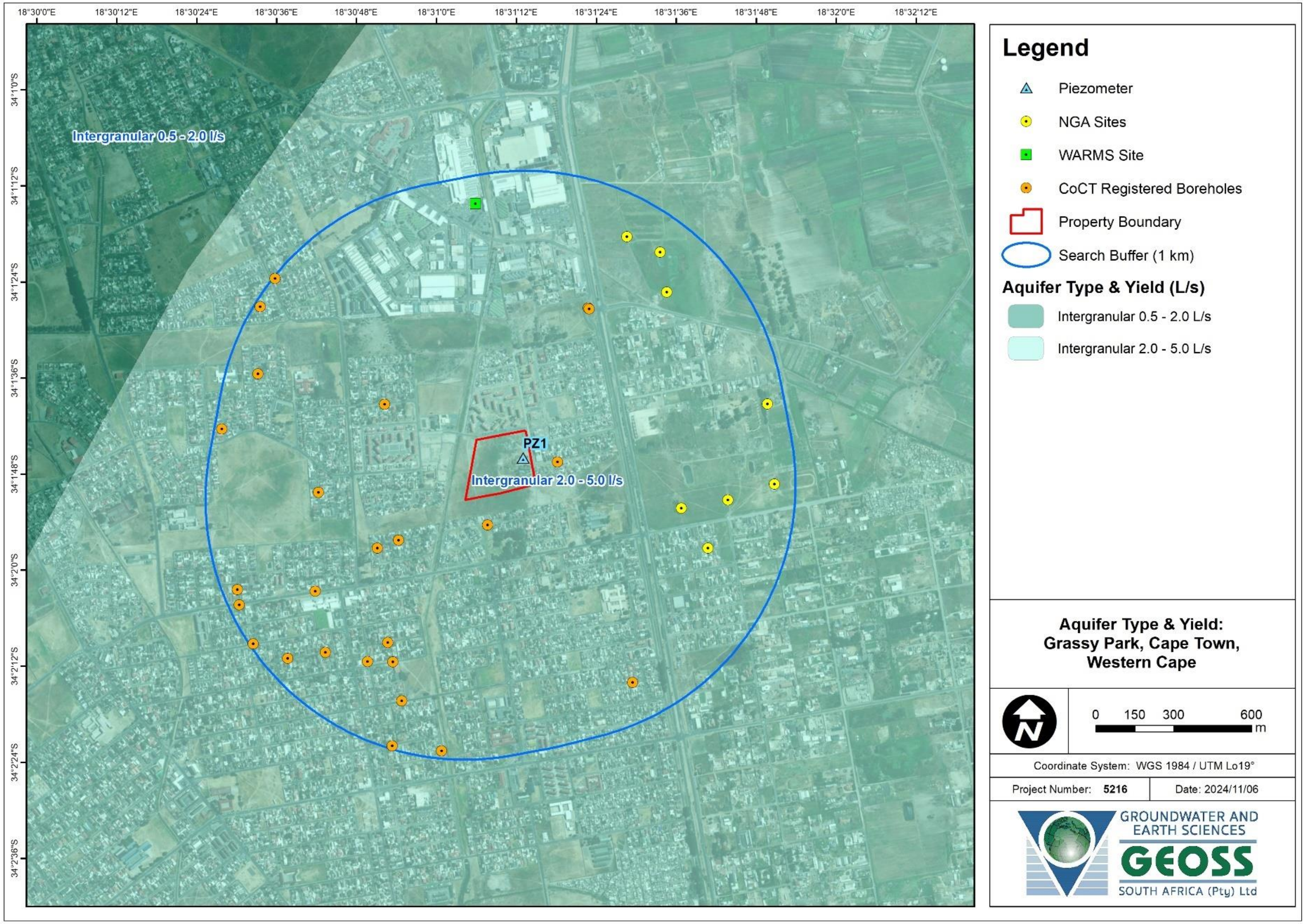
The national scale groundwater vulnerability map, which was developed according to the DRASTIC methodology (Conrad and Munch, 2007), indicates that the study site has a "**very high**" vulnerability to surface-based contamination (**Map 7**). This vulnerability rating is linked to the host geology. High to very high vulnerability ratings are associated with the unconsolidated intergranular aquifer. The DRASTIC method considers the following factors:

D = depth to groundwater (5)
A = aquifer media (3)
T = topography (1)
C = conductivity (hydraulic) (3).
R = recharge (4)
S = soil type (2)
I = impact of the vadose zone (5)

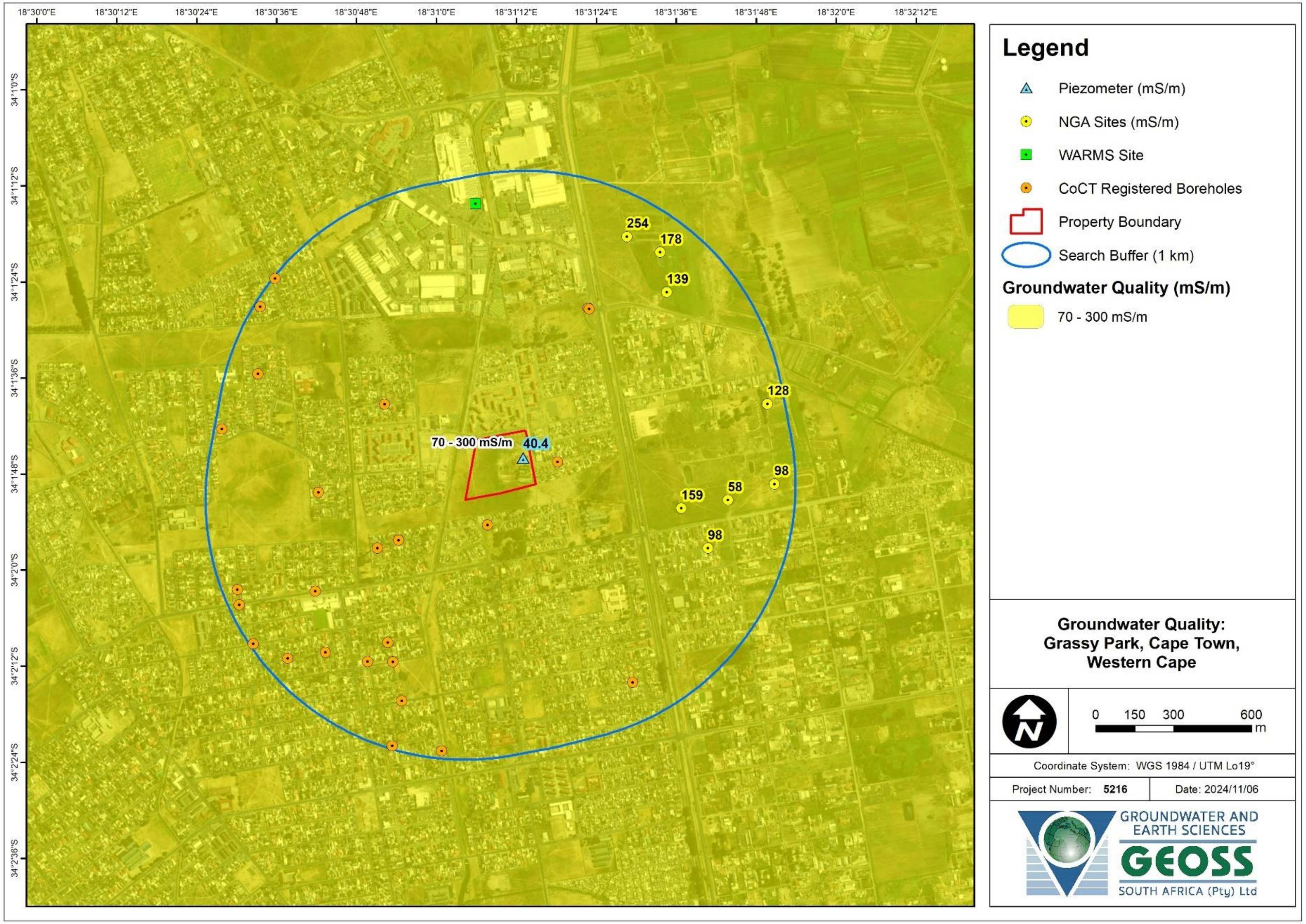
The number indicated in parenthesis after each factor description, is the weighting or relative importance of that factor. The intergranular aquifer hosted in the unconsolidated sands directly beneath the site is highly porous and permeable. Primary aquifers generally have less capacity for attenuating contaminated recharge entering at their surface (WRC, 1995). Therefore, the intergranular (primary) aquifer is susceptible to point and non-point sources of contamination.



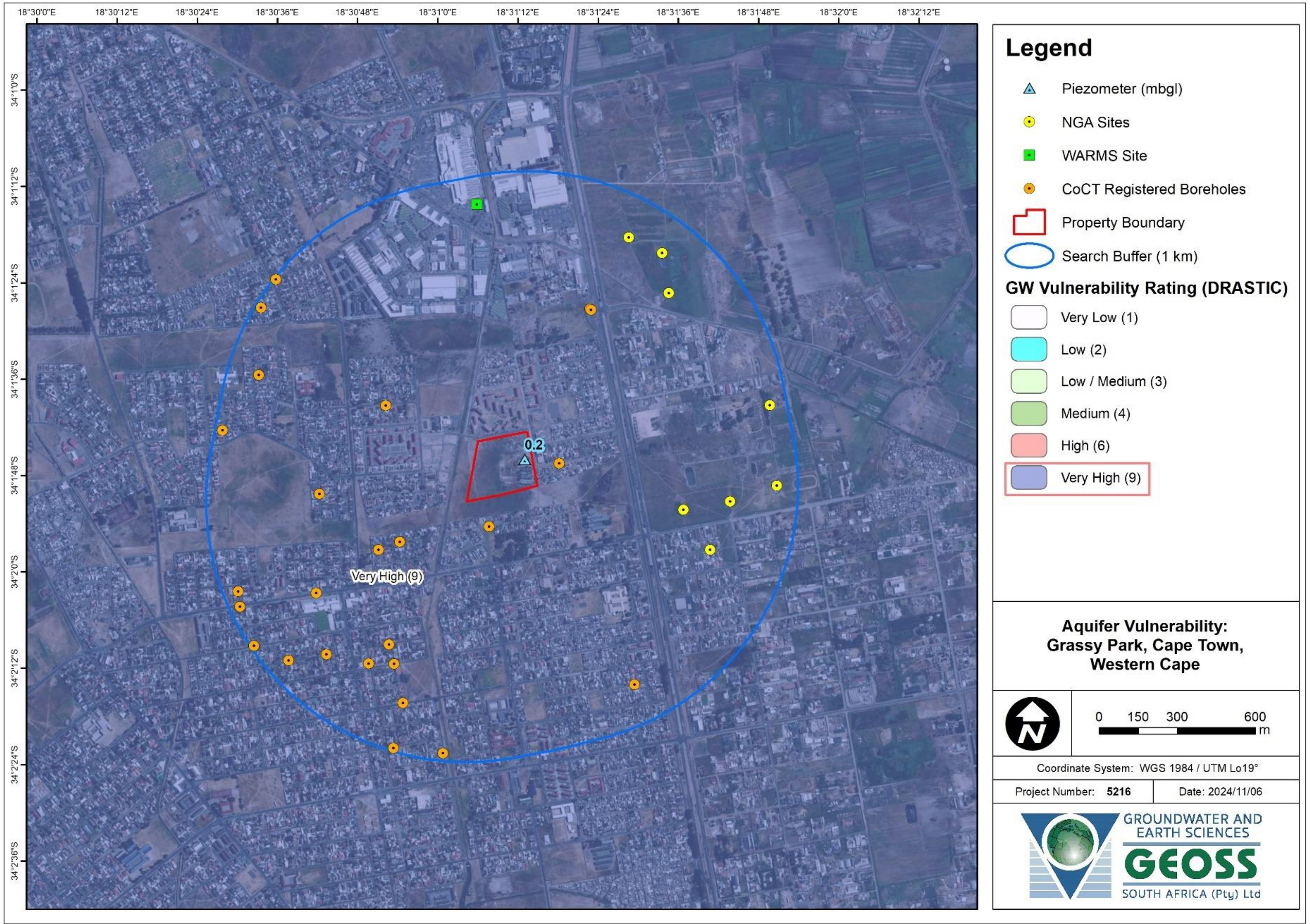
Map 4: Extent of the Cape Flats Aquifer (CFA) system in relation to the study area, Western Cape.



Map 5: Regional aquifer yield (L/s) (DWAF, 2002).



Map 6: Regional groundwater quality (EC in mS/m) from DWAF (2002).



Map 7: Aquifer vulnerability rating (DWAF, 2005) and groundwater depths (mbgl).

7 Site Specific Information

7.1 Desktop Assessment (Existing Groundwater Information)

To determine whether there are any groundwater users in the area that may be affected by activities on site, a database search was conducted using a 1-km radius around the site. This portion of the study was completed by obtaining groundwater information from existing databases. A search was conducted on a number of databases, namely the National Groundwater Archive (NGA), the Water Use Authorisation and Registration Management System (WARMS), the City of Cape Town (CoCT) database as well as the internal GEOSS database. These resources provide data on borehole positions, groundwater chemistry and yield, when available. Based on the desktop assessment of the various databases, there are a number of groundwater users in the area surrounding the proposed development.

7.1.1 National Groundwater Archive (NGA) Database

Assessment of the National Groundwater Archive (NGA) database, which provides data on various groundwater positions, level, chemistry and yield, indicated that there are eight (8) seepage ponds located within a 1-km search area of the site. A seepage pond refers to a groundwater discharge site at the surface. All seepage bonds are located to the east of the study site. No boreholes were found within the 1-km radius. The NGA sites are indicated on **Map 8** and summarised in **Table 2.**

Table 2: Summary of NGA borehole/wellpoint details.

Site ID	Type	Latitude (DD, WGS84)	Longitude (DD, WGS84)	EC (mS/m)
3418BA00227	Seepage Pond	-34.03269	18.52790	98
3418BA00224	Seepage Pond	-34.03130	18.52679	159
3418BA00225	Seepage Pond	-34.03102	18.52873	58
3418BA00226	Seepage Pond	-34.03047	18.53068	98
3418BA00255	Seepage Pond	-34.02769	18.53040	128
3418BA00265	Seepage Pond	-34.02380	18.52623	139
3418BA00266	Seepage Pond	-34.02241	18.52596	178
3418BA00267	Seepage Pond	-34.02186	18.52457	254

7.1.2 City of Cape Town (CoCT) Database

Assessment of the City of Cape Town Database indicates that there are 26 boreholes located in the area surrounding the study site. Little information is known about these boreholes and there are no water level or quality measurements associated with these sites. The City of Cape Town maintains a separate database for wellpoints, but GEOSS was unable to obtain this information from the municipality. Consequently, it is highly likely that there are a greater number of groundwater users in the area than what has been reported. The borehole details are listed in **Table 3,** and the sites are indicated on **Map 8.**

Table 3: Summary of the City of Cape Town borehole details

Site ID	Longitude	Latitude
CoCT_BH1	18.511663	-34.030690
CoCT_BH2	18.511925	-34.036239
CoCT_BH3	18.513675	-34.036563
CoCT_BH4	18.509278	-34.024230
CoCT_BH5	18.514448	-34.027638
CoCT_BH6	18.524722	-34.037339
CoCT_BH7	18.514115	-34.032630
CoCT_BH8	18.521641	-34.029672
CoCT_BH9	18.509898	-34.023263
CoCT_BH10	18.522949	-34.024332
CoCT_BH11	18.522949	-34.024332
CoCT_BH12	18.514692	-34.039492
CoCT_BH13	18.508263	-34.034051
CoCT_BH14	18.515093	-34.037929
CoCT_BH15	18.509170	-34.026563
CoCT_BH16	18.516756	-34.039679
CoCT_BH17	18.514520	-34.035909
CoCT_BH18	18.514737	-34.036582
CoCT_BH19	18.508338	-34.034571
CoCT_BH20	18.514993	-34.032359
CoCT_BH21	18.518710	-34.031844
CoCT_BH22	18.508915	-34.035934
CoCT_BH23	18.507653	-34.028470
CoCT_BH24	18.511514	-34.034120
CoCT_BH25	18.522995	-34.024365
CoCT_BH26	18.510354	-34.036446

7.1.3 Water Use Authorisation and Registration Management System (WARMS) Database

Assessment of the Water Use Authorisation and Registration Management System (WARMS) Database revealed that there is only one (1) registered borehole within 1-km of the study site. This borehole is registered for industrial use. No geological log is available for this site, so groundwater abstraction can be occurring from the intergranular Cape Flats Aquifer, or the underlying fractured aquifer. However, due to the mapped extensive sand cover in the area, the borehole is suspected to be drilled into the intergranular aquifer. This data was extracted from the latest update of the WARMS database (2023). The borehole details are listed in **Table 4** and are presented in **Map 8.**

Table 4: Summary of WARMS borehole details.

Site_ID	Registered Use	Resource Type	Latitude (DD, WGS84)	Longitude (DD, WGS84)
WARMS_BH1	Industry: Urban	Borehole	-34.020694	18.518269

7.1.4 GEOSS Internal Database

Assessment of the GEOSS Internal Database reveals that there are no groundwater sites within 1-km of the study area. GEOSS has, however, conducted piezometer installations in the Grassy Park area approximately 2.5 km southwest. Piezometer logs for these sites indicate similar soil types as what was encountered beneath the study site during the field visit.

7.2 Hydrocensus

Due to inherent safety issues within the study area, a hydrocensus could not be conducted for this study area. Reliance was made on the available desktop information and observations made in the field.

8 Site Visit (Field Work)

8.1 Site Conditions

The site visit occurred on a single day on 27 August 2024. The weather was cold, rainy and overcast during the course of the fieldwork. During the site visit, heavy downpours were experienced and flooding/ponding of water was noted across the property. Further, due to safety concerns in the area, the time on site was limited, resulting in only one piezometer being installed.

8.2 Site Observations

The site visit occurred in late-August 2024, towards the end of the wet season. The water table is expected to be still relatively shallow in comparison to the pre-winter season. During the site visit, flooding and ponding of water was noted across the property, in both paved and grassy areas. A large extent of the site is also noted to be covered with informally discarded waste, the full extent of which is unknown.

Aerial imagery and topocadastral maps indicate that a school was built on the property between 1973 – 1980, but is no longer operational. Building structures forming part of the school were demolished around April 2021. During the site visit, it was observed that there were people occupying the remaining school building structures. Between 2010 and 2016, aerial imagery indicates that there were two unclassified industrial activities occurring on site which have since ceased. Additionally, informal housing (shacks) was noted to be present on site during the field visit and appear to have been in existence since early-2021. Historical images can be seen in **Appendix A.**

8.3 Augering

The site visit involved the augering of holes in an attempt to determine groundwater depth and groundwater quality on site as well as to provide an indication of soil types. The positions of the augered holes are typically chosen to provide a good spatial coverage of the study area (vegetation permitting). The holes are typically hand dug using an auger kit to a maximum depth of 5 m or until water is reached, whichever comes first. When water is intersected, a piezometer is installed. Piezometer installation involves installing a 50 mm PVC pipe as deep as possible below the groundwater level. The PVC pipe is slotted (i.e., screened) to allow groundwater to flow into the pipe. The general construction of such a screened piezometer can be seen in **Figure 3.**

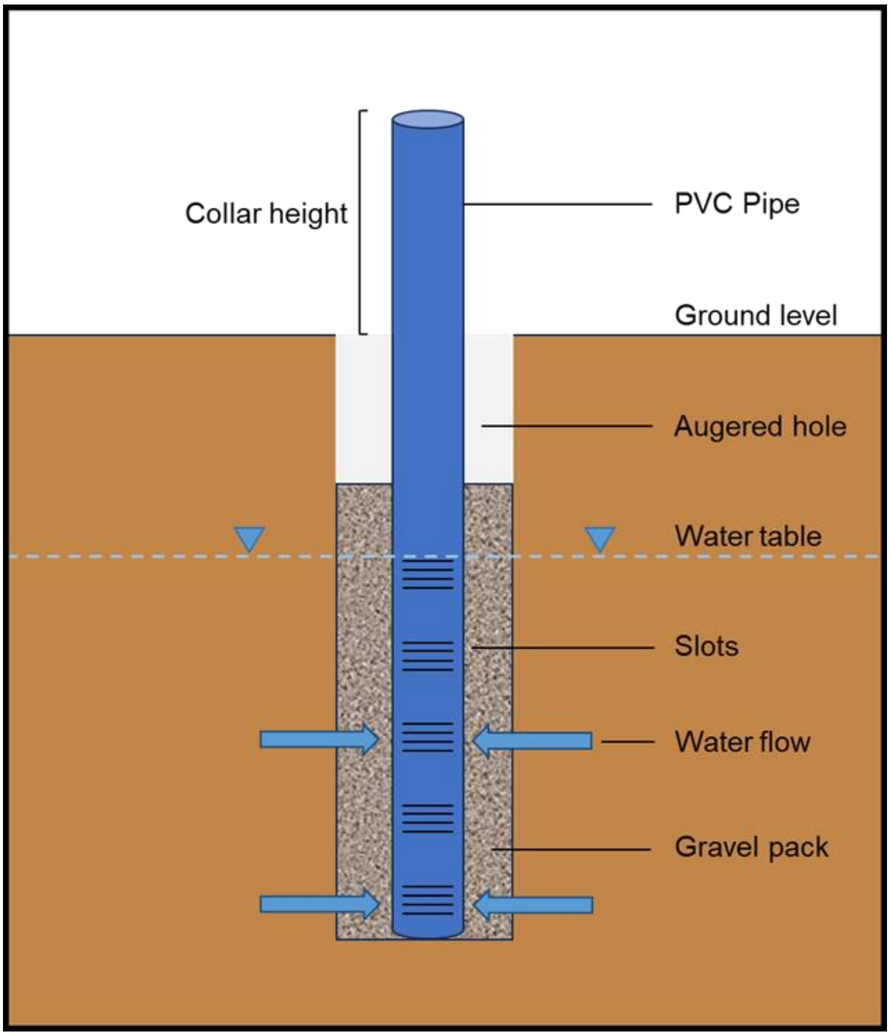


Figure 3: Typical piezometer installation.

During the site visit, only one piezometer was successfully installed. The piezometer was installed at a depth of 1.24 mbgl at an elevation of 15 mamsl. The water level was intersected at 0.18 mbgl. Following the piezometer installation, the piezometer was photographed, and data for the piezometer was logged. The piezometer logs for the site is available in **Appendix B** and site photographs are available in **Appendix C.** The details for the sites are summarised in **Table 5.**

Table 5: Summary of field measurements (27 August 2024).

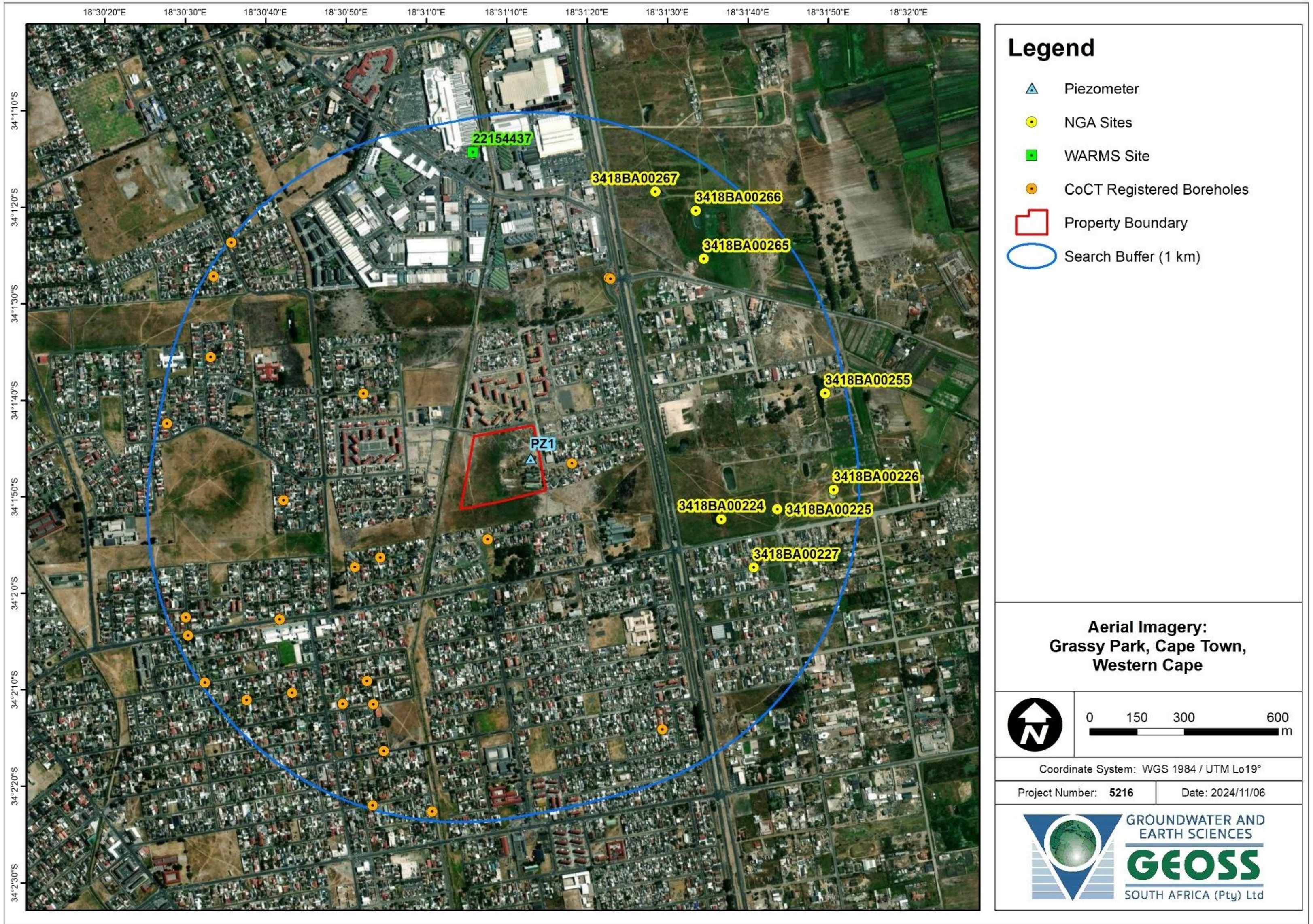
Site_ID	Elevation (mamsl)	Depth (m)	CH (m)	WL (mbgl)	WL (mamsl)
PZ1	15	1.24	0.10	0.18	14.82

Based on the data collected from the auger hole, the soil profile is generally dominated by brown to beige, medium-grained sands of aeolian origin, with layers and lenses of clayey horizons, and horizons characterised by a marked increase in their organic content. A generalised soil profile is presented in **Table 6.**

Table 6: Generalised soil profile for the study area.

Unit	Depth (mbgl)	Description
Unit 1	0.00 to ± 0.54	Wet, orange, clay-rich but sandy soil. Poorly sorted, becomes more clay-rich with depth. Angular gravel clasts encountered. Note: Waste encountered on the surface.
Unit 2	0.54 to ± 0.73	Wet, dark-grey to brown, consolidated, medium- to coarse-grained, quartz-rich SAND. Aeolian in nature.
Unit 3	0.73 to ± 1.42	Wet, beige, consolidated, well-sorted, medium-grained, quartz-rich SAND. Aeolian in nature.
Unit 4	1.42 to EOH	Dark-brown, wet, well-sorted, fine-grained, organic-rich soil. Hole collapse encountered in this layer.

Based on the soil types logged, and the site observations made during the fieldwork, particularly the flooding of the site and a noted decrease in moisture content of the soil unit beneath the clay-rich unit, it is inferred that perched aquifer conditions exist across the site. It is not suspected that this is the case across the entire site, only in certain places, particularly to the south of the property. This is further evidenced by historical aerial imagery.



Map 8: Aerial image showing the property boundary in relation to general surface features and groundwater locations.

8.4 Site Conceptual Model

A regional study undertaken by Adelana, Xu and Vbrka, (2010) sought to determine the hydrogeological conditions in the greater Cape Flats Aquifer. Broadly, the conceptual geological and hydrogeological model of the present site is likely similar to those presented in **Figure 4**. It is worth noting that the organic and clayey materials described in the present investigation, appear to be consistent with the data presented by Adelana, Xu and Vbrka, (2010; **Figure 4**). The reader's attention is drawn to the southwestern end of the geological cross-section labelled G on the accompanying map within the figure.

Based on the field data, a north-south site conceptual model has been compiled for the study area. The soil horizons, particularly the clay layer, are not inferred beyond the piezometer site. The conceptual model is presented in **Figure 5** and based on the geological cross-section presented in **Map 3**.

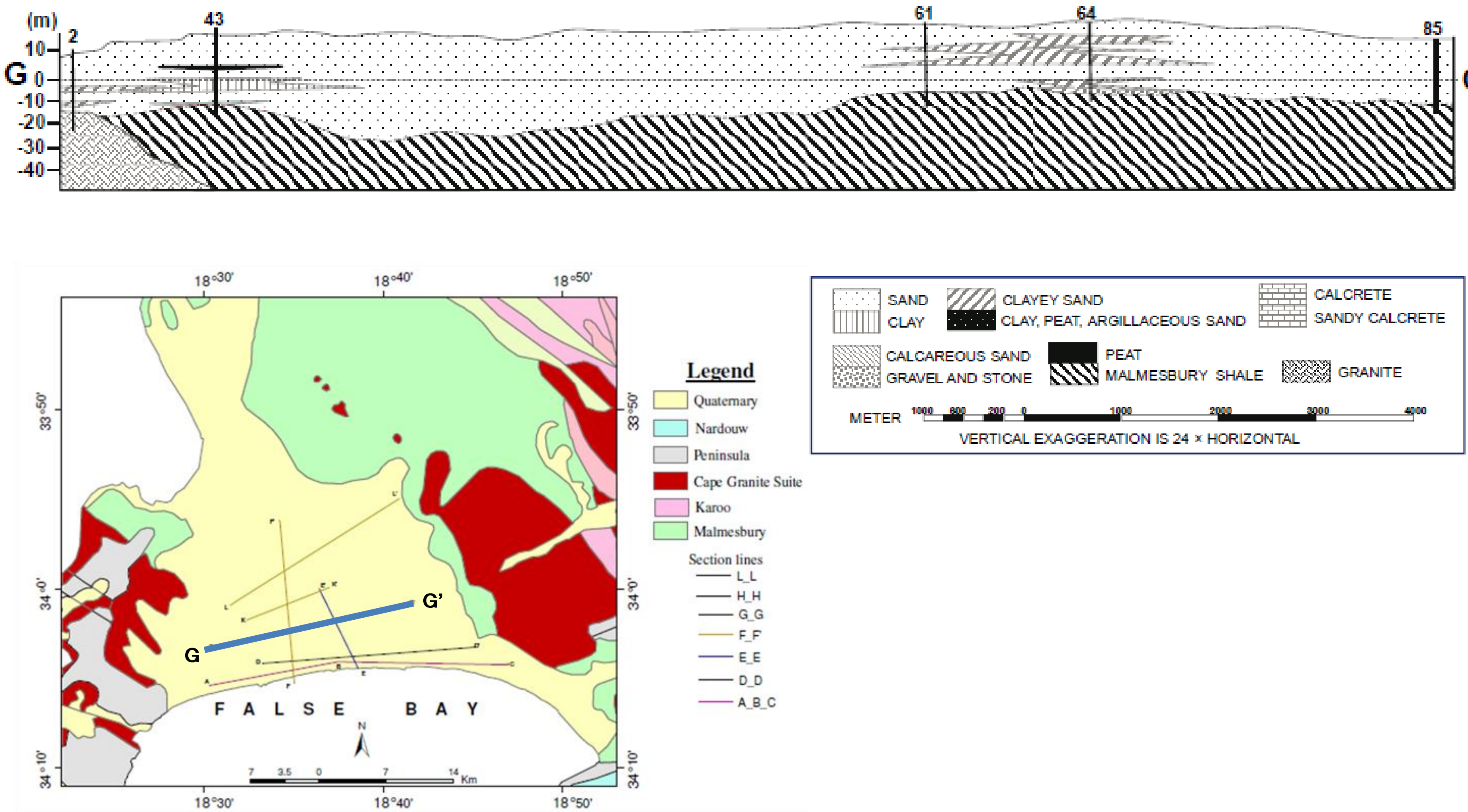


Figure 4: Conceptual diagram of the underlying geology (Adelana, Xu and Vbrka, 2010).

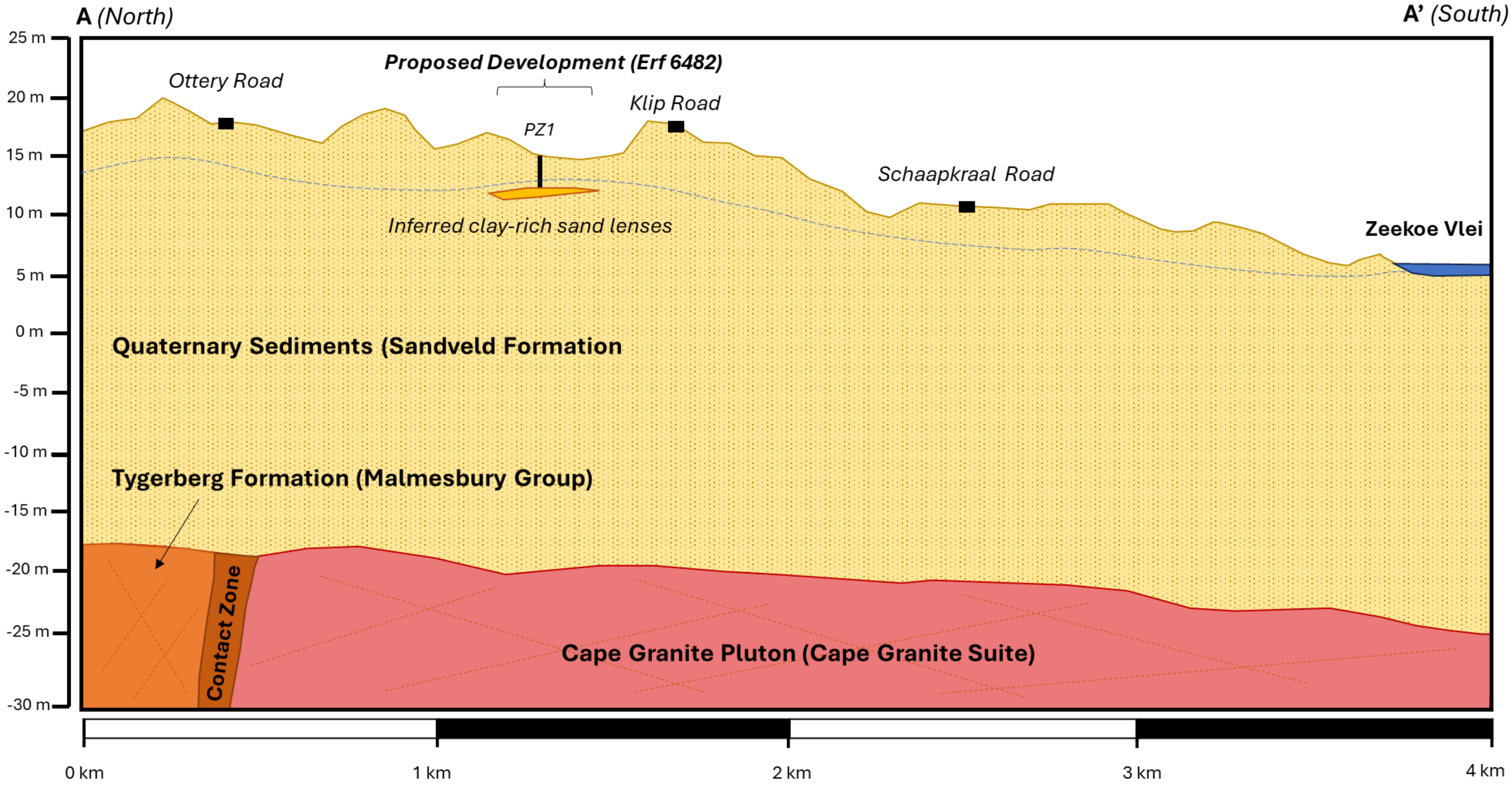


Figure 5: Conceptual diagram of the study area.

8.5 Field Chemistry

During the site visit, field chemistry was recorded where possible. Groundwater pH, electrical conductivity (EC), total dissolved solids (TDS) content, salinity, oxidation-reduction potential (ORP) and temperature were recorded. Measurements were recorded from the piezometer installed during the site assessment, PZ1. Measurements are available in **Table 7** below.

Table 7: Chemistry field measurements for the installed piezometer (27 August 2024).

Site_ID	pH	EC (mS/m)	TDS (mg/L)	Temp (ºC)	SAL (ppt)	ORP (mV)
PZ1	6.85	40.36	323.05	15.2	0.24	168.6

The field chemistry indicates that the water quality is classified as 'ideal' in terms of pH, EC and TDS (DWAF, 1998). The groundwater pH is sub-neutral and the recorded EC is actually better than what is regionally mapped for the area.

8.6 Water Quality Analysis

One groundwater sample was collected during the field visit on 27 August 2024. The sample was collected from PZ1. The chemistry data from the sample has been evaluated to give an indication of the groundwater quality that can be expected at the study site. The laboratory results are available in **Appendix D.** The chemistry results for this site has been classified according to the SANS241-1: 2015 standards for drinking water (**Table 8**). **Table 10** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 8: Classification table for the specific limits.

Acute Health	Aesthetic	Chronic Health	Operational	Acceptable

The chemistry results have also been classified according to the DWAF (1998) standards for domestic water. **Table 9** enables an evaluation of the water quality with regards to the various parameters measured (DWAF, 1998). **Table 11** presents the water chemistry analysis results colour coded according to the DWAF domestic water assessment standards.

Table 9: Classification table for the groundwater results (DWAF, 1998).

Class	Water quality	Description
Class 0	Ideal	Suitable for lifetime use.
Class I	Good	Suitable for use, rare instances of negative effects.
Class II	Marginal	Conditionally acceptable. Negative effects may occur.
Class III	Poor	Unsuitable for use without treatment. Chronic effects may occur.
Class IV	Dangerous	Totally unsuitable for use. Acute effects may occur.

It is important to note that the groundwater intersected on site will not be used for human consumption. The aforementioned domestic use (DWAF, 1998) and drinking water (SANS 241-1:2015) standards are <u>used for reference purposes only</u> as they are widely used quality standards.

The chemistry data indicates that the water quality is classified as 'ideal' in terms of EC and TDS (DWAF, 1998). However, due to elevated iron, turbidity, colour, lead and aluminium exceeding limits (SANS, 2015), the water is classified as dangerous quality and should not be consumed prior to treatment. Elevated turbidity can be attributed to the elevated clay content of the soil which in turn affects the colour of the sample. Aluminium is elevated in the groundwater sample and is likely due to the clay content of the soil. The clays were most likely formed through the weathering of aluminium silicate-bearing minerals in the bedrock. Elevated iron is likely also a function of weathering of the bedrock in the area. Overall, trace metal concentrations (nickel, copper, cadmium, mercury, etc.) are low in the groundwater sample, and are within the relevant SANS 241:2015 drinking water standards. Lead, however, is elevated in the groundwater, but the origin of the lead is unknown.

Table 10: Groundwater quality analysis classified results according to SANS 241-1:2015.

Analyses	PZ1	SANS 241-1:2015
pH (at 25 °C)	7.1	≥5 - ≤9.7 Operational
Conductivity (mS/m) (at 25 °C)	54.3	≤170 Aesthetic
Total Dissolved Solids (mg/L)	368.15	≤1200 Aesthetic
Turbidity (NTU)	894.00	≤5 Aesthetic ≤1 Operational
Colour (mg/L as Pt)	38.00	≤15 Aesthetic
Sodium (mg/L as Na)	34	≤200 Aesthetic
Potassium (mg/L as K)	6	N/A
Magnesium (mg/L as Mg)	7	N/A
Calcium (mg/L as Ca)	81	N/A
Chloride (mg/L as Cl)	42.23	≤300 Aesthetic
Sulphate (mg/L as SO_4)	19.73	≤250 Aesthetic ≤500 Acute Health
Combined Nitrate & Nitrite (ratio)	0.068	≤1 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	≤11 Acute Health
Nitrite Nitrogen (mg/L as N)	<0.05	≤0.9 Acute Health
Ammonia Nitrogen (mg/L as N)	<0.15	≤1.5 Aesthetic
Total Alkalinity (mg/L as $CaCO_3$)	198.5	N/A
Total Hardness (mg/L as $CaCO_3$)	231.2	N/A
Fluoride (mg/L as F)	0.22	≤1.5 Chronic Health
Aluminium (mg/L as Al)	12.726	≤0.3 Operational
Total Chromium (mg/L as Cr)	0.011	≤0.05 Chronic Health
Manganese (mg/L as Mn)	0.020	≤0.1 Aesthetic ≤0.4 Chronic Health
Iron (mg/L as Fe)	5.084	≤0.3 Aesthetic ≤2 Chronic Health
Nickel (mg/L as Ni)	<0.008	≤0.07 Chronic Health
Copper (mg/L as Cu)	0.004	≤2 Chronic Health
Zinc (mg/L as Zn)	0.024	≤5 Aesthetic
Arsenic (mg/L as As)	<0.010	≤0.01 Chronic Health
Selenium (mg/L as Se)	<0.008	≤0.04 Chronic Health
Cadmium (mg/L as Cd)	0.002	≤0.003 Chronic Health
Antimony (mg/L as Sb)	<0.013	≤0.02 Chronic Health
Mercury (mg/L as Hg)	<0.001	≤0.006 Chronic Health
Lead (mg/L as Pb)	0.010	≤0.01 Chronic Health
Uranium (mg/L as U)	<0.028	≤0.03 Chronic Health
Cyanide (mg/L as CN^-)	0.025	≤0.2 Acute Health
Total Organic Carbon (mg/L as C)	26.95	N/A
Charge balance %	9.7	≥-5 - ≤5 Acceptable

Table 11: Classified groundwater sample results according to DWAF (1998).

Analyses:	PZ1	DWA (1998) Drinking Water Assessment Guide				
		Class 0	Class I	Class II	Class III	Class IV
pH	7.1	5-9.5	4.5-5 & 9.5-10	4-4.5 & 10-10.5	3-4 & 10.5-11	< 3 & >11
Conductivity (mS/m)	54.3	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	894.00	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L					
Total Dissolved Solids	368.15	<450	450-1 000	1 000-2 400	2 400-3 400	>3 400
Sodium (as Na)	34	<100	100-200	200-400	400-1 000	>1 000
Potassium (as K)	6	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	7	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	81	<80	80-150	150-300	>300	
Chloride (as Cl)	42.23	<100	100-200	200-600	600-1 200	>1 200
Sulphate (as SO_4)	19.73	<200	200-400	400-600	600-1 000	>1 000
Nitrate (as N)	0.068	<6	6.0-10	10-20	20-40	>40
Fluoride (as F)	0.22	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.020	<0.1	0.1-0.4	0.4-4	4-10	>10
Iron (as Fe)	5.084	<0.5	0.5-1.0	1.0-5.0	5-10	>10
Copper (as Cu)	0.004	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	0.024	<20	>20			
Arsenic (as As)	<0.010	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Cadmium (as Cd)	0.002	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	231.200	<200	200-300	300-600	>600	
Charge Balance %	9.7	≥-5 - ≤5 Acceptable				

8.6.1 Water Quality Diagrams

The Piper diagram in **Figure 6** illustrates the cation and anion distribution relative to one another for the sample collected during the field visit. The Piper diagram indicates that the water quality results for PZ1 can be classified as calcium-carbonate-type water.

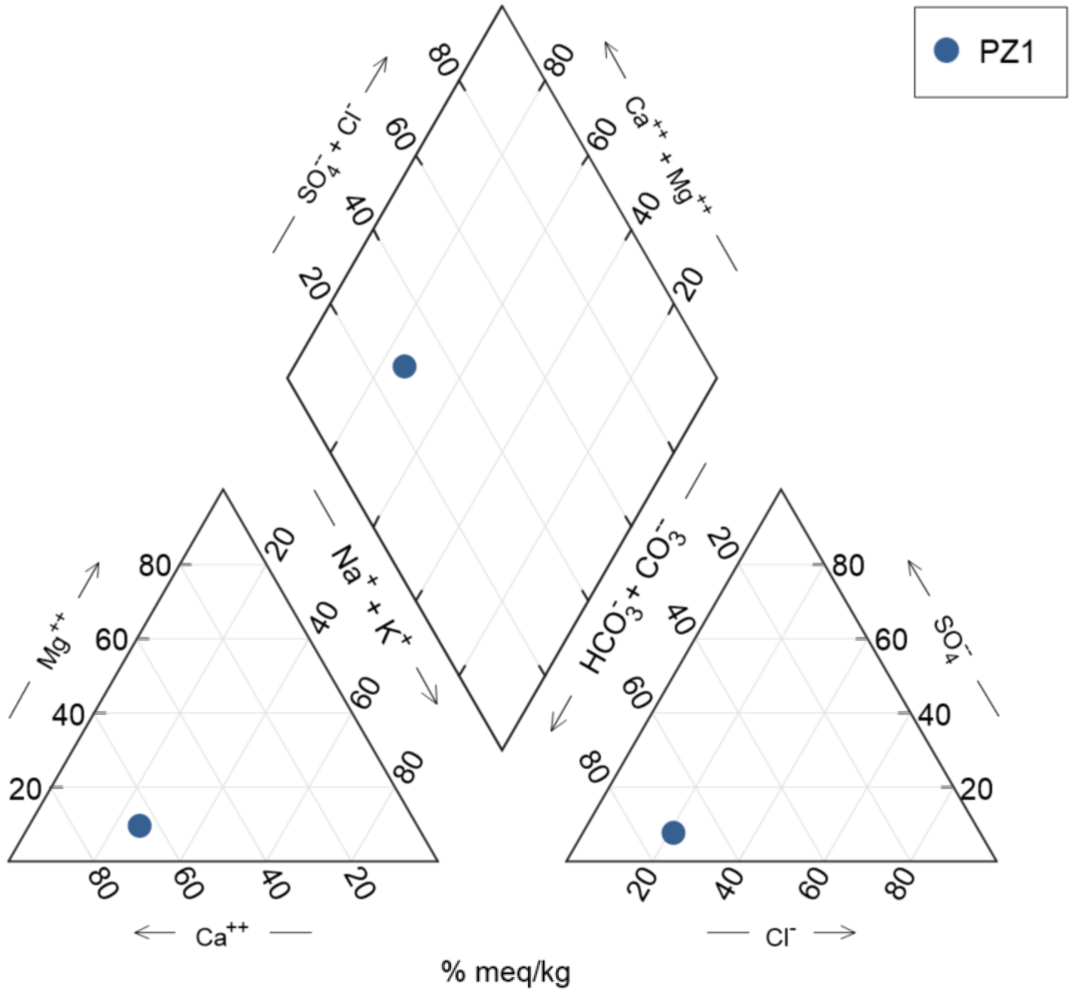


Figure 6: Piper diagram of the groundwater sample collected at PZ1

Stiff diagrams are a quick visual representation of the distribution of major anions and cations within a sample, and are presented in **Figure 7.** Similar to the Piper diagram, the Stiff Diagram indicates that in terms of dissolved ionic content, Ca^{2+} is noted as the dominant cation in sample PZ1 wile HCO_3^- + CO_3^{2-} are the dominant anions.

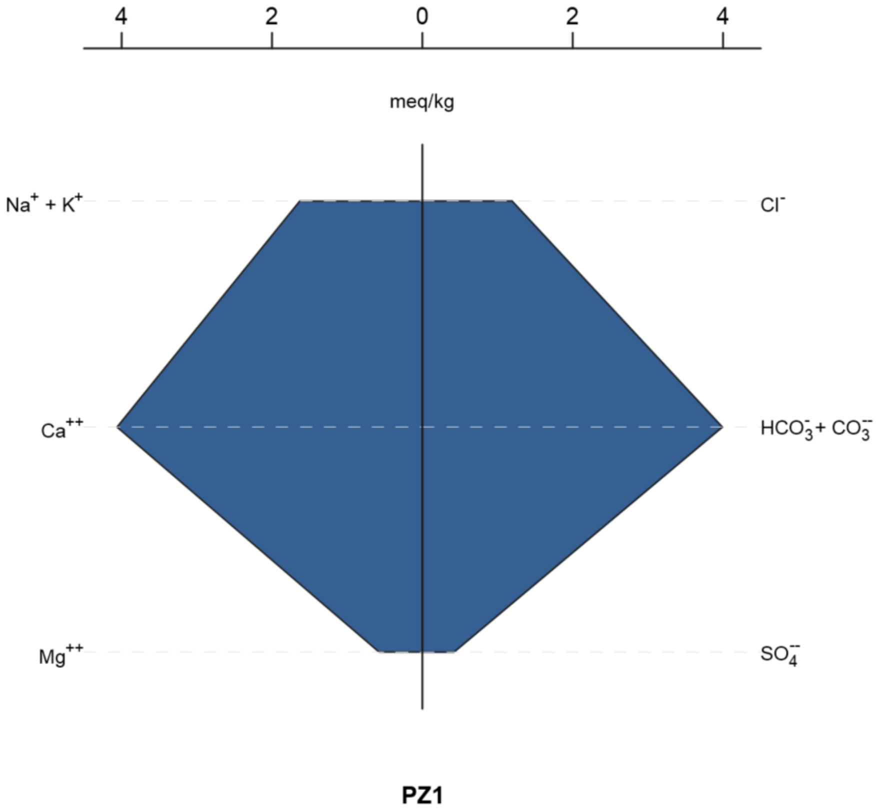
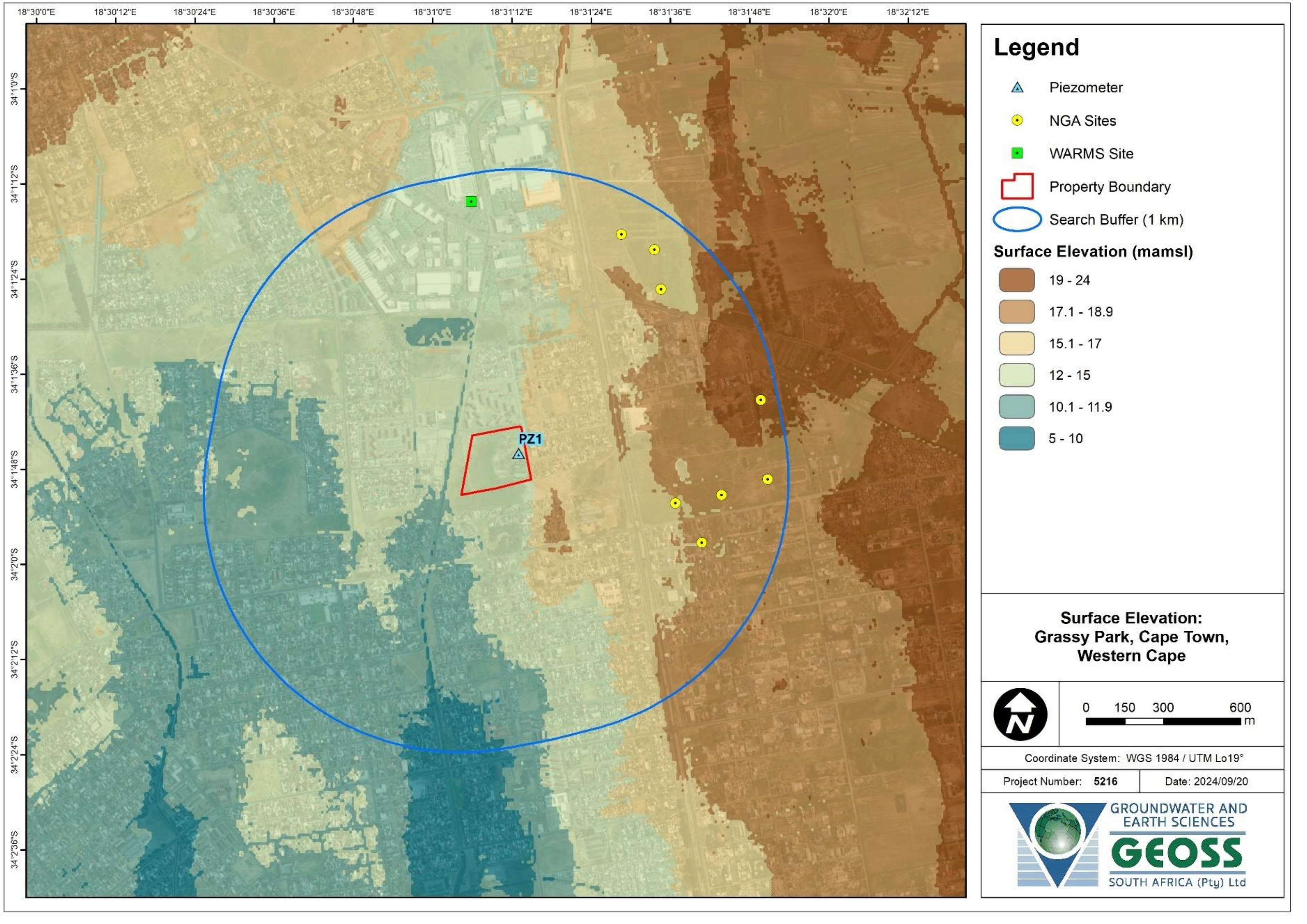


Figure 7: Stiff diagram of the groundwater sample collected at PZ1

8.7 Groundwater Flow Direction

Groundwater flow generally follows surface topography, flowing from areas of high elevation to areas of low elevation. In order to evaluate the relationship between groundwater levels and topography, the surface elevations and groundwater table elevations are plotted relative to each other to assess the applicability of an interpolation technique. Where close correlation between surface elevations and water table elevations exist, interpolation techniques are an appropriate method to estimate values for areas with limited data.

Due to a lack of groundwater level data in the area, however, a groundwater level contour map could not be generated. As groundwater is assumed to flow from topographical highs to lows, a surface elevation map has been constructed and is presented in **Map 9.** There are topographical highs to the east and northwest of the site. Consequently, groundwater is anticipated to follow topography and flow roughly from a north to north easterly direction towards Zeekoevlei, in a south to south westerly direction.



Map 9: Interpolated ground surface elevation map for the study area.

9 Risk Impact Assessment

The site is located on a highly permeable intergranular aquifer which has a “very high” vulnerability classification, indicating that the aquifer has high susceptibility to contamination from anthropogenic activities. Despite the inference that the primary aquifer is perched immediately beneath the site in certain areas, available data would suggest that the clay layer is not continuous throughout the site. It would therefore mean that the major aquifer system may still be susceptible to the same risks. As a result, the following impact assessment pertains to the primary unconsolidated aquifer.

The impact assessments included in this chapter include assessment of potential positive impacts and negative impacts which the development may have for:

- Groundwater quantity (with regard to both recharge and availability),
- Groundwater quality (with regard to pollution).

The risk assessment includes the identification and rating of the potential risks associated with the proposed development and any proposed mitigation measures where possible. Each risk is qualitatively assessed based on the existing information. The risk rating is measured according the criteria in **Appendix E.**

Table 12: Impact table assessing development options as it pertains to groundwater availability

Potential Impact of Development Options on Groundwater Availability	
OPERATIONAL PHASE	
Potential impact and risk:	**Negative – Reducing the available area for groundwater recharge**
Nature of impact:	Direct
Extent and duration of impact:	Local, long-term
Consequence of impact or risk:	Decreased recharge into the local aquifer, ultimately reducing groundwater volumes.
Probability of occurrence:	Probable
Degree to which the impact may cause irreplaceable loss of resources:	Marginal loss of resource
Degree to which the impact can be reversed:	Reversible
Indirect impacts:	Loss of groundwater storage and decreased availability for groundwater users. Downstream wetlands and associated biodiversity may be affected.
Cumulative impact prior to mitigation:	Moderate
Significance rating of impact prior to mitigation	Moderate
Degree to which the impact can be avoided:	Fully avoidable
Degree to which the impact can be managed:	Fully manageable
Degree to which the impact can be mitigated:	Fully mitigated
Proposed mitigation:	Allowance must be made for clean stormwater to be appropriately directed and allowed to infiltrate into the primary aquifer to prevent extensive loss of volume.
Cumulative impact post mitigation:	Low
Significance rating of impact after mitigation	Low

Table 13: Impact table assessing the development as it pertains to groundwater quality prior to the operational phase

Potential Impact of Development Options on Groundwater Quality	
PLANNING, DESIGN AND DEVELOPMENT PHASE	
Potential impact and risk:	**Negative – potential groundwater contamination due to fuel/oil spills and/or leaks during site development**
Nature of impact:	Direct
Extent and duration of impact:	Site specific, medium-term
Consequence of impact or risk:	Moderate
Probability of occurrence:	Possible
Degree to which the impact may cause irreplaceable loss of resources:	Low
Degree to which the impact can be reversed:	High (with rehabilitation)
Indirect impacts:	Hydrocarbon contamination of the soil and/or groundwater could render the water quality as dangerous for consumption and/or use and this will affect other users and ecosystems in the area if the contamination mobilises. Downstream wetlands and associated biodiversity may be affected.
Cumulative impact prior to mitigation:	Moderate
Significance rating of impact prior to mitigation	Medium
Degree to which the impact can be avoided:	Fully avoidable
Degree to which the impact can be managed:	Fully manageable
Degree to which the impact can be mitigated:	Fully mitigated
Proposed mitigation:	Vehicles must be maintained regularly and kept in good working order. No heavy equipment or vehicles must be left on sands/ open soil when not in use (hardstanding surfaces for parked vehicles). Drip trays to be used when vehicles are not in use. Dirty water should be captured, to be re-used where possible. No dirty water is allowed to be discharged into the surrounding environment. Implement monthly groundwater quality monitoring during the construction phase. Developer to ensure any activities with potential to impact groundwater quality are appropriately conducted, and that any spillages/events are responded to timeously. The potential loss of the aquifer as a result of contamination is highly unlikely if proposed mitigation measures are adhered to.
Cumulative impact post mitigation:	Low
Significance rating of impact after mitigation	Low

Table 14: Impact table assessing the development as it pertains to groundwater quality during the operational phase

OPERATIONAL PHASE		
Potential impact and risk:	Negative – infiltration of contaminated stormwater	Negative – potential contamination due to sewage leaks
Nature of impact:	Direct and Indirect	Direct and Indirect
Extent and duration of impact:	Local, long-term	Local, long-term
Consequence of impact or risk:	Contamination of the soil and/or groundwater could render the water quality as dangerous for consumption and/or use and this will affect other users and ecosystems in the area if the contamination mobilises. Downstream wetlands and associated biodiversity may be affected.	
Probability of occurrence:	Probable	Possible
Degree to which the impact may cause irreplaceable loss of resources:	Moderate	High
Degree to which the impact can be reversed:	Moderate	Low
Indirect impacts:	Deterioration of groundwater quality may result in other groundwater users being without suitable water quality and can affect wetland and vegetation health, can also lead to soil pollution. Contaminated groundwater can cause disease and infections with those who come in contact with the water.	
Cumulative impact prior to mitigation:	Moderate	High
Significance rating of impact prior to mitigation	Moderate	High
Degree to which the impact can be avoided:	Fully to partly avoided	Fully avoided
Degree to which the impact can be managed:	Fully managed	Fully managed
Degree to which the impact can be mitigated:	Fully mitigated	Fully mitigated
Proposed mitigation:	Specific attention must be given to the handling of stormwater and sewage, as detailed in the respective design documents. Contaminated water must be treated and transported off-site. Appropriate leak detection procedures must be put in place with frequent monitoring of resources. Should any critical sites be identified in the SDP, regular shallow groundwater monitoring is recommended.	
Cumulative impact post mitigation:	Low	Low
Significance rating of impact after mitigation	Low	Low

10 Discussion

The proposed development overlies thick and laterally extensive intergranular cover which forms the regional Cape Flats Aquifer (CFA). The CFA has been classified as a Major Aquifer System by Parsons and Conrad (1998) due to its high-yielding potential and good water quality. The aquifer has been highlighted as an alternate water supply source to augment the current supply sources in Cape Town. The aquifer, however, is under pressure from agricultural and industrial groundwater users as well as their associated activities. Due to the highly permeable nature of the geology and the shallow water table, localised contamination of the aquifer is likely. The yield of an average borehole in the vicinity of the site, is in the range of 2.0 – 5.0 L/s. Good to marginal quality groundwater (70 – 300 mS/m) is mapped for the area, and assessment of the available information indicates that within the 1-km surrounding the study site, EC ranges from 58 – 254 mS/m.

Use of the National Freshwater Ecosystem Priority Areas (NEFPA) (CSIR, 2011) and the National Wetland Map 5 (NMW5) (CSIR, 2018) hydrological resource databases did not reveal any mapped wetlands or seeps on the property. The delineations are primarily based on remote sensing and may therefore, not account for all wetlands. Analysis of historical aerial imagery, however, suggests that there is a perched water table beneath the site, particularly in the centre of the southern boundary of the property. Seepage at the surface is evidenced by the lush, green areas that have been observed on the property even during the dry seasons of the 2015 – 2018 regional drought.

The perched aquifer conditions are likely due to clay-rich soils present at shallow depths beneath the site. This was substantiated by the soil profiles observed in the auger hole installed on site where wet conditions were observed above the clay-rich soil at a depth of approximately 0.55 mbgl. In the soil layer beneath, soil moisture was noted to decrease. The aerial imagery as well as the conceptual understanding of the aquifer would suggest that perched aquifer conditions do not exist across the entire site. Clay and clay-rich soils are known to be present in lenses within the Cape Flats area. Therefore, the presence of the clay-rich layer is not anticipated to mitigate the risk of the proposed development.

Due to safety concerns in the study area, the duration of the site investigation was limited. Despite this, GEOSS has worked in the area and is familiar with the hydrogeological conditions in the area. The closest study site is located along Klip Road in Grassy Park, approximately 2.5 km away. Similar geological conditions were identified during the site investigation. Beige, aeolian sand, typical of the CFA, was predominant with certain areas of the site being underlain by clay-rich layers. These layers were not consistent throughout the site but promoted flooding/ponding on the surface during periods of high rainfall.

It must also be mentioned that the current (yet informal) land use poses a risk to the aquifer as well. Squatters are present on site and the illegal occupation of the site is associated with unregulated activities (discarding of waste, etc.). A large portion of the site is also covered in illegally discarded waste. The origins and spatial extent of the waste layer is unknown. Based on this, the waste layer will need to be excavated prior to development. Should the waste layer prove to be extensive, it is recommended that a soil study be conducted to assess whether soil contamination has occurred and whether there is a risk to future construction workers and inhabitants of the development. This will also provide insight into whether there is a risk of leaching of contaminants into the groundwater. It must be noted that the piezometer installed on site was installed into perched conditions and not in very close proximity to the waste. Should any hazardous types of waste be

encountered during the excavation, a soil sampling study will be necessary.
Although the aquifer beneath the site is considered to have a very high vulnerability to point-source contamination, the proposed land use has a relatively low risk. Despite a housing development being considered as a low risk land use, the risk for potential contamination still exists. Contamination may occur during the construction phase or during the operational phase of the development. If groundwater contamination does occur, it would most likely follow the groundwater flow direction. Regionally, groundwater flow is towards Zeekoevlei and False Bay in the south. With sufficient mitigation measures in place, the associated risks will be lowered and the development may proceed.

Given the very high vulnerability of the underlying aquifer, the risk of contamination is considered. For a risk to exist there must be a source(s), pathway(s) and receptor(s). All three are present in this case. The proposed development represents a potential source of contamination. The underlying aquifer represents both a potential pathway and receptor. Groundwater users and the surrounding environment represent receptors of potential contamination. As all three are present, the source-pathway-receptor linkages are considered to be complete. The source-pathway-receptor model is presented in **Figure 8**.

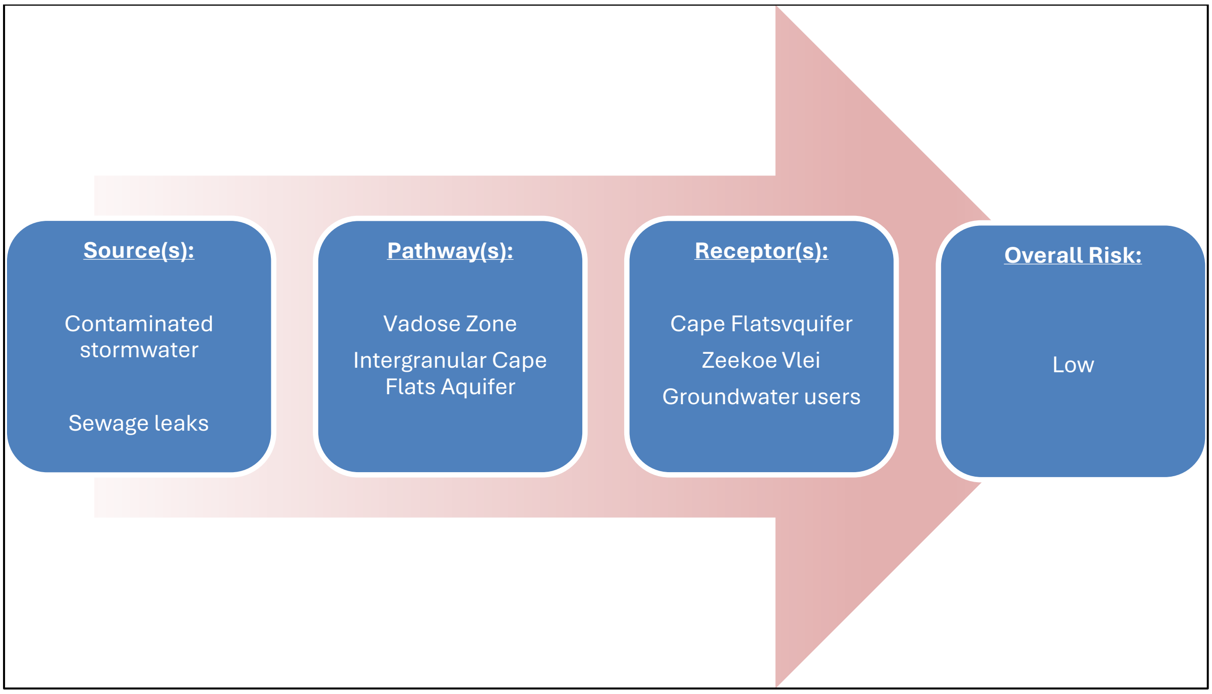


Figure 8: Source, Pathway and Receptor Assessment.

11 Conclusion and Recommendations

Although the aquifer beneath the site is considered to have a very high vulnerability to point-source contamination, the proposed land use is assessed to have a has a relatively low risk. Despite a housing development being associated with a lowered risk, mitigation measures should still be implemented. With sufficient mitigation measures in place, the development may proceed. It must be noted, however, that at the time of report preparation, no proposed site development plan was available for the site which may affect the final risk assessment of the site. Based on the findings of the report, the following recommendations are made:

- It is recommended that the extent of the existing waste observed on site, be investigated. Should the waste be superficial, the waste can be cleared and the development should proceed. Should the waste layer prove to be extensive, it is recommended that a soil study be conducted to assess whether soil contamination has occurred and whether there is a risk to future construction workers and inhabitants of the development. This will also provide insight into whether there is a risk of leaching of contaminants into the groundwater. Should any hazardous types of waste be encountered during the excavation, a soil sampling study will be necessary.
- It is strongly recommended that should the proposed development be approved, that a hydrogeologist review the final site development plan. If necessary, the report will then be revised to:
  - Identify any high risk activities;
  - Update the risk assessment and provide additional mitigation measures where necessary;
  - Compile a groundwater monitoring plan based on the site layout; this may include monitoring during both the construction and operational phases
  - Provide comment on stormwater management design
- Appropriate stormwater management systems must be designed to ensure that clean run-off water is appropriately directed off-site and does not cause flooding of low-lying or clay lined areas nearby. Ideally, clean stormwater should be allowed to infiltrate into the underlying aquifer. The stormwater management system must ensure that potentially contaminated stormwater originating on site is captured. The system must be continually monitored to ensure that no potentially contaminated run-off water flows off-site.
- Appropriate spill and leak detection must be enforced for contaminated stormwater and sewage systems. Additionally, all areas where any potentially hazardous activities will take place, must be appropriately lined and/or bunded.

12 Assumptions and Limitations

The following assumptions and limitations are noted for this study:

- Available data was sourced from the relevant groundwater databases and sources. The aquifer vulnerability, yield and quality data is predominantly accurate, albeit mapped at a regional scale.
- At the time of the report issue, no available site development plan was available and a general assessment was conducted of the demarcated property to determine the potential impact on groundwater resources in the area.
- A further limitation was the temporal nature of the site visit. The field work was undertaken on a single day in August 2024, and does not account for the temporal variability of the water table. This, however, is not anticipated to affect the findings of the report as the shallow water table is accounted for.
- Due to safety concerns in the area and despite the police escort to the site, the site visit was cut short and only a single piezometer could be installed in the time available.
- Again, due to safety concerns, no hydrocensus was conducted and desktop data was relied on to indicate the distribution of surrounding groundwater users. It is possible that there

are a greater number of groundwater users in the area than what has been reported in this study as not all groundwater use tends to be registered, particularly when small volumes are used for domestic purposes.

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14 Appendix A: Historical Aerial Imagery

Photo 1: Aerial imagery of Erf 6482, Grassy Park in 1980

Photo 2: Aerial imagery of Erf 6482, Grassy Park in July 2012

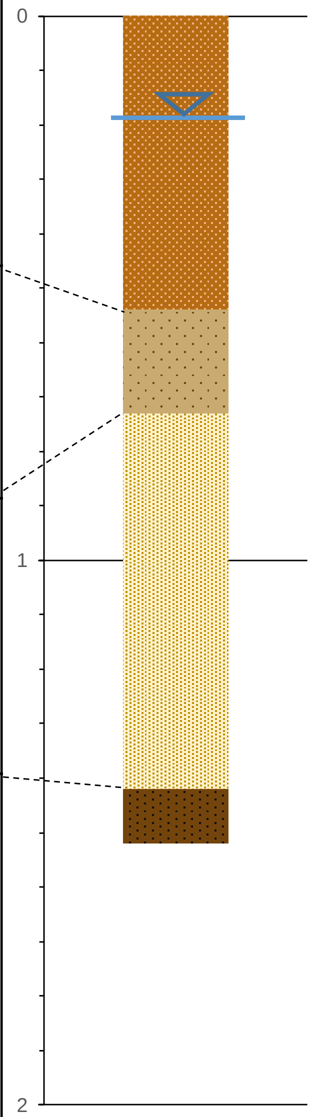
Photo 3: Aerial imagery of Erf 6482, Grassy Park in May 2021

Photo 4: Aerial imagery of Erf 6482, Grassy Park in May 2024

15 Appendix B: Piezometer Logs

Log of Piezometer No.:	PZ1

Location:	Grassy Park	**Latitude:**	-34.029522
Date:	27-Aug-24	**Longitude:**	18.520220
Client:	Chand Consultants	**Ground Elevation:**	15 mamsl

Lithological Description	Lithology (mbgl)	Construction	Comments
Unit 1: 0.00 - 0.54 Wet, unconsolidated, orange, poorly-sorted, medium grained, clay-rich SAND, Top Soil. Roots and extensive discarded waste material in this layer. Angular gravel clasts present.			End Cap 50 mm solid PVC
Unit 2: 0.54 - 0.73 Wet, aeolian, unconsolidated, medium- to coarse-grained, dark grey to brown sand. Beach sand. Quartz grains evident.			
Unit 3: 0.73 - 1.42 Wet, aeolian, consolidated, well-sorted, medium-grained, beige sand. Beach sand. Quartz grains evident.			(~0.50 meters of 50 mm slotted PVC)
Unit 4: 1.42 - 1.52 Wet, well-sorted, dark brown, fine-grained, organic-rich sand. Moisture decreases with depth.			End Cap

Excavated By:	GEOSS	**Remarks:**	End of Hole = 1.52 mbgl. Hole collapse prevented further augering. Water level at 0.28 mbgl.
Drill Method:	Hand Auger		
Logged By:	Zita Harilall		

16 Appendix C: Field Photos

Photo 1 - 4: Soil profiles encountered at PZ1

Photo 5: PZ1

Photo 6: Flooding noted on site on existing paved areas

Photo 7: Ponding noted on site on grassy area

Photo 8: Site conditions observed during the field visit

17 Appendix D: Laboratory Results

vinlab H2O
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Distillery Road
Stellenbosch
Tel 021-8828866/7
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2024-09-02

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

P.O.Box 12412
Die Boord, Stellenbosch
7613
+27218801079

@VinlabSA

Sample Details					
SampleID	W54914				
Water Type	Drinking Water				
Water Source	Not Indicated				
Sample Temperature					
Description	PZ1 (Groundwater)				
Batch Number	PZ1 (Groundwater)				
PO Number	5216_A				
Date Received	2024-08-28				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C (Water)		VIN-05-MW01	^^^	>=5 to <= 9.7	7.10				
Conductivity@25C (Water)	mS/m	VIN-05-MW02	^	<= 170	54.3				
Turbidity (Water)*	ntu			<= 5	894.00				
Total dissolved solids (Water)*	mg/L			<= 1200	368.15				
Free Chlorine (Water)*	mg/L			<= 5	<0.02				
Ammonia (NH4) as N (Water)	mg/L	VIN-05-MW08	8.90%	<= 1.5	<0.15				
Nitrate as N (Water)	mg/L	VIN-05-MW08	11.00%	<= 11	<1.00				
Nitrite as N (Water)	mg/L	VIN-05-MW08	4.50%	<= 0.9	<0.05				
Chloride (Cl-) - Water	mg/L	VIN-05-MW08	10.12%	<= 300	42.23				
Sulphates (SO4) - Water	mg/L	VIN-05-MW08	7.56%	<= 500	19.73				
Fluoride (F) - Water	mg/L	VIN-05-MW08	12.30%	<= 1.5	0.22				
Alkalinity as CaCO3 (Water)*	mg/L				198.50				
Colour (Water)*	mg/L Pt-Co			<= 15	38				
Total Organic Carbon (Water)*	mg/L			<=10	26.95				
Date Tested					2024-08-28				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		81				
Magnesium (Mg) - Water	mg/L	VIN-05-MW43	8.49%		7				

Please click here for SANS241-1:2015 drinking water limits

Test results relate only to the items tested as received. This Document shall not be reproduced without the written approval of Vinlab (Pty) Ltd.Opinions and interpretations expressed herein are outside the scope of SANAS accreditation. Results for methods VIN-05-MW12, 13 and 14, are based on Cq values, a positive result (detected) indicates a Cq value <35 and a negative result (non-detected) indicates a Cq value of >35.

*** Not SANAS Accredited. Results marked "Not SANAS Accredited" in this report are not included in the SANAS Scope of Accreditation for Vinlab.**

Vinlab is not liable to any client for any loss or damages suffered which could, directly or remotely, be linked to our services Alcohol results are obtained using the most appropriate or a combination of one of the following methods: Py= pycnometer; W=winescan; Al=alcolyzer. W= Winescan. Micro results: Enumeration of yeast: WL nutrient, 3 days unless otherwise specified, 30°C. Samples that have had prior microbiological spoilage or treatment for spoilage should always be sterile filtered at bottling. SO2 additions less than 10 days may depress the growth of microbes in culture although they are viable/active in the wine. Some microbes, especially lactobacilli, may not grow in culture even where viable/potentially active in the wine.

^ - Conductivity <1000mS/m = ±1mS/m , >1000mS/m = ±9mS/m
^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

sanas Testing Laboratory T1131

Doc No V55404 | VIN 09-01 07-05-2024 | Page: 1 of 2 | Visit Vinlab H20 vinlab H2O

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TEST REPORT

Water

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Attn: Alison McDuling

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@VinlabSA

Sodium (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	34					
Potassium (K) - Water	mg/L	VIN-05-MW43	9.42%		6					
Zinc (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	0.024					
Antimony (Sb) - Water*	µg/L			<=20	<13.0					
Arsenic (As) - Water*	µg/L			<= 10	<10.0					
Boron (B) Water	µg/L	VIN-05-MW43	11.79%	<= 2400	33					
Cadmium (Cd) Water	µg/L	VIN-05-MW43	12.26%	<= 3	2					
Chromium (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	11					
Copper (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	4					
Iron (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	5084					
Lead (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	10					
Manganese (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	20					
Nickel (Ni) - Water	µg/L	VIN-05-MW43	17.38%	<= 70	<8					
Selenium (Se) - Water*	µg/L			<= 40	<10.0					
Aluminium (Al) - Water	µg/L	VIN-05-MW43	13.49%	<= 300	12726					
Cyanide (CN) - Water*	µg/L			<= 200	25.0					
Mercury (Hg) - Water*	µg/L			<= 6	<1.0					
Barium (Ba) Water	µg/L	VIN-05-MW43	14.09%	<= 700	48					
Uranium (U) - Water*	µg/L			<= 30	<28					
Date Tested					2024-08-28					

Comments
W54914 Ion balance = 9.7%

AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)
VIN-05-
M01,M02,M03,M04,M05,MO8,M10,M28,
M43, MW01, MW02, MW03, MW04,
MW05, MW06, MW07, MW08/9/10,
MW12, MW13, MW14

Please click here for SANS241-1:2015 drinking water limits

^ - Conductivity <1000mS/m = ±1mS/m , >1000mS/m = ±9mS/m
^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

sanas Testing Laboratory T1131

18 Appendix E: Risk Rating Criteria

Nature of impact	**Description**
Positive	Impacts would benefit the receiving environment (including people).
Negative	Impacts would harm the receiving environment (including people).
Type of impact	**Description**
Direct	Impacts that result directly from the causal activity, usually at the same time and in the same space as that activity
Indirect	Secondary impacts may result from direct impacts, generally occurring later in time and may manifest elsewhere in space (e.g. downstream)
Induced	Impacts that may happen as a consequence of the Project (e.g., migration of people along newly created access routes)
Cumulative	Impacts that add to or magnify existing or reasonably foreseeable future impacts on the same receiving environment or specific resource
Extent Rating	**Description**
Site specific	Impact (and implications) limited to the project site.
Local	Impact extends only as far as the activity, limited to the site and its immediate surroundings, and local assets/ resources.
Regional	Impact extends to a regional scale, and affects provincial resources, e.g. District or Province; Western Cape
National	Impact extends to a national scale, and affects national resources; South Africa.
International	Impact extends across national borders, and affects global resources.
Duration Rating	**Description**
Short term	0 - 5 years
Medium term	5 - 15 years
Long term	Where the impact will cease after the operational life of the activity, either because of natural processes or by human intervention. Generally >15 years but <30 years
Permanent	Where the impact will, for all intents and purposes, endure in perpetuity. That is, it would be regarded as 'irreversible'
Intensity Rating	**Description**
Low	Where the impact affects the environment in such a way that a small or negligible proportion of resources and/or beneficiaries would be affected. Receptors in the receiving environment are not threatened or vulnerable, and affected communities have negligible or very low dependence on affected resources for livelihoods, health and safety.
Medium	Where a sizeable proportion of resources and/ or of beneficiaries would be affected, and natural, cultural and social functions and processes would continue, albeit in a modified way. Receptors in the receiving environment are moderately threatened or vulnerable, and/ or affected communities have some dependence on affected resources for livelihoods, health and safety, affected resources could be substituted.
High	Where most/ a major proportion of resources and/ or beneficiaries would be affected, and natural, cultural and social functions or processes are altered to the extent that they would temporarily or permanently cease. Receptors in the receiving environment are highly threatened or vulnerable (i.e. close to environmental or legal thresholds, standards or targets), and affected

	communities are highly dependent on affected resources for livelihoods, health and safety, and/ or resources are considered to be irreplaceable (if lost they could not be substituted, and/ or their loss would undermine achieving targets, standards).
Probability Rating	**Description**
Improbable	Where the possibility of the impact materializing is very low, but it could occur e.g. in unplanned / upset conditions
Possible	Where there is a possibility that the impact will occur during normal operations.
Probable	Where the impact is expected to occur during normal operations
Definite	Where the impact will undoubtedly occur.
Confidence Rating	**Description**
High	High confidence in predictions.
Medium	Some uncertainty in predictions e.g. due to information gaps, constraints on study
Low	Little confidence in predictions e.g. due to constraints on study, information gaps, inherent uncertainties
Significance Rating	**Description**
Negligible	Where the receiving environment (including people) would not be materially affected by the proposed activity(ies). *There would be no need for mitigation.*
Very Low	Where there would be minimal effect on the environment or human wellbeing, and impacts would be well within environmental quality standards or targets, or legal requirements. *There would be no need for mitigation.*
Low	Where there would be little material effect on the environment or human wellbeing, and impacts would be well within environmental quality standards or targets, or legal requirements. *Minor mitigation measures may be required.*
Moderate	Where the activity (ies) would have a material effect on the receiving environment (including people), legal requirements would still be met but thresholds of potential concern with regard to environmental quality may be crossed. *Mitigation measures – avoidance, minimization and rehabilitation/ restoration, and in some cases offsets/ compensation - would be needed to reduce the impact significance.*
High	Where there would be major effects on the receiving environment to the extent where environmental quality standards or targets may be jeopardized, legal requirements may not be met, and the health, safety, livelihoods and/or wellbeing of affected people could be jeopardized. *Mitigation measures – preferably avoidance/ impact prevention, minimization, rehabilitation/ restoration, and offsets/ compensation – are essential to reduce the impact significance substantially.*

Very High	Where there would be severe or substantial effects on the receiving environment to the extent where environmental quality standards or targets would be undermined/ exceeded, there would be non-compliance with legal requirements or commitments, and the health, safety, livelihoods and/or wellbeing of affected people would be jeopardized. *Mitigation measures – avoidance or prevention of impacts as a priority would be required, since impacts are unacceptable. Additional measures to minimize, rehabilitate/ restore, and offset/ compensate for residual impacts would be – are essential to reduce the impact significance substantially*

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