APPENDIX 37

BULK ENGINEERING SERVICES REPORT (VERSION L)

JULY 2025

Cape Winelands Airport

Engineering Services Report

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1 Introduction

1.1 Background

Cape Winelands Airport Limited intends to redevelop Fisantekraal Airfield, an existing ex-South African Air Force aerodrome built circa 1943. This site is approximately 150ha in size and was acquired in November 2020 by Cape Winelands Airport Limited. Since then, adjacent parcels of land have been secured by way of purchase or Power of Attorney, taking the current scope of the development to approx. 425 ha with total land parcels acquired to be approximately 880ha.

These parcels of land include the following:

- Portion 10 of Farm 724 Joostenberg Vlakte
- Portion 4 of Farm 474 Joostenberg Kloof
- Remainder of Farm 724 Joostenberg Vlakte
- Portion 7 of the Farm 942 Kliprug
- Remainder of Farm 474 Joostenberg Kloof
- Portion 23 of Farm 724 Joostenberg Vlakte

The proposed new development for the Cape Winelands Airport proposes a combination of mixed office, retail, aircraft hangers of varying sizes, parking spaces, heliports, commercial buildings, hotels, terminal buildings and administrative buildings with a total estimated building area of 350,000 m^2. The fully detailed development plan and preliminary bulk figures from the architects (Vivid) are included in Appendix A and B respectively to this report.

1.2 Zoning

The initial property (blue) was rezoned in March 2021 from Agricultural to Transport 1 with consent for an airport and falls within the City of Cape Town municipality. The remaining extent (green) of the planned footprint is still to be rezoned and are therefore still zoned as Agricultural. Refer Figure 1 below.

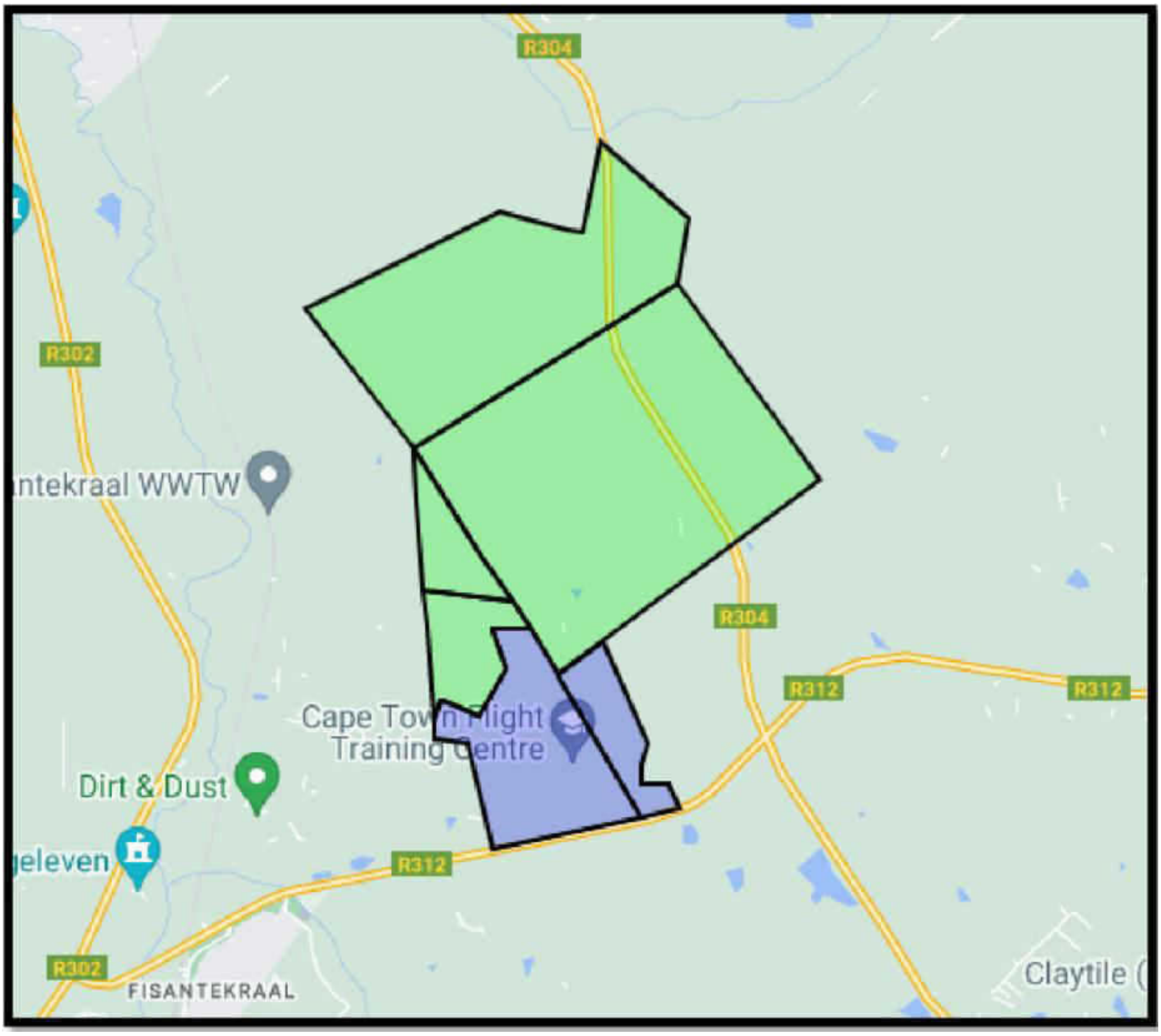


Figure 1: Erven Rezoning map

1.3 Location of Development

The Site is located in the Fisantekraal suburb, north of the R312 (Lichtenburg Road) and east of the R302 (Klipheuwel Road) as shown in Figure 2: Locality Plan. The property is located within the jurisdictional area of the City of Cape Town (CoCT), Northern Panorama regions and Kraaifontein region.

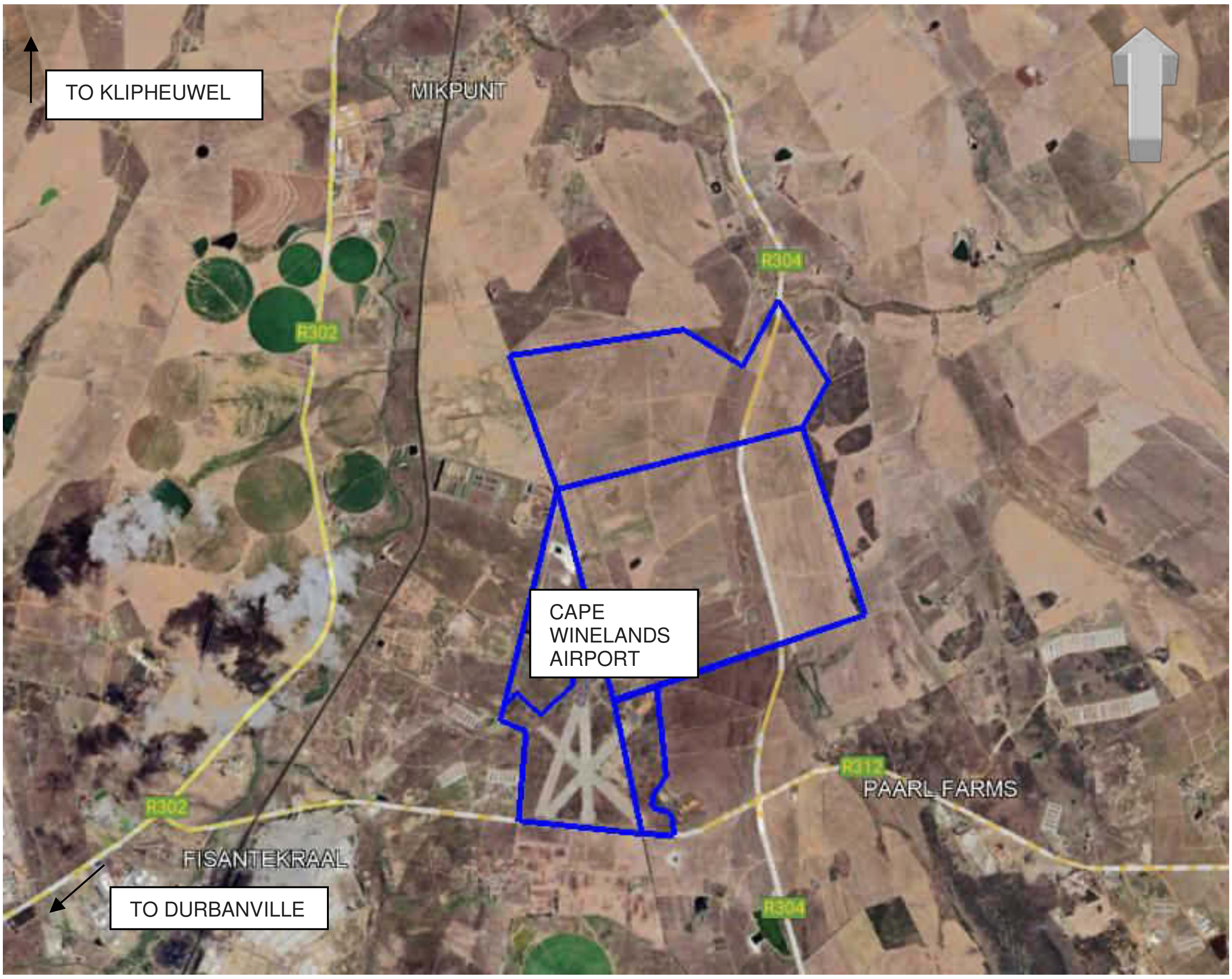


Figure 2: Locality Plan

1.4 Scope of Work

Zutari was appointed to deliver professional services to support the preparation of an Engineering Services Report for the Cape Winelands Airport development.

- Internal Services & Earthworks Design and Approval (Preliminary & Detailed).
- External Bulk Services & Earthwork Design and Approval (Preliminary and Detailed).

This report will focus primarily on the western precinct of the Cape Winelands Airport Development as shown in Figure 3 below (Red area).

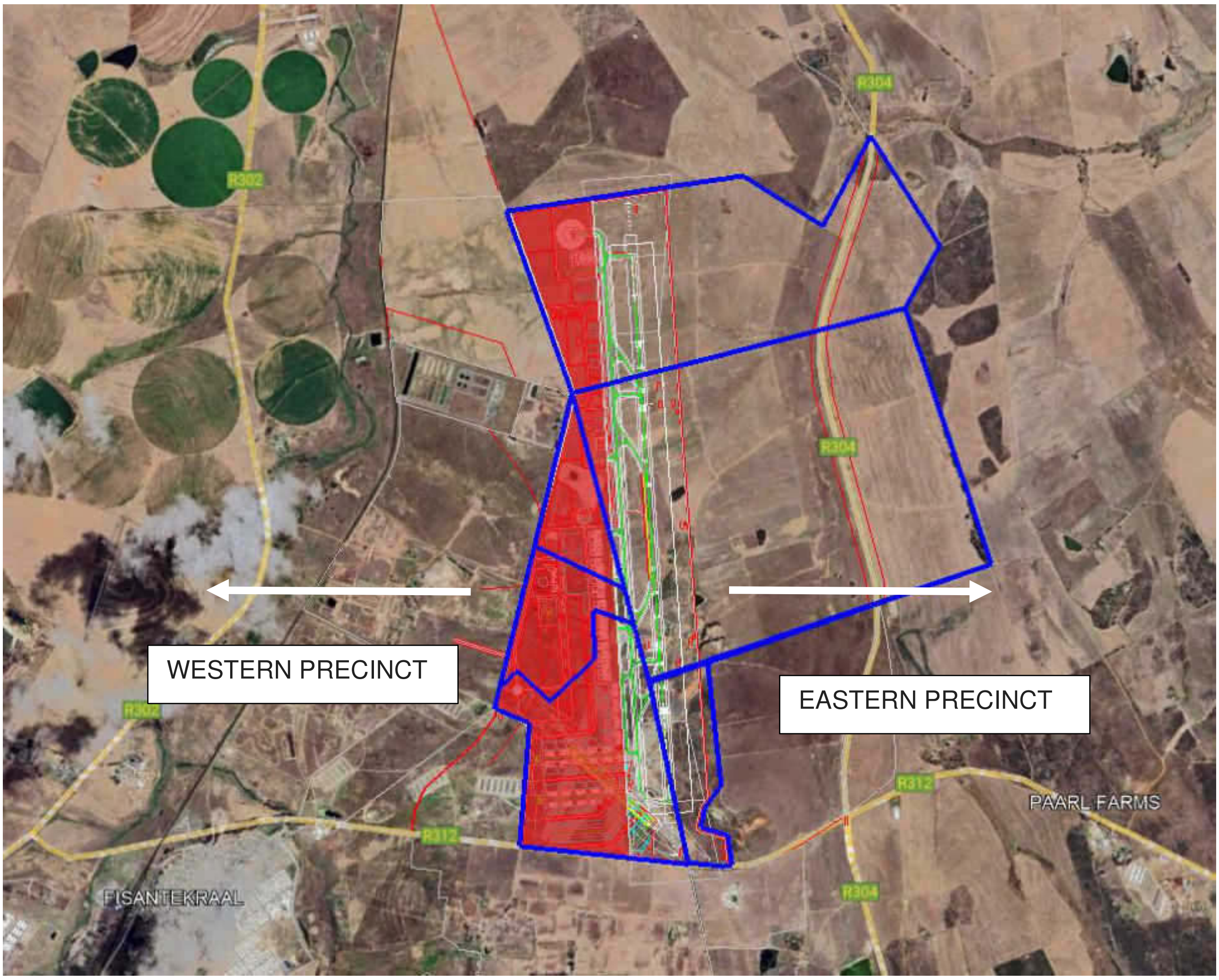


Figure 3: Precinct Layout

1.5 Purpose of this Report

This report intends to collate information about various services and investigations obtained and investigated as part of the initial stages of the project, to provide information on the status quo in terms of existing infrastructure, findings from specialist studies, design criteria for the proposed development and highlighting design elements to be further developed over the project's lifespan.

2 Phasing of Development

The development of Cape Winelands Airport, encompassing its five proposed planning phases, is grounded in the "Anchor scenario" air traffic forecast results for the defined Planning Activity Levels (PALs) 1A, 1B, 2, 3, and 4.

The PALs establish the timeframes for initiating and realizing expansion projects aimed at enhancing the airport's infrastructure and building facilities. This section should be read in conjunction with the masterplan, which provides a more detailed definition of the phases. For the purposes of this engineering services report, PAL 4 will be used to illustrate the final phase of the development and its associated engineering services, while PAL 1 will be referenced to describe the initial phase and the provision of services.

2.1 Phase 1 (PAL 1)

The fundamental infrastructure of the airport is developed in PAL 1. As per the "Anchor" forecast scenario, the initial phase will include significant infrastructure, terminals, aircraft stands, and facilities.

Figure 4:PAL 1 Masterplan Layout

The fully detailed PAL 1 development Plan is included in Appendix C.

2.2 Phase 4 (PAL 4)

In the planning horizon, PAL 4 is the final phase of planning for Cape Winelands Airport (refer to Appendix A for detailed layout). In this stage of the project, all facilities have reached their full size in accordance with the master plan.

Figure 5: PAL 4 Masterplan Layout

3 Site Shaping & Earthworks

3.1 Design Philosophy & Design Standards:

Earthworks were designed following the *SANS 1200: Standardised Specification for Civil Engineering Construction* guidelines and site-specific conditions.

3.2 Overview of existing conditions:

The Cape Winelands Airport Development is situated on top of a natural watershed line, thus most of the portion's slope away to both sides of the watershed. The development site also has a natural slope form south to north with an average slope of 0.38%. The natural levels on the site range from 124.00masl to 108.50masl.

3.3 Design Parameters:

The future earthworks design for the site is governed by the runway longitudinal slope and orientation. The earthworks design for the airports airside precinct is determined by key geometric considerations for the runway, taxiways, aircraft parking bays and other associated areas with considerations to minimise earthworks to keep the operation area of the airport matching the slope and levels of the existing runway and existing ground levels.

The aim for the final shaping of the CWA is to balance the bulk earthworks cut and fill operations between the airports western and eastern precincts as far as possible and is dependent on the in-situ soil conditions. The cut and fill schematic as shown in the Figure 6 illustrates the even distribution of minimal cut (depicted in yellow) and fill (depicted in green) heights visually representing a cut to fill balanced. This schematic illustrates that most of the area is either in 3m of cut or 3m of fill, this demonstrates minimal cut and fill heights, given the long runway while adhering to the maximum and minimum grade requirements.

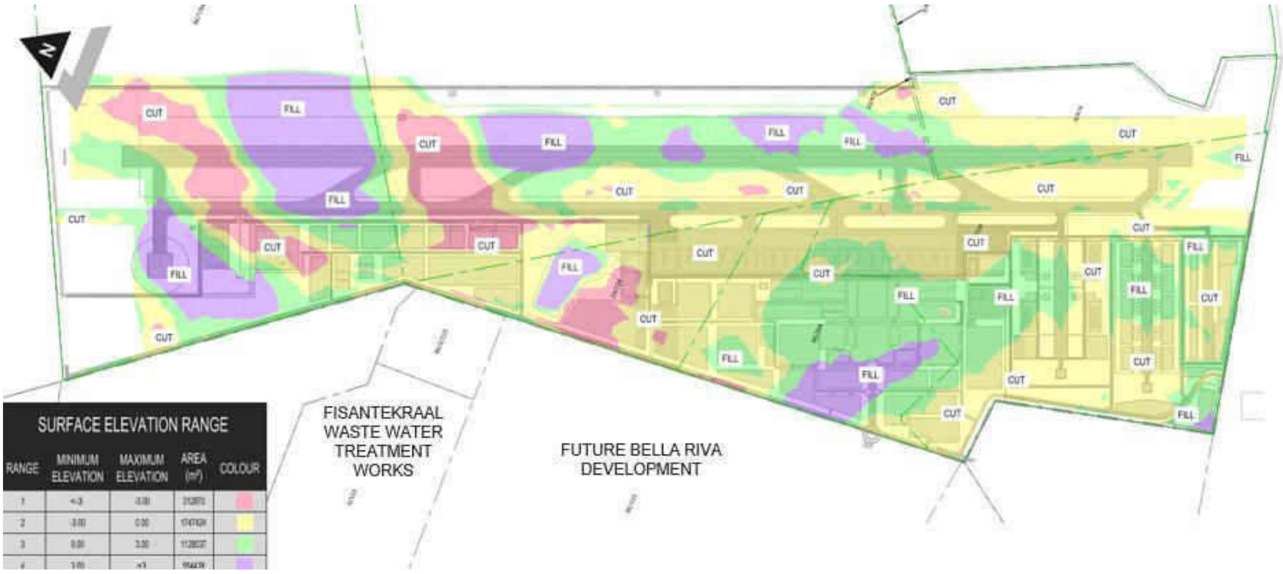


Figure 6: Cut and Fill Schematic

3.3.1 Materials:

An initial geotechnical investigation was conducted by GEOSS South Africa (Pty) Ltd and during their investigation the following was found: (Direct quote out of Geotechnical report, please refer to Appendix D)

- Five Geotechnical Zones have been delineated based on the investigation results:

A – Residual materials derived from granitoid sources.

B – Residual Materials derived from pelitic sources.

C – Area falling within Zones A and B with residual soils exhibiting characteristics of potentially expansive materials, and/or soils that are prone to settlement.

D - Areas of relatively deep/thick transported aeolian sand.

E – Areas of surficial ferricrete and/or silcrete.

- All materials encountered in the trial pits classified as soft to intermediate excavation (SANS 1200D). The hardpan ferricrete horizons may require rock-breaking apparatus in areas of the site.
- In the case of structures with heavy structural loadings, where deeper foundations/piling are/is required, it would be prudent to consider a series of exploratory drilling as part of the site-specific investigations to determine whether core stones exist at depth, particularly in areas underlain by residual granitoids.
- A perched groundwater table was intersected on-site at between 0.85 and 1.4 mbgl. Excavations deeper than 1.0 mbgl will require battering to ensure safe working conditions. Final designs will have to cater for aggressive and corrosive groundwater and/or soil conditions. Drainage precaution will be required.

A detailed geotechnical investigation is underway which will provide detailed insight into earthworks operations for the development, to be considered during detailed design.

3.3.2 Embankments & Retaining:

There is a requirement for embankments on the site to tie in with the existing ground levels. These embankments will be constructed within the site, but alternative solutions can be investigated.

Retaining walls may be required and the extents of which will be confirmed during the design phase

3.4 Indicative Layout:

Refer to Appendix E for indicative grading plan.

Drawing name:

A89083-0000-DRG-CC-101

4 Internal Roads

4.1 Design Philosophy & Design Standards:

Roads will be designed following the standard details found in standards and guidelines for Roads & Stormwater, Version 1 October 2020. The roadway design is also inclusive of additional requirements from CAW and Zutari's. Supplementary design standards also consulted:

- SANS 1200: Standardised Specification for Civil Engineering Construction.
- UTG 10: Guidelines for the Geometric design of commercial and industrial local streets

This section is to be read in conjunction with the Traffic Impact study by ITS engineers and with the Masterplan document. These documents details traffic movements and other design considerations that will be considered during the geometrical design of the roads.

4.2 Design Parameters:

The main form of transport to the airport will be private and public motorized transport. The final road configuration will be decided with the client, architect, and transport engineer during detailed design. Following the Masterplan document the airport will be divided into 2 different road priorities, a primary road network and a secondary road network. The primary road network will be responsible for providing access to the passenger facilities. The secondary road network will be responsible for providing access across the entire airport development.

One of the main design parameters discussed in the masterplan is design speed:

Design Speed for passenger vehicles:

- Main airport road, speed limit 60 km/h
- Kerb and parking roads 40 km/h
- Secondary roads 60 km/h

4.2.1.1 Typical Cross-sections

The Cape Winelands Airport development constitutes of a mix of Class 4 and Class 5 roads with most road reserves 32m wide. See below for proposed cross-sectional designs for each type of road reserve.

Indicative layerworks for the cross-section as seen below are based on preliminary geotechnical data and based on projects of a similar nature and will be confirmed as part of the detail design process.

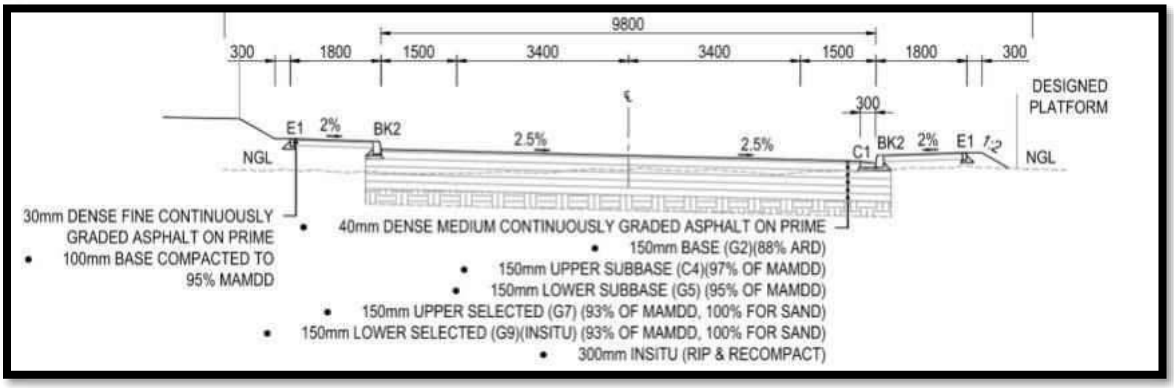


Figure 7: 32m Road Reserve Typical Cross-section

4.2.1.2 Road markings:

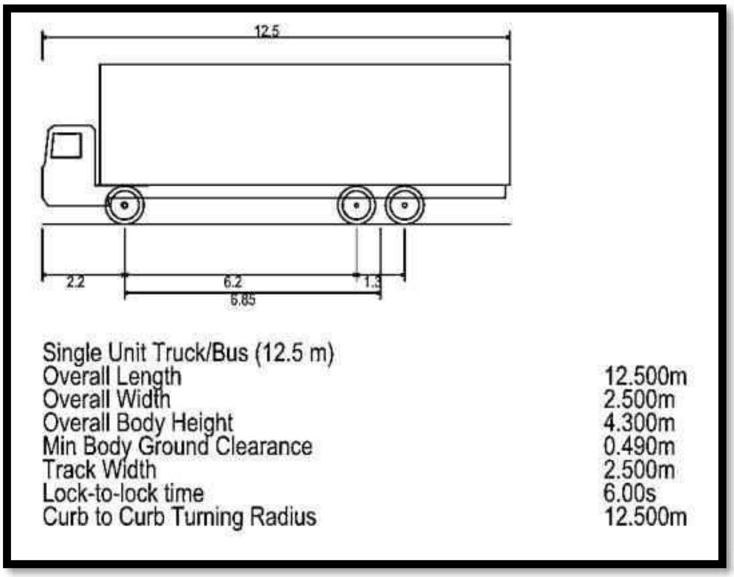
All road markings to conform to the South African Road Traffic Signs Manual.

4.2.1.3 Design Vehicles:

The primary design vehicle for the development is a standard 12.5m single unit delivery truck.

The secondary design vehicle is a 22.34m interlink truck.

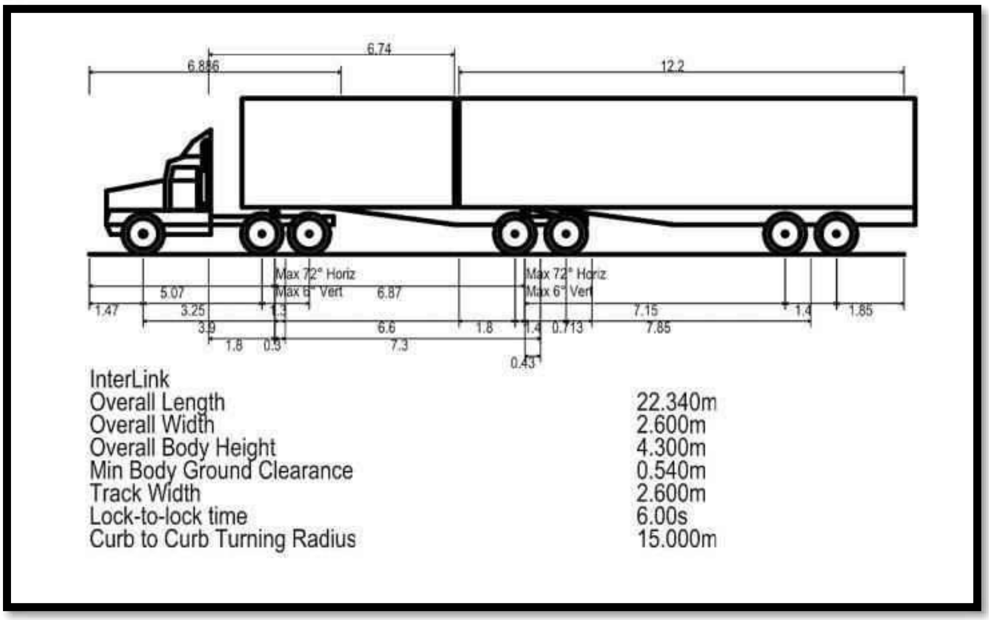
Design speed for the development is 40 Km/h for the primary design vehicle and 30 Km/h for the secondary design vehicle. These vehicles will be limited to these design speeds to enable meneuverablility within the development, where as standard passenger vehicles will follow the design parameters as set out in the Masterplan document.



Single Unit Truck/Bus (12.5 m)

Overall Length	12.500m
Overall Width	2.500m
Overall Body Height	4.300m
Min Body Ground Clearance	0.490m
Track Width	2.500m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	12.500m

Figure 8: 12.5m Single Unit Deliver Truck



InterLink

Overall Length	22.340m
Overall Width	2.600m
Overall Body Height	4.300m
Min Body Ground Clearance	0.540m
Track Width	2.600m
Lock-to-lock time	6.00s
Curb to Curb Turning Radius	15.000m

Figure 9: 22.34m Interlink Truck

4.3 Indicative Layout:

Refer to Appendix E for indicative roads layout.

Drawing name:

A89083-0000-DRG-CC-200 – Concept Layout Roads

5 Stormwater Drainage

5.1 Design Philosophy & Design Standards

The stormwater drainage design philosophy will be informed by the approved Stormwater Management Plan and in accordance with the:

- Management of Urban Stormwater Impacts Policy
- Floodplain and River Corridor Management Policy

In so far as the design of the stormwater drainage network the key design standard that will be adopted is the Standards and guidelines for Roads & Stormwater, Version 1 October 2020, City of Cape Town.

5.2 Existing Services

The existing stormwater drainage services on the site is limited and mainly consists of open drains and limited pipework to drain areas around the existing airfield into the existing water courses. A large portion of the site is essentially a Greenfields development from a stormwater and no formal municipal infrastructure services the site from a stormwater perspective.

5.3 Stormwater Reticulation

5.3.1 Pipe Material

All pipes that are to be installed in road reserves are to be spigot and socket Type Class 100D reinforce concrete pipes. Pipe sizes will vary in size from 300mm to 1350mm in diameter. Where necessary precast concrete box culverts of similar specifications will be used.

The 300mm dia. pipes are mainly to be used for connections between catch pits and manholes with the main line being a minimum of 375mm in diameter. Stormwater manholes are to be constructed from precast concrete manhole rings with a minimum internal diameter of 1.2m with step irons cast into the rings. Heavy-duty polymer concrete lockable covers and frames to be used.

5.3.2 Key Design Criteria

The following key design criteria derived from the CoCT's Standards and guidelines for Roads & Stormwater, Version 1 October 2020 will be applied and include:

Table 1: Key Stormwater Design Criteria

Criteria	Value
Pipe Positioning	• Stormwater pipes to be positioned 1.7m from road centre line. • Exceptions to avoid acute angles in the pipe.
Pipe Slope	• Minimum pipe slope to be 1:360. • Maximum pipe slope to be designed to minimize supercritical flow within the pipes.
Depth of Cover	• 1m from crown of pipe to finished road level

5.4 Stormwater Management

Urbanisation typically impacts on natural waterway health in two key ways:

- The quantity of stormwater runoff is increased as the proportion of impervious area within a catchment is increased, leading to larger peak flows and more frequent runoff which may have detrimental effects on river health and can cause flooding in downstream areas.
- The quality of runoff is also negatively impacted with additional pollutant loads in the form of gross pollutants, suspended sediments, and various other pollutants such as nitrogen, phosphorus, and heavy metals.

The Management of Urban Stormwater Impacts Policy has been prepared by The City of Cape Town's Catchment, Stormwater and River Management Branch to address these stormwater impacts and ensure that new developments incorporate Water Sensitive Urban Design elements.

As such, a detailed Stormwater Management Plan will have to be prepared to obtain final approval for the development. The Stormwater Management Plan will:

- Identify measures to comply with the Council's Management of Urban Stormwater Impacts Policy (C58/05/09).
- Propose methods (structural controls) for removing, reducing, or retarding runoff flows, and preventing targeted stormwater runoff constituents, pollutants and contaminants from reaching receiving waters.
- Propose operation and maintenance procedures.

Typically, considerations for the implementation of stormwater management measures for the proposed development will occur in the following manner:

a) Assess the status quo and existing stormwater infrastructure.

b) Assess policy requirements and engage in high-level discussion with City of Cape Town officials.

c) Prepare a Concept Stormwater Management Plan for recommending high-level interventions and implementations to ensure compliance with the Policy.

d) Prepare detailed Stormwater Management Plan to recommend measures to mitigate the hydrology-, hydraulic-, and pollution-related effects of surface water released into the municipal stormwater network, and to illustrate how the policy will be complied with.

Zutari have engaged with the City of Cape Town's Catchment, Stormwater & River Management (CSRM) officials regarding the various submission requirements associated with stormwater management on the site and were tasked with preparing a Concept Stormwater Management Plan and flood risk assessment.

The Concept Stormwater Management Plan addresses points a) to c) listed above with any comments received from CSRM to be incorporated into the submission of a detailed Stormwater Management Plan. The flood risk assessment addresses the impact of the development on flood risks in the surrounding areas for the 1:100-Year recurrence interval (RI) flood. Copies of these reports can be made available upon request.

A detailed stormwater management plan will be developed during the latter design stages of the development.

5.5 Concept Design

Refer to **Appendix E** for an indicative stormwater network layout proposed for the development. The layout under consideration will divide the site into various catchments. The runoffs from these catchments will channel towards various dry stormwater ponds which will both treat and attenuate stormwater. As the name suggests, the dry attenuation ponds will only attenuate stormwater runoff during peak rain events and will remain dry for the rest of the time. Refer to typical dry pond details below. The quarry however on the western edge of the site is being converted into a wet pond which will treat and attenuate stormwater.

List of Stormwater Drawings:

A89083-0000-DRG-CC-302 – Concept Layout Stormwater

A89083-0000-DRG-CC-303 – Concept Stormwater Ponds Layout

A89083-0000-DRG-CC-310 – Quarry as Stormwater Attenuation Pond

The western precinct will have to be shaped in such a manner that most of the stormwater flows towards the quarry.

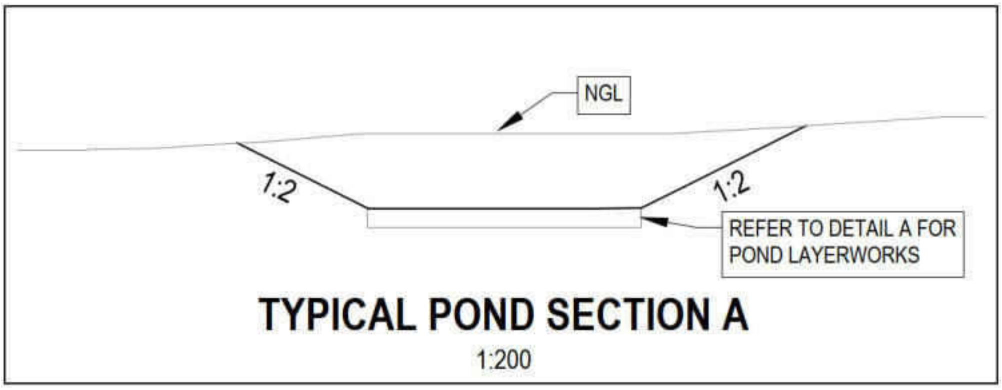


Figure 10: Typical section of dry pond

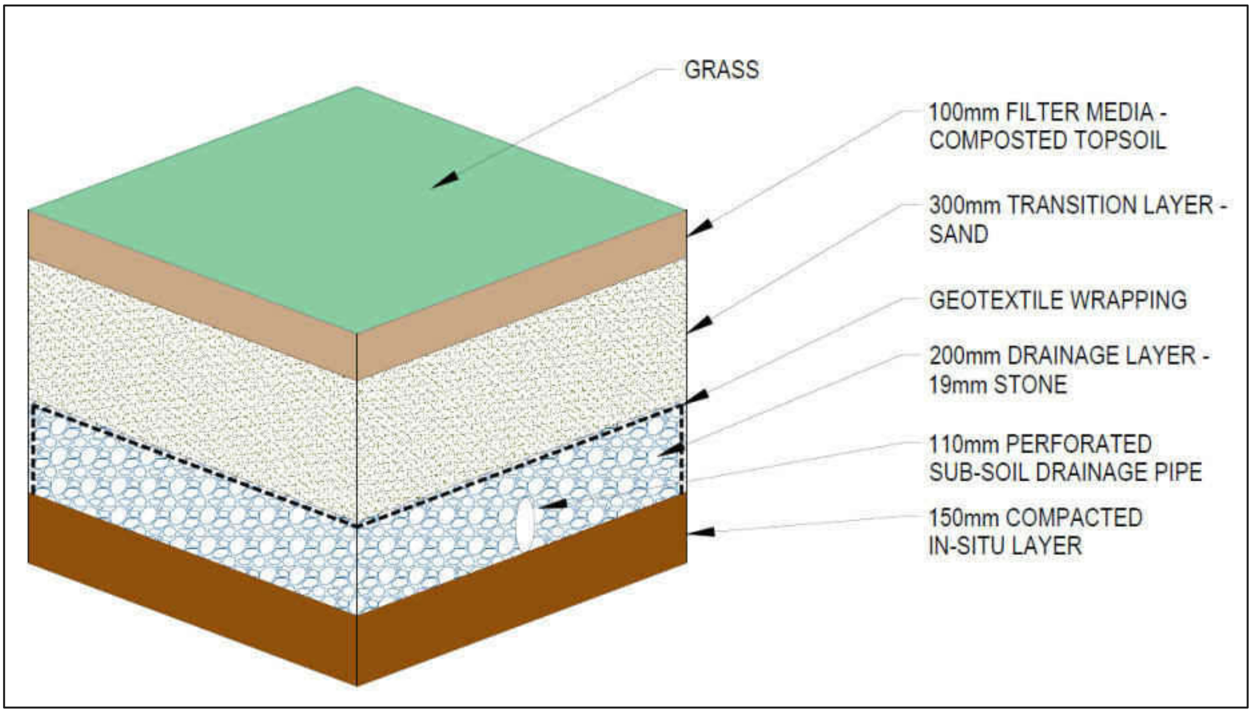


Figure 11: Typical dry pond layerworks detail

5.6 Addressing Avifauna Concerns in Stormwater Pond Design and Mitigation Measures

Concerns regarding the potential attraction of avifauna to the proposed stormwater ponds were raised in the avian bird strike and the poultry biosecurity assessment. To address this, all ponds, except for Pond 2 (the rehabilitated quarry which currently has a permanent water body), have been designed as dry ponds. In line with the City's stormwater management policy, all dry ponds are designed to provide 24-hour extended detention for the 1-year storm recurrence interval, ensuring a water retention time of no more than 24 hours. For Pond 2, excess stormwater above the permanent water level will be retained for a duration of 36 to 48 hours before receding to the permanent water level.

Following discussions with the avian specialist, the dry ponds are not expected to pose a significant concern for attracting birds. For Pond 2, which currently already is a permanent water body, various mitigation measures will be investigated during the detailed design phase. The most likely approach will involve covering the exposed water surface area. In conjunction with the landscape architect additional measures will be investigated which include maintaining consistency in planting vegetation on either side of the ponds to discourage bird movement between ponds which will also be considered during detailed design.

Overall, the short retention times for uncovered ponds (less than 48 hours) should effectively mitigate the risk of attracting wild birds and posing a risk to poultry biosecurity. Moreover, close monitoring as part of the proposed Bird and Wildlife Hazard Management Programme, in collaboration with the avian specialists, will provide ongoing mitigation and ensure compliance with safety and environmental requirements.

6 Foul Sewer Drainage

6.1 Existing services

The site is located on the urban edge and thus sewage services provision in proximity to the site is limited and existing municipal services are located a considerable distance from the site. The site is thus not provided with municipal connection for foul sewer drainage.

However, the site falls into catchment area serviced by the Fisantekraal WWTW which is in close proximity to the site. Figure 12 below indicates the existing water and sewer services which are located in the vicinity of the proposed development.

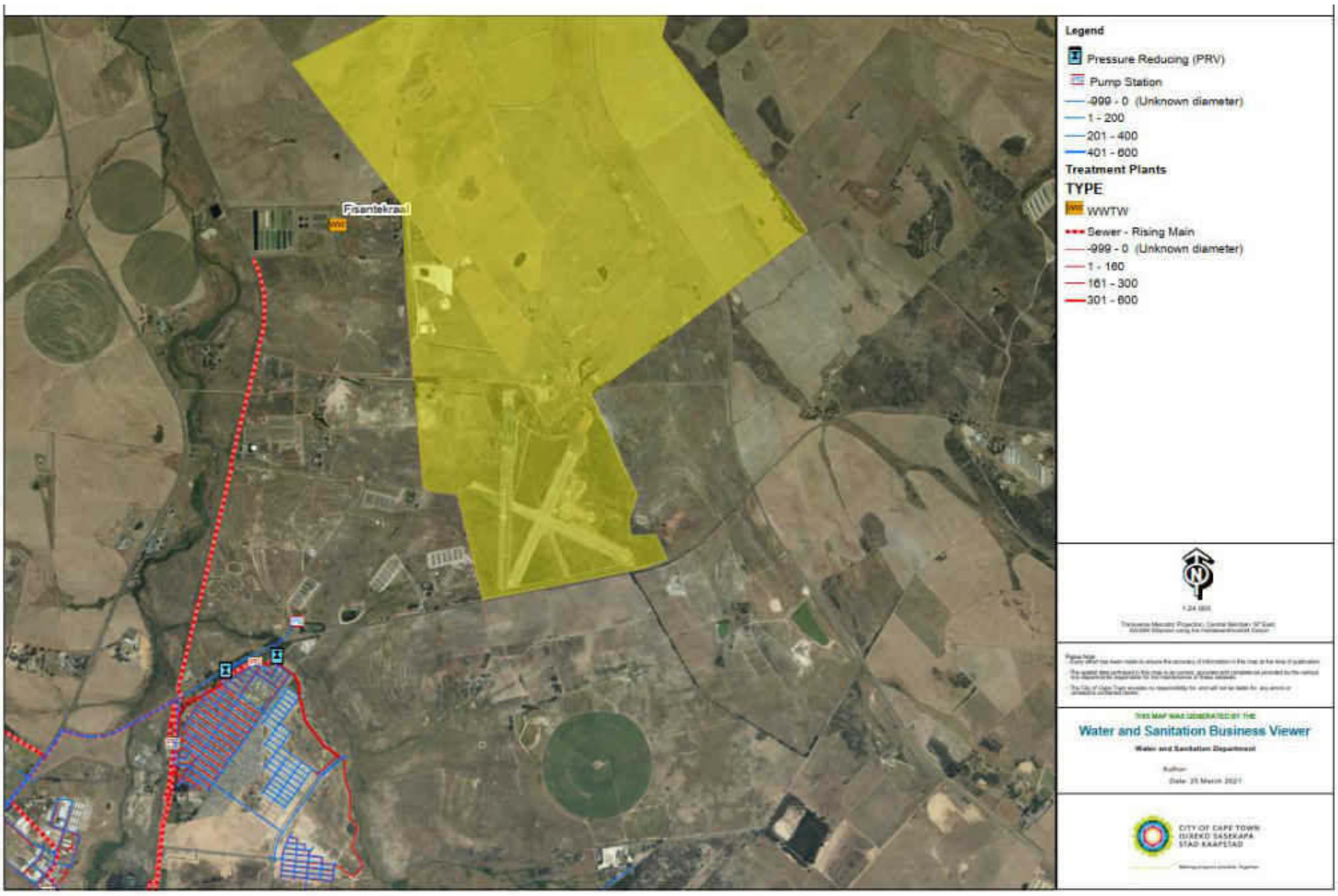


Figure 12: Existing Water & Sewer Services

The existing municipal services are described as follows:

- There are no existing municipal sewage pipelines in proximity to the site.
- The nearest existing municipal services are found in Fisantekraal.
- The site falls within a catchment area which is serviced by the Fisantekraal WWTW.
- The areas in Fisantekraal drain to a series of pumpstations where the sewage is then either pumped to the Fisantekraal WWTW in the north or Kraaifontein WWTW in the south.

Refer to **Appendix E** for an overview of the existing services.

The status quo for sewage service provision to the site is described as follows:

- The site is currently not serviced with a municipal sewer connection.

- The existing buildings at the airfield being serviced through septic tanks.
- There are proposed developments in close proximity where municipal sewer lines are proposed and include the Greenville development to the south and the Bella Riva development to the east.
- Both these developments include proposals to expand the municipal sewage network, and these were considered as possible opportunities to tie into the municipal network.
- However, these developments are still in the planning stage and there is no confirmation that either development will have sewage infrastructure constructed in the short term.

6.2 Design Philosophy & Design Standards

The design philosophy for the sewer network consists of adjusting the site grading to allow for sewer drainage network that primarily is gravity drainage network converging on a location from where the sewage will either be conveyed offsite to a municipal treatment facility or treated on site.

The sewer flows were determined using the following guidelines/standards:

- Minimum Standards for Civil Engineering Services in Townships (July 2013).
- Guidelines for Human Settlement Planning and Design ('The Red Book 2019'), published by the CSIR.

In considering the design of the sewage network the following designs standards was referenced

- COCT Water and Sanitation Department, Service Guidelines & Standards.

Supplementary documents that have also been considered include:

- City of Cape Town: Treated Effluent By-Law, 28 October 2009, promulgated 30 June 2010
- City of Cape Town: Environmental Health By-Law, 30 June 2003.

6.3 Sewage Flows

The sewage flows for the proposed development have been determined and are based on the applicable design guideline listed in Section 6.2.

In determining the sewer flows Zutari included a land use allocation in accordance with '*The Red Book 2019'*, as detailed in Appendix F. As an airport development is somewhat unique from a land use perspective, where necessary certain interpretations have been made for land uses that are not defined in these guidelines. An example of which is the sewage flows for hangars. Hangars have large floor areas but an extremely low occupancy and thus their sewage flows do not necessarily conform to comparable land uses. The sewage flows are summarized in Table 2.

Table 2: CWA - Sewage Flows

Sewage Flow Calculations							
Land use	**Average Dry Weather Flow (ADWF)**	**Unit**	**PAL 1**	**PAL 1B**	**PAL 2**	**PAL 3**	**PAL 4**
Business/Commercial	Based on Redbook 2019 AADD Method	KL/day	249	249	386	440	440
Yard Connection	Based on Redbook 2019 AADD Method	KL/day	8	8	9	10	10
Warehousing	Based on Redbook 2019 AADD Method	KL/day	46	46	145	159	159
Hotel	Based on Redbook 2019 AADD Method	KL/day	34	34	68	68	68
Park - Grounds Only	Based on Redbook 2019 AADD Method	KL/day	0	0	0	0	0
Wash Facility	Based on Redbook 2019 AADD Method	KL/day	0	0	0	0	0
Club - Buildings only	Based on Redbook 2019 AADD Method	KL/day	0	0	0	0	0
Industrial	Based on Redbook 2019 AADD Method	KL/day	23	23	23	23	23
Garage and filling station	Based on Redbook 2019 AADD Method	KL/day	9	9	9	9	9
Parking Grounds(car park)	Based on Redbook 2019 AADD Method	KL/day	0	0	0	0	0
Terminal Building	Based on Redbook 2019 AADD Method	KL/day	155	155	210	264	312
Total ADWF		**Kℓ/day**	**524**	**524**	**850**	**973**	**1021**
Instantaneous demand		ℓ/s	6	6	10	11	12
Avg Peak Factor		-	Varies	Varies	Varies	Varies	Varies
Instantaneous Peak Dry Weather Flow (IPDWF)		**ℓ/s**	10	10	16	18	19
Stormwater Infiltration @ 30%		ℓ/s	Varies	Varies	Varies	Varies	Varies
Instantaneous Peak Wet Weather Flow (IPWWF)		**ℓ/s**	**15**	**15**	**23**	**27**	**28**

6.4 Proposed infrastructure

Due to the limited network coverage, conveyance infrastructure must be implemented outside of the site boundary in order to convey the sewage to the municipal wastewater treatment works.

Considering this requirement, two options are contemplated:

1) Option 1: Construction of an on-site packaged Sewage Treatment Plant to treat sewage on site.

   OR

2) Option 2: Construction of pumpstation and associated rising main to pump sewage to the Fisantekraal WWTW.
3) Option 3: Optimized Sewage Treatment and Non-Potable Water Reuse Strategy (Preferred option)

To enhance the reliability and resilience of the system, the installation of an emergency overflow pond is proposed which shall provide a mitigation against spillage should there be a problem with the pumpstation.

6.4.1 Option 1: Construction of Onsite Package STP

This proposal entails the construction of an on-site package treatment plant to treat the sewage generated by the CWA development. The intention is that the treated sewage effluent is then re-used for irrigation and toilet flushing.

The proposal for Option 1 entails the following:

- Internal sewer network to convey sewage to Package Sewage Treatment Plant
- Sludge processing area
- Emergency overflow pond
- Emergency overflow rising main to Fisantekraal WWTW

An internal sewer network will collect sewage from the various buildings and convey it to a package sewage treatment plant. The package treatment plant will treat the sewage to a quality that meets the applicable limits required for re-use. The treated effluent will then be stored and used as a non-potable water supply. The package treatment plant will be designed as a closed system with all waste generated handled in accordance to the relevant city by laws.

The design will ensure that all treated effluent generated on-site will be effectively managed and disposed of in an environmentally compliant manner.

To enhance the reliability and resilience of the system, the installation of an emergency rising main to the Fisantekraal Wastewater Treatment Works (WWTW) as well as an emergency overflow pond is proposed. This additional infrastructure will provide redundancy measures for the following scenarios detailed below:

Scenario 1: Fault at the Package Wastewater Treatment Plant

- If there is a malfunction with the package wastewater treatment plant, a bypass valve will be activated, to divert flows from the treatment plant via a pump and sewer rising main to the Fisantekraal WWTW, on a temporary basis until the issue is resolved.
- This measure ensures that untreated sewage does not accumulate unnecessarily, thereby maintaining the integrity of the on-site sanitation system and mitigating against environmental contamination.

Scenario 2: Fault at the Pump Station

- If there is a malfunction with the pump station, a bypass valve will be activated to divert flows to the emergency overflow pond.
- This will prevent back-up and possible overflows in the sewer network. Once the issue is resolved, a valve will be opened to allow sewage to flow back to the pump station and subsequently to the package wastewater treatment plant.
- This approach mitigates the risk of sewage overflow and ensures continuous operation of the sewage management system.

By incorporating these emergency measures, the aim is to safeguard the functionality and efficiency of the sewage treatment process, maintaining high standards of sanitation and environmental protection.

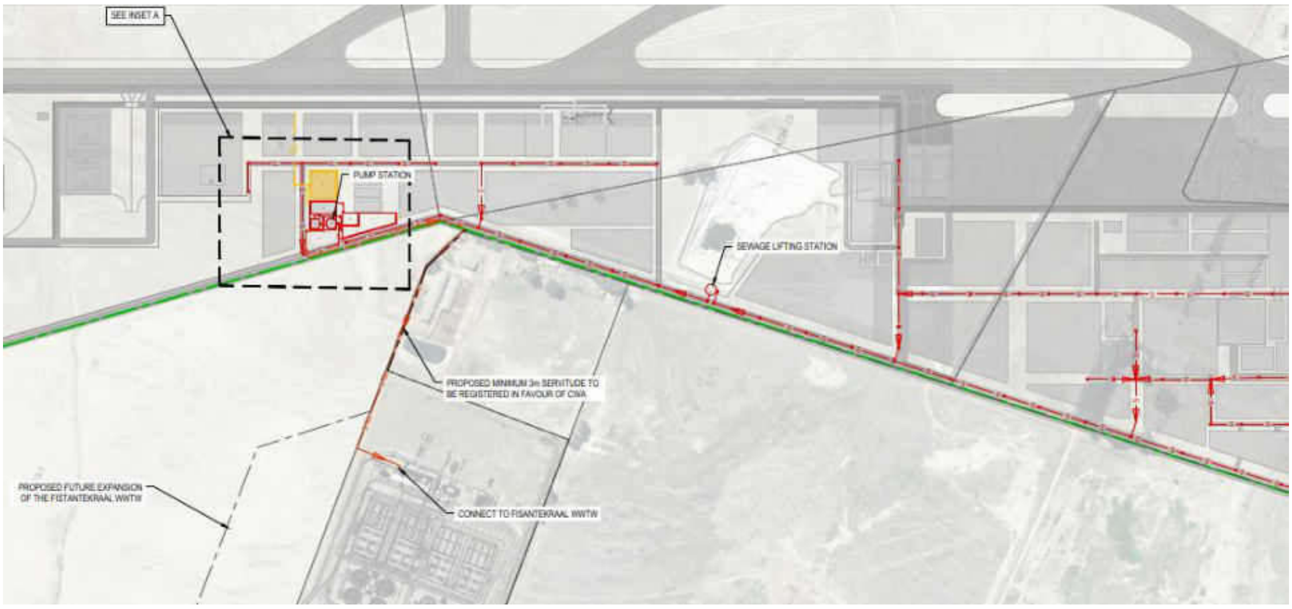


Figure 13: Option 1: Proposed route of sewage rising main.

Table 3 below outlines the infrastructure requirements for this option and the corresponding asset owner.

Table 3: Option 1: Required Sewage Infrastructure Elements

ID	Element	Description	Asset Owner
1	Internal Sewer Gravity Network	Gravity mains to convey sewage within the development to the primary sewage pumpstation.	CWA
2	Minor Sewage Lifting Stations	If required lifting stations will be placed inside the CWA property to pump/lift the sewer in areas where the pipes become too deep in order to assist conveying sewage to the main sewage station.	CWA
3	Primary Sewage Lift Stationing	This pumpstation will collect and then lift the sewage into the package treatment plant.	CWA
4	Package Sewage Treatment Plant	The Package Sewage Treatment will treat the sewage emanating from the CWA development for re-use	CWA
5	Emergency Storage Pond	In the event that there is a malfunction with the primary lifting station or sewage treatment plant flows will be diverted to the emergency overflow pond.	CWA
6	Emergency bypass rising main	A bypass emergency sewage rising main from the primary sewage lifting to the Fisantekraal WWTW.	CWA
7	Servitude	A servitude registered across the Bella Riva and CoCT properties in favour of CWA is required in order accommodate the emergency bypass sewer rising main.	n/a
8	Additional inlet chamber	An additional chamber is required at the inlet works to receive the sewage from the lifting station. The inlet works at WWTW is of the above ground type as it was designed to received pumped flows only.	CoCT

Refer to Appendix E for concept layout of the foul sewer network where the options are included.

6.4.2 Option 2: Pumpstation and Rising main

6.4.2.1 Infrastructure overview

Due to the proximity of the CWA Development to the Fisantekraal WWTW it is apparent that is advantageous to install a pumpstation and associated rising main that conveys the sewage directly to Fisantekraal WWTW to the north rather than convey the sewage to the south-west towards the municipal sewage network in Fisantekraal which can receive the sewage. The proposed route is shown in Figure 14.

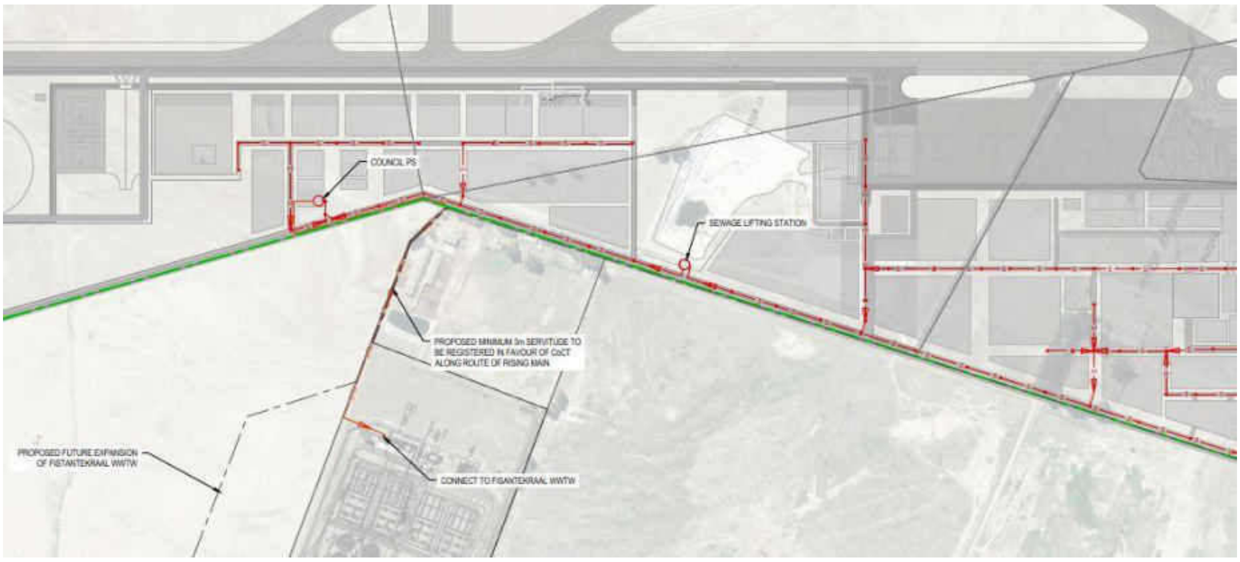


Figure 14: Option 2: Proposed route of sewage rising main

The elements proposed for this solution are included in Table 4 below.

Table 4: Option 2: Required Sewage Infrastructure Elements

ID	Element	Description	Asset Owner
1	Internal Sewer Gravity Network	Gravity mains to convey sewage within the development to the primary sewage pumpstation.	CWA
2	Sewage Lifting Stations	If required lifting stations will be placed inside the CWA property to pump/lift the sewer in areas where the pipes become too deep in order to assist conveying sewage to the main sewage station.	CWA
3	Primary Sewer Pumpstation	A Primary Sewage pump station to pump all sewage flows from the CWA Development to the Fisantekraal WWTW.	CoCT
4	Rising Main	A sewage rising main from the municipal pumpstation to the Fisantekraal WWTW.	CoCT
5	Servitude	A servitude registered across the Bella Riva property in favour of CoCT is required in order accommodate the sewer rising main.	n/a
6	Additional inlet chamber	An additional chamber is required at the inlet works to receive the sewage from the lifting station. The inlet works at WWTW is of the above ground type as it was designed to received pumped flows only.	CoCT

Refer to **Appendix E** for concept layouts developed for Option 2 with the intention to connect to the Fisantekraal WWTW via a rising main.

6.4.2.2 Spare Capacity Assessment

An application was made to the City of Cape Town to determine if spare capacity exists in the municipal sewage system to accept the sewage flows generated from the proposed CWA development. The detailed response from the City of Cape Town is included in **Appendix G**. The key aspects of the response are summarized as flows.

Treatment Capacity

Spare capacity exists at the Fisantekraal WWTW. The previous application to the CoCT, the city was able to accept the sewage flows from the development of the then calculated flow of 472kl/day. A revised application will be required to the City of Cape Town to determine if an additional 549kl/day is available in the municipal system should we pursue option 2.

Network Capacity

- The municipal sewage network and pumpstations that can convey the sewage to the WWTW are located to the southwest of CWA near the Fisantekraal Settlement and Greenville development.
- However, network coverage is limited and conveying the flows to the existing municipal pump station in Fisantekraal and then onward conveyance to the Fisantekraal WWTW cannot be achieved without network expansion towards the east.

Treated Effluent Capacity

- A letter of intent has been submitted to the CoCT Treated Effluent Department to confirm whether the Fisantekraal WWTW would have spare capacity to receive the excess treated effluent generated by the development, should Sewer Option 1 be pursued.

The letter of intent also includes the maximum projected treated effluent required for non-potable demand, should Sewer Option 2 be pursued, to confirm whether the Fisantekraal WWTW would have the capacity to meet the development's treated effluent demands. The design will ensure that all treated effluent generated on-site will be effectively managed and disposed of in an environmentally compliant manner; and that no treated effluent will be discharged into the stormwater system.

Based on subsequent discussions with CoCT officials, support was given for a direct route from the proposed development to the Fisantekraal WWTW.

6.4.3 Option 3: Pump to Fisantekraal with extraction (Preferred option)

The proposed solution for sewage discharge on the development integrates a dual-treatment approach to efficiently manage effluent and meet non-potable water demands. Sewage from the development will be diverted through a pump system to a proposed on-site package treatment plant. This plant will treat the sewage to a standard suitable for non-potable water use, such as irrigation or flushing, thereby addressing the development's internal non-potable water requirements.

To avoid excessive effluent production and maintain compliance with wastewater discharge regulations, the remaining sewage will be directed to the nearby municipal wastewater treatment works (WWTW) for further treatment and disposal. This approach aims to optimize effluent reuse, reduce pressure on the WWTW, as well as environmental concerns with respect to excess treated effluent generated.

The proposal for Option 3 entails the following key components:

- An internal sewer network to convey sewage.
- A lifting station to divert a portion of sewage to a package sewage treatment plant to meet the non-potable demands of the development.
- A primary sewer pump station to direct the remaining sewage to the Fisantekraal Wastewater Treatment Works (WWTW) via a pump and rising main.
- A sludge processing area.
- An emergency overflow pond.
- An emergency overflow to the primary sewer pump station from the package treatment plant, directing all development demands to the Fisantekraal WWTW in case of failure.

An internal sewer network will collect sewage from various buildings and convey it to a lifting station. From here, the required sewage volume will be diverted to the proposed package sewage treatment plant, which will treat the sewage to meet the applicable quality limits for reuse (at minimum to the cities general limits). The treated effluent will then be stored and utilized as a non-potable water supply. The package sewage treatment plant will be designed as a closed system, with all waste generated handled in compliance with relevant city by-laws.

The design ensures that all treated effluent generated on-site is effectively managed and disposed of in an environmentally compliant manner.

To enhance the reliability and resilience of the system, the installation of an emergency rising main to the primary municipal pump station and an emergency overflow pond is proposed. This additional infrastructure provides redundancy for the following scenarios:

Scenario 1: Fault at the Package Sewage Treatment Plant

- If the package sewage treatment plant malfunctions, a bypass valve will divert flows from the package sewage treatment plant to the primary sewer pump station, which will convey the sewage to the Fisantekraal WWTW.
- This measure ensures that untreated sewage does not accumulate on-site, maintaining system integrity and preventing environmental contamination.

Scenario 2: Fault at the Municipal Pump Station

- If the primary sewer pump station malfunctions, a bypass valve will divert flows to the emergency overflow pond.
- This prevents backups and possible overflows in the sewer network. Once the issue is resolved, the stored sewage can be redirected to the pump station and subsequently to the PSTP.
- This approach mitigates the risk of overflows and ensures continuous operation of the sewage management system.

By incorporating these emergency measures, the proposed system safeguards the functionality and efficiency of sewage treatment processes while maintaining high standards of sanitation and environmental protection.

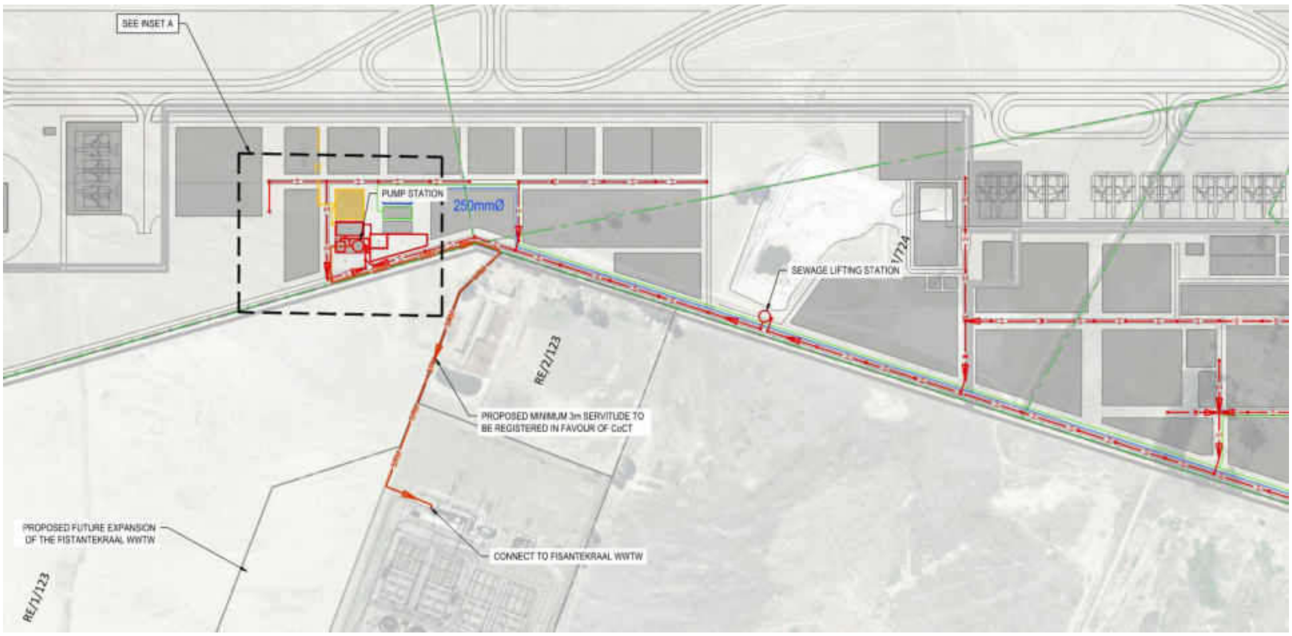


Figure 15: Option 3: Proposed route of sewage rising main.

Table 5 below outlines the infrastructure requirements for this option and the corresponding asset owner.

Table 5: Option 3: Required Sewage Infrastructure Elements

ID	Element	Description	Asset Owner
1	Internal Sewer Gravity Network	Gravity mains to convey sewage within the development to the primary sewage pumpstation.	CWA
2	Minor Sewage Lifting Stations	If required lifting stations will be placed inside the CWA property to pump/lift the sewer in areas where the pipes become too deep in order to assist conveying sewage to the main sewage station.	CWA
3	Primary Sewage Lift Stationing	This pumpstation will collect and then lift the sewage into the package treatment plant and divert the remainder to the Pump Station.	CWA
4	Package Sewage Treatment Plant	The Package Sewage Treatment will treat the sewage emanating from the CWA development for re-use	CWA
5	Emergency Storage Pond	In the event that there is a malfunction with the primary lifting station or sewage treatment plant flows will be diverted to the emergency overflow pond.	CWA
6	Primary Sewer Pumpstation	A Primary Sewage pump station to pump all sewage flows from the CWA Development to the Fisantekraal WWTW.	CoCT
7	Rising Main	A sewage rising main from the municipal pumpstation to the Fisantekraal WWTW.	CoCT
8	Servitude	A servitude registered across the Bella Riva property in favour of CoCT is required in order accommodate the sewer rising main.	n/a
9	Additional inlet chamber	An additional chamber is required at the inlet works to receive the sewage from the lifting station. The inlet works at WWTW is of the above ground type as it was designed to received pumped flows only.	CoCT

Refer to Appendix E for concept layout of the foul sewer network where the options are included.

6.5 Key Design Criteria

The key design criteria that will inform the design of the sewer networks are summarized in Table 6.

Table 6: Key Sewer Design Criteria

Criteria	Value
Pipe Positioning	• Sewer pipes to be installed in the centre of the road with 1m offset from C/L • Exceptions to avoid acute angles in the pipe.
Material	• GRAVITY pipes range from 160 mm dia. to 250mm dia shall be uPVC Class 34 heavy duty on Class B bedding. • FORCED MAIN pipes to be uPVC Class 12 rising main pipe required or HDPE depending on working pressure. • Sewer manholes to be precast ring manholes with a diameter of 1.2m concrete lockable covers and frames to be used.
Pipe Slope	• Pipe slopes to be designed to maintain self-cleansing flow velocities between 0.6m/s and 2.5m/s.
Depth of Cover	• 1m from crown of pipe to finished road level. • Soil improvement for pipes with a depth of cover less than 1m will be considered. • Such improvements will consist of cement stabilised material (4% cement) on top of the required pipes.

7 Potable Water

7.1 Existing services

The site is located on the City's urban edge and thus water services provision is limited with the closest, existing accessible services located about 3km to the east of the CWA site. The site falls into Spes Bona Reservoir supply zone with the main trunk supply being a 400mm dia. pipe located in the R312 Lichtenburg Road. Refer to Figure 16 for an overview of the existing bulk water infrastructure in the vicinity of the development.

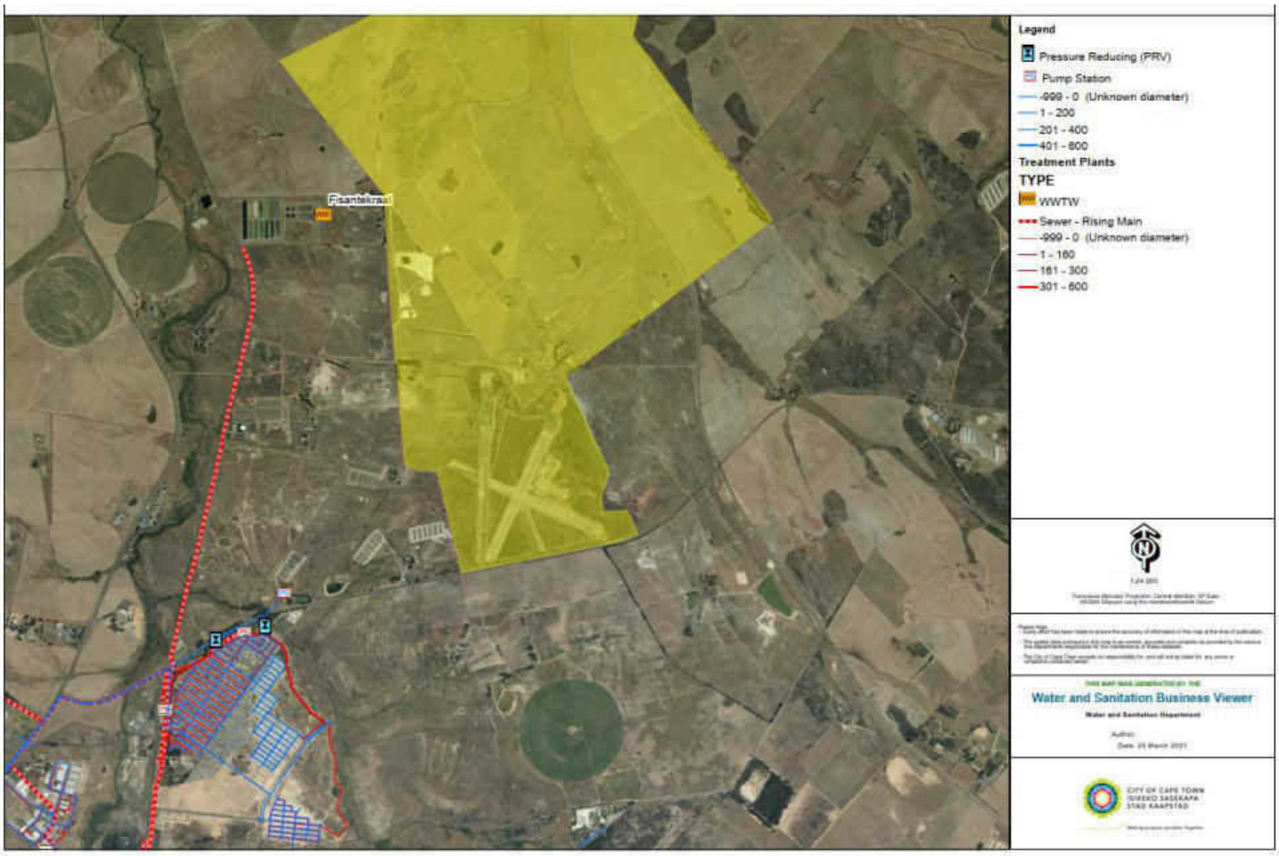


Figure 16: Overview of Existing Potable Water Infrastructure

Based on the as-built data received from the CoCT it is clear that there is limited bulk water infrastructure in close proximity or adjacent to the CWA development. Refer to Appendix E, for a detailed overview of the existing potable infrastructure.

The status quo for **water service provision** to the site is summarized as follows:

- The site is currently not serviced with a municipal water connection.
- The existing buildings on site are serviced through boreholes.

The status quo for **existing municipal water services** is as follows:

- The site falls within the Spes Bona Reservoir supply zone.
- There are no existing municipal potable pipelines in close proximity to the site.
- Although there are some supply mains to the chicken farms to the west of the CWA development the nearest accessible existing municipal water services are found in Fisantekraal settlement

- The tie in point is along a trunk main from the Spes Bona Reservoir is a 400mm dia. located in the R312 Lichtenburg which road and the extent of which terminates just after the railway crossing.
- There are proposed developments in close proximity where municipal water mains are proposed and include the Greenville development to the south and the Bella Riva development to the east. Both developments were considered as possible tie-in locations however, these developments are still in the planning stage and there are no firm indications that either development will have water infrastructure constructed in the short term in time to supply CWA.

Refer to Appendix E for an overview of the existing services.

7.2 Design standards

The applicable design standards that have been adopted include:

- Guidelines for Human Settlement Planning and Design ('The Red Book 2019'), published by the CSIR.
- Minimum Standards for Civil Engineering Services in Townships (July 2013).
- SANS 1200: Standardised Specification for Civil Engineering Construction.
- SANS 241 of 2015

7.3 Proposed water demands

The water demands for the proposed CWA development have been determined and are based on the applicable design guidelines listed in Section 7.2. For sewer and water demand purposes Zutari included a land use allocation in accordance with '*The Red Book 2019'*, as detailed in Appendix F. Where necessary certain interpretations have been made for land uses that are not defined in these guidelines such as the water demand for airport hangers (see Appendix F). In this instance where land uses are not defined a process of rationalizing an equivalent land use or combination of lands uses was undertaken with appropriate reductions if deemed necessary. The water demands are summarized in Table 7 below.

Table 7: Water Demand Calculations Summary

Water Demand Calculations							
	Description	**Units**	**PAL 1 Demand**	**PAL 1B Demand**	**PAL 2 Demand**	**PAL 3 Demand**	**PAL 4 Demand**
Peak Water Demand Calculations	Total AADD	**Kℓ/day**	874	874	1282	1435	1552
	Instantaneous demand	ℓ/s	10	10	15	17	18
	Peak Factor (PF)		3.3	3.3	3.3	3.3	3.3
	Peak instantaneous demand (Qp) AADD x PF_{HOUR}	ℓ/s	33	33	49	55	59
	Consider 15% losses	ℓ/s	38	38	56	63	68
	Peak Fire Flow (Qf)	ℓ/s	215	215	215	215	215
Total Peak Instantaneous Demand (Q) Qp + Qf		**ℓ/s**	**287**	**287**	**320**	**333**	**342**

Water demands were then also broken down into potable and non-potable demands based on figures found in the Guidelines for Human Settlement Planning and Design ('The Red Book 2019'), published by the CSIR., refer to Table 8 below for these water demand splits.

The split between non-potable and potable will be refined during the detailed design process once the landscaping and services designs are developed.

Table 8: Water Demand Split

Water Demand Split Summary							
Total Average Annual Daily Demand (TAADD = AADD + Losses)							
Description		**Unit**	**PAL 1 Demand**	**PAL 1B Demand**	**PAL 2 Demand**	**PAL 3 Demand**	**PAL 4 Demand**
TAADD	Indoor Water Demand (90% of TAADD-NP)	Kℓ/day	694	694	1125	1287	1352
	Outdoor Water Demand (10% of TAADD-NP)	Kℓ/day	77	77	125	143	150
	Non Potable Irrigation Water Demand (NP)	Kℓ/day	258	258	258	258	324
Indoor Water Demand (90% of TAADD)	Typical water usage (Potable)	Kℓ/day	520	520	844	966	1014
	Toilet flushing (Non Potable)	Kℓ/day	173	173	281	322	338
Irrigation Water Demand	Non Potable Water Demand & Outdoor Demand	Kℓ/day	335	335	383	401	475
Total Peak Annual Daily Demand (TPADD = TAADD x PF_{DAY})							
Description		**Unit**	**PAL 1 Demand**	**PAL 1B Demand**	**PAL 2 Demand**	**PAL 3 Demand**	**PAL 4 Demand**
Indoor Water Demand (90% of TPADD)	Typical water usage (Potable)	Kℓ/day	884	884	1435	1641	1723
	Toilet flushing (Non Potable)	Kℓ/day	295	295	478	547	574
Bio Digester Demand	Bio Digester (Non Potable)	Kℓ/day	200	200	200	200	200
Total Non-Potable Irrigation Water Demand	Non Potable Water Demand & Outdoor Demand	Kℓ/day	569	569	650	681	807
Summary	**Total Peak Potable Water Daily Demand**	**Kℓ/day**	**884**	**884**	**1435**	**1641**	**1723**
	Total Peak Non-potable water Daily Demand	**Kℓ/day**	**1064**	**1064**	**1329**	**1428**	**1581**
Summary	**Total Peak Potable Water Daily Demand**	**l/s**	**10.2**	**10.2**	**16.6**	**19.0**	**19.9**
	Total Peak Non-potable water Daily Demand	**l/s**	**12.3**	**12.3**	**15.4**	**16.5**	**18.3**

7.4 Spare capacity assessment

An application was made to the City of Cape Town to determine if spare capacity exits in the municipal water system to supply the water requirements of the proposed CWA development.

This application was done using water demands calculated for a previous concept layout for the development.

The detailed response from the City of Cape Town is included in Appendix G whilst the key aspects of the response are summarized as flows:

Storage Capacity

- Sufficient storage capacity exists in the Spes Bona reservoir to supply the short term water requirements of the CWA development.

Network Capacity

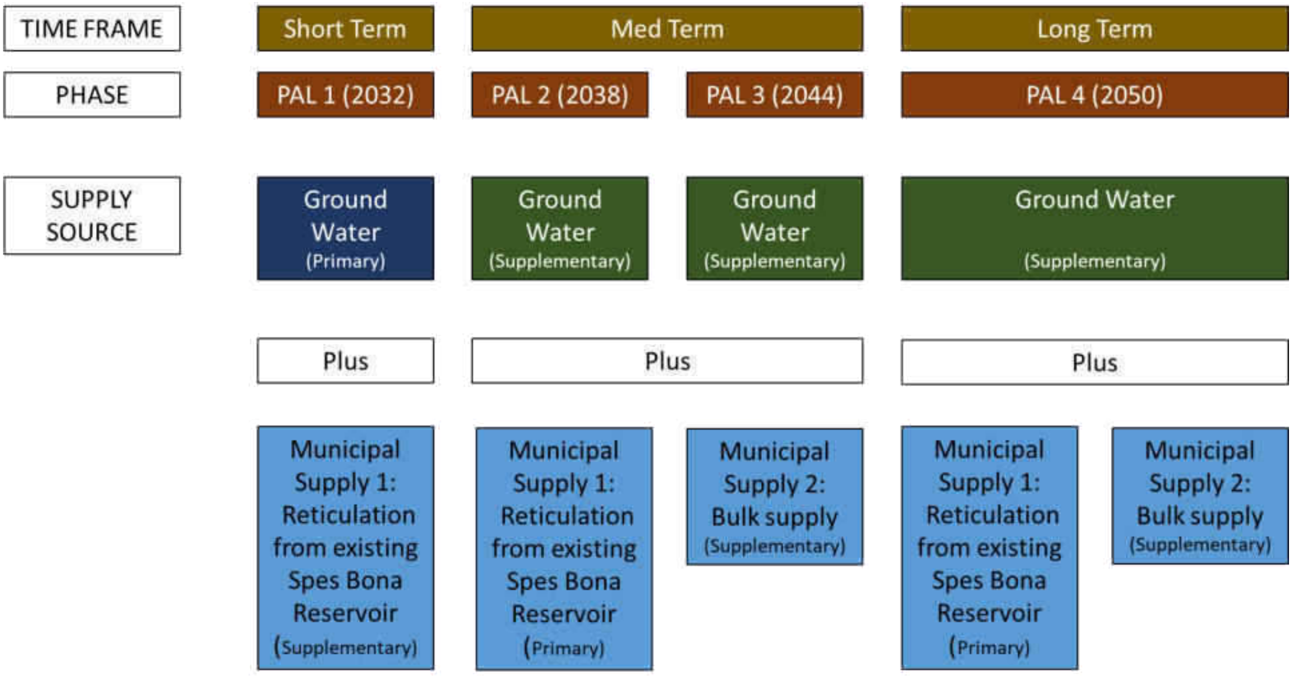
- The network infrastructure in the area is limited.
- The existing network pipe diameters are restricted and as a result should the CWA development connect to the network the flow velocities will exceed that which is acceptable.
- The CoCT indicated that the CWA development will only be able to obtain 25% (5.65l/s of then calculated demand of 22.52l/s) of its requested peak instantaneous demand capacity (Qp) from the municipal system. (This would only be 9.6% of the current calculated peak instantaneous demand of 59 l/s)

Future Scenario

In a meeting with City of Cape Town Bulk Water and Water Reticulation on the 4th of October 2024, a proposal for bulk water supply to CWA and neighbouring developments was put forth to meet the medium and long term water requirements for the CWA development. The recommendation was based on the bulk water master planning for the northern edge of the city, an initial proposal included constructing a 300 ML reservoir at the old Spes Bona reservoir site (hereafter referred to as Spes Bona Reservoir 3) to enhance climate resilience and meet future water demand. While the proposal underwent an Environmental Impact Assessment (EIA), which approved a pipeline from the proposed Spes Bona 3 Reservoir to Muldersvlei. It was suggested that CoCT Water Reticulation evaluate the feasibility of constructing a reservoir at the proposed site for Spes Bona 3 using the EIA-approved pipeline route to supply water to the site and neighboring developments, noting that no progress has been made on land acquisition for the proposed pipe route. The reservoir size would be determined by CoCT Water Reticulation department, and financing could be partially offset by Development Contributions (DCs) from these developments. Zutari have submitted a letter to CoCT water reticulation to request support for the developments medium and long term water supply.

Due to the current constraints in the municipal system alternative potable water sources will have to be considered for the CWA development in the short to medium term. In addition, consideration should be given to non-potable systems to reduce the demand for potable water.

The strategy for water supply to CWA is one of a phased approach and entails using ground water as a primary supply source in the short term up until municipal infrastructure can either supplement the groundwater supply or be the primary source of supply. The strategy is illustrated in the diagram below.



TIME FRAME	Short Term	Med Term		Long Term
PHASE	PAL 1 (2032)	PAL 2 (2038)	PAL 3 (2044)	PAL 4 (2050)
SUPPLY SOURCE	Ground Water (Primary)	Ground Water (Supplementary)	Ground Water (Supplementary)	Ground Water (Supplementary)
	Plus	Plus		Plus
	Municipal Supply 1: Reticulation from existing Spes Bona Reservoir (Supplementary)	Municipal Supply 1: Reticulation from existing Spes Bona Reservoir (Primary)	Municipal Supply 2: Bulk supply (Supplementary)	Municipal Supply 1: Reticulation from existing Spes Bona Reservoir (Primary) Municipal Supply 2: Bulk supply (Supplementary)

Figure 17: Potable Water Supply Strategy

7.4.1 Phase 1: Borehole supply

There are currently several boreholes in proximity to the CWA Development and some of these boreholes have favourable yield and water quality. Three production boreholes were drilled on site, these borehole seems to have sufficient yield to form the primary water supply for the preliminary demand for the CWA Development, for further details refer to Appendix H for the boreholes yield and water quality testing reports. A water treatment plant is being considered to treat the borehole water to a potable water standard.

If a developer elects to treat groundwater to supply their development in lieu of municipal supply, then the developer is required to obtain a Water Supply Intermediary Licence from the CoCT. Discussions have been held with the CoCT in this regard. The application is supported in principle and is subject to a formal application and review of the proposal by the CoCT. The elements proposed for this solution are included in Table 9 below.

Refer to Appendix E for an indicative layout of the proposed water supply to the development. We note that as part of the water strategy for CWA, treated effluent will be used to supplement potable water in so far as treated effluent will be used for toilet flushing and irrigation. The treated effluent generated from the on-site wastewater treatment plant proposed in Foul Sewer Layout Option 1 is to be used to supply the non-potable demand in this scenario.

Table 9: Phase 1: Borehole Supply

ID	Element	Description	Asset Owner
1	Boreholes	Several boreholes will be sunk to meet the demand of the CWA development.	CWA
2	Water Treatment Plant	A water treatment plant will be provided to treat the water to meet SANS 241 (2015) standard.	CWA
3	Storage Tanks	Storage tanks will be provided to provide a buffer against peaks flows and as emergency storage if the boreholes or WTP experience down time.	CWA
4	Booster Pumpstation	To supply water at the required flow and pressure.	CWA
5	Brine Evaporation ponds	If required brine evaporation ponds to deal with the brine as a byproduct of the water treatment process.	CWA

7.4.2 Phase 2: Municipal supply

Phase 2 involves primary supply via the proposed connection to the municipal supply in Lichtenberg Rd. Once the bulk supply is available then the connection will be made directly onto the network.

Table 10: Phase 2: Municipal Supply

ID	Element	Description	Asset Owner
1	Municipal Tie- in	A tie-in to the municipal network	CoCT

7.4.3 Internal water reticulation network

The proposed internal water reticulation network for CWA is proposed to be sourced from a combination of boreholes and municipal supply. These sources will feed into proposed on-site storage tanks, from which water will be distributed throughout the development. There will be no direct connection to the municipal supply line for reticulation purposes. The on-site storage tanks will be designed to provide sufficient buffering capacity to accommodate peak demand and high-demand scenarios, ensuring consistent water availability. For fire demand scenarios, a separate set of dedicated fire storage tanks is proposed. These tanks will be designed with adequate capacity to meet fire-fighting requirements without imposing additional stress on the municipal water supply system.

7.5 Design Parameters

The following design parameters listed in Table 11 are from the documents mentioned in section 7.2 and as per design consideration based on site-specific conditions.

Table 11: Key Water Design Criteria

Criteria	Value
Pipe Positioning	• All water pipes to be placed at least 1m inside the road reserves or from the erven boundary to provide enough space for metered house connections.
Depth of cover	• All water pipes to have at least 1m of the depth of cover.
Materials	• Watermains to be 110mm dia. to 250mm dia uPVC Class 12. • Fire mains to be uPVC Class 16.

8 Transport

Traffic impact assessment to be done by roads and traffic engineer. Also refer to the Masterplan document for additional information. This section of the report will be expanded during the develop design stage of the development.

9 Electrical

New electrical infrastructure is required to the site in order to provide the site with sufficient load.

All electrical provisions to the site to be done by the Electrical engineer. This section of the report will be expanded during the develop design stage of the development.

Electrical sleeves will be provided at all road crossings as indicated in Appendix E.

10 Telecommunication

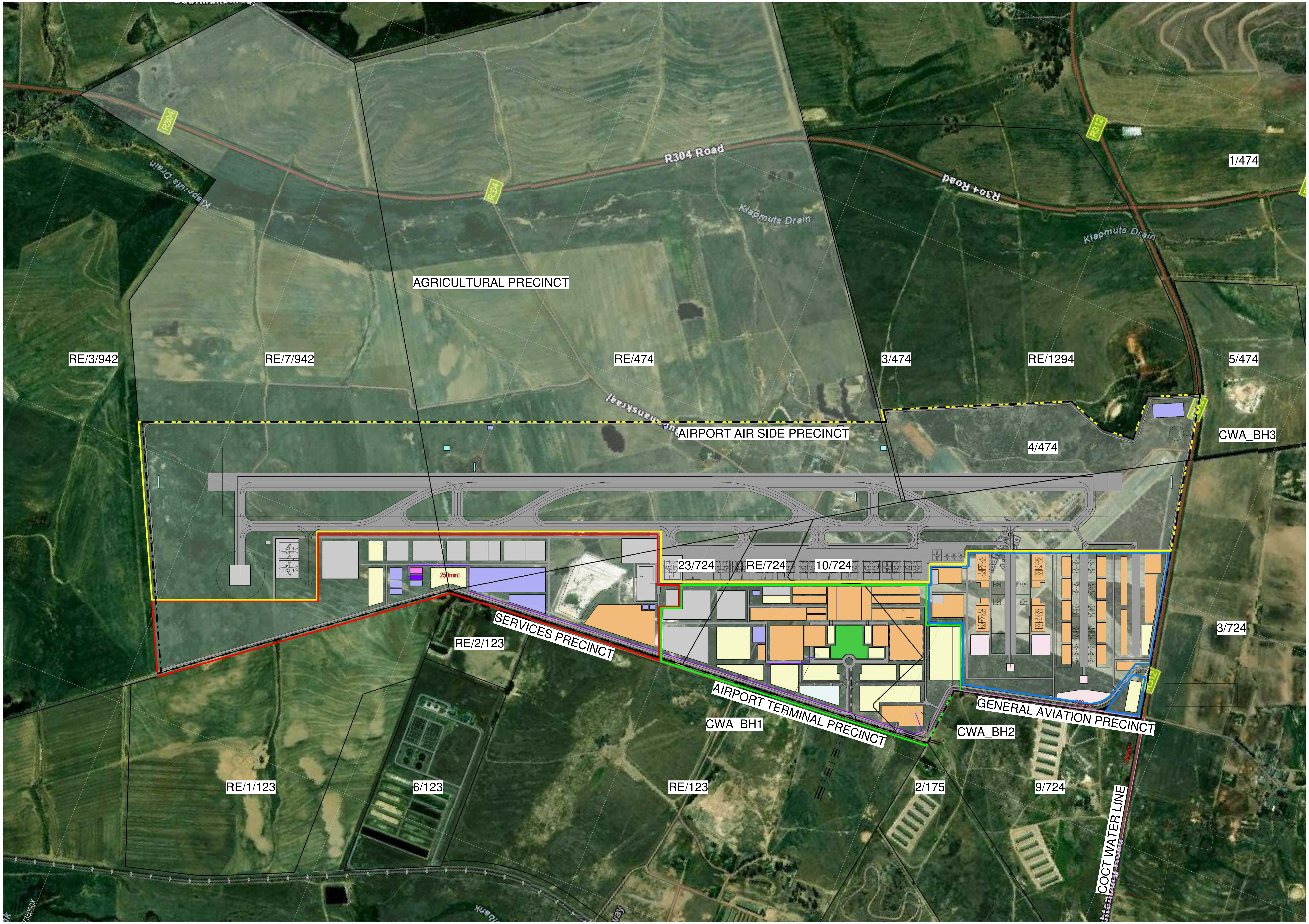
All telecommunications to the site will be done by a suitably qualified professional. This section of the report will be expanded during the develop design stage of the development.

Telecommunication sleeves will be provided at all road crossings as indicated in Appendix E.

11 Geotechnical

To formalise infrastructure within the Cape Wine Lands Airport development a Geotechnical investigation was required to inform design decisions on the site. Refer to Appendix D for geotechnical investigation report.

Appendix A



SITE PLAN - PHASE 2

0 62.5 m 125.0 m 250.0 m
SCALE: 1:5000

GENERAL NOTES

- * ALL BUILDING WORK AND BUILDING REQUIREMENTS ARE TO BE CARRIED OUT IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE NATIONAL BUILDING REGULATIONS AND BUILDING STANDARDS ACT (No 103 OF 1977).
- * THIS DRAWING IS NOT TO BE SCALED. USE FIGURED DIMENSIONS ONLY.
- * ALL DIMENSIONS AND LEVELS, ETC., TO BE CHECKED ON SITE, BEFORE ANY WORK IS COMMENCED.
- * ANY DISCREPANCIES, QUERIES, ETC., RELATED TO THIS DRAWING ARE TO BE REFERRED TO CAPEX PROJECTS, BEFORE ANY WORK IS COMMENCED.
- * REINFORCED CONCRETE AND STRUCTURAL STEELWORK IS TO BE IN ACCORDANCE WITH THE STRUCTURAL ENGINEER'S DESIGN AND SPECIFICATIONS.

DRAINAGE NOTES

- * ALL DRAINAGE RUNS TO BE ACCESSIBLE ALONG THEIR ENTIRE LENGTH.
- * V.P.'s TO BE CARRIED UP TO 2m ABOVE ANY WINDOW OR DOOR OPENING IN THE BUILDING OR ANY OTHER BUILDING WITHIN A DISTANCE OF 6m.
- * INSPECTION EYES (i.e.'s) TO BE PROVIDED AT ALL BENDS AND JUNCTIONS OF SOIL AND WASTE PIPES.
- * RODDING EYES (r.e.'s) TO BE PROVIDED AT HEADS OF DRAINS AND AT A MAXIMUM OF 25m SPACINGS ALONG RUNS OF DRAINS.
- * MARKED COVERS TO BE PROVIDED AT GROUND LEVEL FOR i.e's BELOW PAVING
- * RESEAL TRAPS TO BE PROVIDED TO ALL WASTE FITTINGS.
- * SOIL WATER DRAINS PASSING UNDER BUILDINGS TO BE ENCASED IN 150mm CONCRETE ALL ROUND AND BE PROVIDED WITH r.e.'s AS CLOSE TO THE BUILDING AS POSSIBLE AT BOTH ENDS.
- * SOIL WATER PIPES HAVING A VERTICAL DROP EXCEEDING 1200mm TO THE MAIN DRAIN TO BE ANTI-SYPHONED.
- * ALL BRANCH DRAINS EXCEEDING 6m IN LENGTH TO BE VENTED.
- * uPVC PIPES ARE TO BE LAID IN ACCORDANCE WITH THE MANUFACTURERS TECHNICAL SPECIFICATIONS.

FIRE DEPARTMENT'S REQUIREMENTS

- * ALL WORK IS TO COMPLY WITH SABS 400.
- * a) EXTINGUISHERS TO BE INSTALLED IN ACCORDANCE WITH SABS 0105.
  b) HOSE REELS TO BE INSTALLED IN ACCORDANCE WITH SABS 543.
  c) HYDRANTS TO BE INSTALLED IN ACCORDANCE WITH SABS 1128 PART 1.
- * PORTABLE FIRE EXTINGUISHERS TO BE HUNG ON PURPOSE MADE BOARDS AND LOCATED IN SECURE POSITIONS AS INDICATED ON PLAN.
- * CLASS "B" FIRE DOORS TO COMPLY WITH SABS 1253 AND TO BE FITTED WITH APPROVED SELF CLOSING OR AUTOMATIC CLOSING DEVICES.
- * STRUCTURAL ELEMENTS AND COMPONENTS TO COMPLY WITH TT7.
- * FIRE EXIT DOORS ARE TO BE FITTED WITH EMERGENCY EXIT LOCKSETS.
- * SYMBOLIC SAFETY SIGNS TO BE IN ACCORDANCE WITH S.A.B.S. CODE 1186 AND POSITIONED AS REQUIRED BY THE FIRE DEPARTMENT.

15	BH, COCT Water Line, Fuel Line and Boundary Adjustments	2025-01-15
14	ISSUED - BOUNDARY FENCE LINE ADJUSTED	2024-08-20
13	ISSUED - PHASE 1 UPDATED	2024-08-19
12	ISSUED FOR REVIEW	2024-08-14
11	ISSUED TO PROFESSIONALS	2024-07-24
10	ISSUED	2024-07-24
9	ISSUED	2024-07-24
8	ISSUED	2024-07-23
7	Revised SDP/EIA For Comment	2024-07-23
6	Revised SDP/EIA For Comment	2024-07-23
5	Added ATCT and Helipad	2024-05-24
4	FOR REVIEW	2024-04-10
3	FOR REVIEW	2024-04-03
2	FOR REVIEW	2024-04-03
1	FOR REVIEW	2024-03-28
Rev	Description	Revision Date

CAPEX PROJECTS
UNIT 10 First Floor
BOSKRUIN BUSINESS PARK
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2188

Tel: 011 792 4260/ 8169

CLIENT
CAPE WINELANDS AERO

Client

Engineer

.

Registration NO: Designer

SACAP NO: ..

CLIENT
ENVIRONMENTAL CONSULTANT

TITLE
PHASE 2

DRAWING
CWA - PRECINCT PLANS

SIZE	DWG NO	REV
A0	2024-3297 400	15

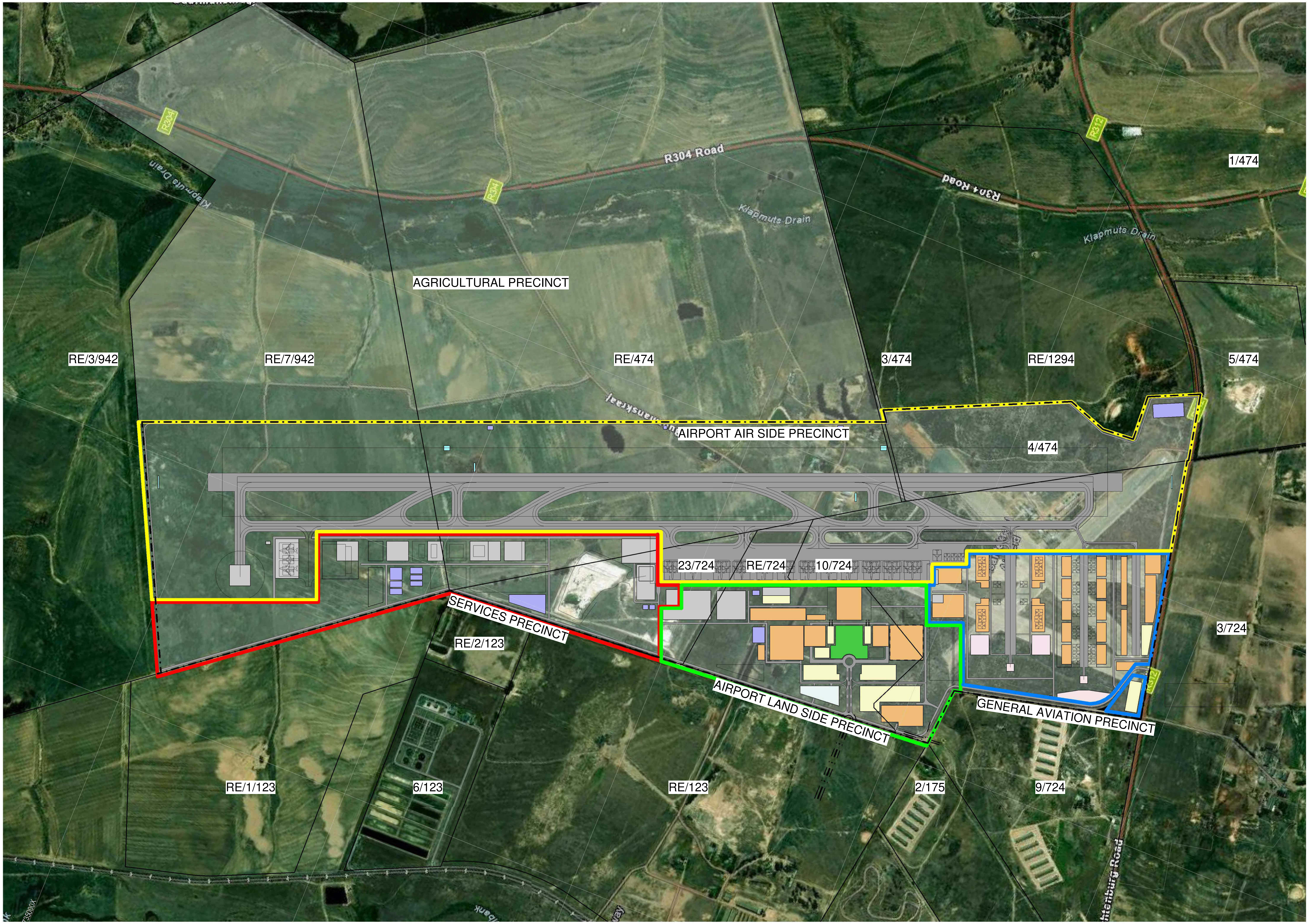
SCALE 1 : 5000
DATE 2025-01-15
DRAWN BY: CW DENNIS

Appendix B

No.	Unique Code	Phase	Occupancy	Ground Area (m^2)	PRIMARY USE	AIRPORT USE	FLOORS	COVERAGE (%)	Building Area (m^2)	Parking Bays
1	A01	1	PASSENGER TERMINAL BUILDING	13979	Transport Use	Terminal Building	2	1	27958	0
2	A02.1	1	CAR RENTAL	1725	Transport Use	Rental Cars	1	1	1725	606
3	A03	1	GA/VIP/GOVERNMENT TERMINAL	6419	Transport Use	Customs and Immigration	1	0.568990497	3652	392
4	A10.1B	1	FBO 1	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0
5	A10.2B	1	FBO 2	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0
6	A10.3B	1	FBO 4	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0
7	A10.4B	1	FBO 3	1220	Transport Use	Warehouse for storage of airfreight	1	0.7	854	0
8	A15.2	3	TERMINAL RESERVE	4468	Transport Use	Terminal Building	2	1	8936	0
9	A15.3	3	TERMINAL RESERVE	1843	Transport Use	Terminal Building	2	1	3686	0
10	A15.4	4	TERMINAL RESERVE	9289	Transport Use	Terminal Building	2	1	18578	0
11	A15.5	4	TERMINAL RESERVE	6308	Transport Use	Terminal Building	2	1	12616	0
12	A15.7	2	TERMINAL RESERVE	5011	Transport Use	Terminal Building	2	1	10022	0
13	A15.8	2	TERMINAL RESERVE	5210	Transport Use	Terminal Building	2	0.648848369	6761	0
14	B05	1	ASS	7216	Transport Use	Airport Administration	0	0	0	0
15	B07	1	CATERING BUILDING	6400	Transport Use	Catering	0	0	0	0
16	B14.1	1	OPS	1500	Transport Use	Airport Administration	2	0.6	1800	0
17	B14.2	1	OPS	7472	Transport Use	Airport Administration	1	0.7	5230	0
18	B14a	1	AIR TRAFFIC CONTROL TOWER	3403	Transport Use	Air Traffic Control	2	0.2	1361	0
19	E.2	1	RESTAURANT	1999	Restaurant	Non Airport Use	1	0.5	1000	0
20	E04.12	1	AIRPORT USE	6315	Shop	Non Airport Use	1	0.5	3158	0
21	E04.3	3	AIRPORT USE	11170	Transport Use	Airport Administration	2	0.467815577	10451	0
22	E04.4	1	AIRPORT USE	9144	Consent Use	Non Airport Use	1	0.5	4572	0
23	E04.5	1	AIRPORT USE	9342	Transport Use	Airport Administration	1	0.5	4671	0
24	E04.6	1	RETAIL	19563	Shop	Non Airport Use	2	0.45	17607	0
25	E04.7	2	AIRPORT USE	5928	Transport Use	Passenger Services	1	0.78879892	4676	0
26	E04.8	2	AIRPORT USE	27081	Transport Use	Airport Administration	2	0.4	21665	0
27	A16	1	GA CLUBHOUSE & FUELING	5204	Restaurant	Non Airport Use	2	0.301787087	3141	0
28	E01.1	1	AIRPORT USE: HOTEL 1	2623	Consent Use	Non Airport Use	3	0.6	4721	0
29	E01.2	2	AIRPORT USE: HOTEL 2	2623	Consent Use	Non Airport Use	3	0.6	4721	0
30	B03	1	MRO HANGER	22961	Transport Use	Aircraft Maintenance and Refurbishment	1	1	22961	0
31	B06	1	AIRPORT MAINTENANCE	10041	Transport Use	Aircraft Maintenance and Refurbishment	1	0.3	3012	0
32	B08	1	GSE MAINTENANCE	5997	Transport Use	Ground Support Equipment	1	0.7	4198	0
33	B09.1	1	GSE STAGING AREA	3998	Transport Use	Ground Support Equipment	0	0	0	0
0	B09.2	1	GSE STAGING	3819	Transport Use	Ground Support Equipment	0	0	0	0
34	E04.14	1	AIRPORT USE	4820	Transport Use	Ground Support Equipment	0	0	0	0
35	E04.15	1	AIRPORT USE	9094	Transport Use	Ground Support Equipment	0	0	0	0
36	A15.1	3	PIER EXPANSION RESERVATION	4126	Transport Use	Terminal Building	0	0	0	0
37	A15.6	3	PIER EXPANSION RESERVATION	5910	Transport Use	Terminal Building	1	0	0	0
38	C12	1	RDTS	225	Transport Use	Air Traffic Control	2	0.5	225	0
39	D01.1	1	LOCALIZER	265	Transport Use	Air Traffic Control	0	0	0	0
40	D01.2	1	LOCALIZER	265	Transport Use	Air Traffic Control	0	0	0	0
41	D02.1	1	GLIDEPATH ANTENNA	500	Transport Use	Air Traffic Control	0	0	0	0
42	D02.2	1	GLIDEPATH ANTENNA	500	Transport Use	Air Traffic Control	0	0	0	0
43	D03.1	1	PAPI	252	Transport Use	Air Traffic Control	0	0	0	0
44	D03.2	1	PAPI	252	Transport Use	Air Traffic Control	0	0	0	0
45	A02.2	1	CAR RENTAL	11666	Transport Use	Parking	0	0	0	250
46	A04.1	1	PUBLIC TRANSPORT	7516	Transport Use	Parking	0	0	0	289
47	A04.2	1	PICK UP & DROP OFF	5569	Transport Use	Parking	0	0	0	120
48	A08	2	PARKING	33217	Warehouse	Non Airport Use	0	0	0	95
49	A08.1	1	PARKING	1827	Transport Use	Parking	0	0	0	1015
50	A08.2	1	PARKING	19515	Transport Use	Parking	0	0	0	3769
51	A08.4	1	PARKING	13469	Transport Use	Parking	0	0	0	559
52	A08.5	1	PARKING	10753	Transport Use	Parking	0	0	0	155
53	A08.6	1	PARKING	2987	Transport Use	Parking	0	0	0	60
54	B01	1	AIRCRAFT PARKING POSITION	7225	Transport Use	Aircraft Taxiway	0	0	0	0
0	B02	1	MRO APRON	15374	Transport Use	Apron	0	0	0	0
55	B11	1	SPECIAL CARGO FACILITY	1575	Transport Use	Warehouse for handling of airfreight	1	0.75	1181	0
56	B11.1	1	CARGO TERMINAL	3500	Transport Use	Warehouse for handling of airfreight	1	1	3500	0
57	B11.2	2	CARGO	17436	Transport Use	Warehouse for handling of airfreight	1	0.5	8718	0
58	B11.3	1	CARGO	14043	Transport Use	Warehouse for handling of airfreight	1	0.5	7022	0
59	B11.4	2	CARGO	22545	Transport Use	Warehouse for storage of airfreight	1	0.5	11273	0
60	B12	1	CARGO APRON	10589	Transport Use	Warehouse for storage of airfreight	0	0	0	0
61	E04.1	2	AIRPORT USE	18348	Transport Use	Warehouse for storage of airfreight	1	0.75	13761	0
62	E04.13	1	AIRPORT USE	4636	Transport Use	Hangars (Storage of Aircraft)	1	0.74525453	3455	0
63	E04.16	2	AIRPORT USE	10993	Transport Use	Warehouse for handling of airfreight	1	0.7	7695	0
64	E04.2	3	AIRPORT USE	7660	Transport Use	Warehouse for storage of airfreight	1	0.75	5745	0
65	E04.9	1	AIRPORT USE	3819	Transport Use	Warehouse for handling of airfreight	2	0.507724535	3878	0
66	A10.1A	1	FBO 1	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0
67	A10.2A	1	FBO 2	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0
68	A10.3A	1	FBO 4	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0
69	A10.4A	1	FBO 3	5798	Transport Use	Warehouse for storage of airfreight	1	0.7	4059	0
70	A11.1	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
71	A11.10	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
72	A11.11	3	GA HANGERS	4678	Transport Use	Hangars (Storage of Aircraft)	1	0.7	3275	0
73	A11.12	1	GA HANGERS	4971	Transport Use	Hangars (Storage of Aircraft)	1	0.7	3480	0
74	A11.13	1	GA HANGERS	8512	Transport Use	Hangars (Storage of Aircraft)	1	0.7	5958	0
75	A11.2	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
76	A11.3	2	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
77	A11.4	3	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
78	A11.5	4	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
79	A11.6	4	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
80	A11.7	3	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
81	A11.8	2	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0

No.	Unique Code	Phase	Occupancy	Ground Area (m2)	PRIMARY USE	AIRPORT USE	FLOORS	COVERAGE (%)	Building Area (m2)	Parking Bays
82	A11.9	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0
83	B10.1	1	FUEL FARM	6797	Transport Use	Fuel Storage	0	0	0	0
84	B10.2	1	FUEL FARM	6797	Transport Use	Fuel Storage	0	0	0	0
85	B13	1	ARFF	14536	Transport Use	Firefighting and Rescue	1	0.3	4361	0
86	B17.1	1	ACCESS CONTROL	102	Transport Use	Security	1	0.6	61	0
87	B17.2	1	ACCESS CONTROL	100	Transport Use	Security	1	0.6	60	0
88	B17.3	1	ACCESS CONTROL	100	Transport Use	Security	1	0.6	60	0
89	B24.1	1	SUBSTATION	260	Utility Service	Non Airport Use	0	0	0	0
90	C01	1	POTABLE WATER	1250	Utility Service	Non Airport Use	0	0	0	0
91	C02	1	GROUNDWATER TREATMENT	1000	Utility Service	Non Airport Use	0	0	0	0
92	C03	1	WATER PUMPSTATION	1000	Utility Service	Non Airport Use	0	0	0	0
93	C04	1	NON-POTABLE WATER	2500	Utility Service	Non Airport Use	0	0	0	0
94	C05	1	SOLID WASTE	1250	Utility Service	Non Airport Use	0	0	0	0
95	C06	1	WTWW + LIFT STATION	1250	Utility Service	Non Airport Use	0	0	0	0
96	C07	2	BIOGAS PLANT	30879	Utility Service	Non Airport Use	0	0	0	0
97	C08	1	ESKOM INCOMING & LS SUBSTATION	8432	Utility Service	Non Airport Use	0	0	0	0
98	C08	1	ESKOM INCOMING & LS SUBSTATION	7056	Utility Service	Substation	0	0	0	0
99	C09	1	ENERGY CENTRE	3250	Utility Service	0	0	0	0	0
100	C10	1	FIREFIGHTING WATER PUMP STATION	440	Transport Use	Firefighting and Rescue	0	0	0	0
101	C11	1	SUBSTATION	460	Utility Service	0	0	0	0	0
102	C11.1	1	SUBSTATION	408	Utility Service	Non Airport Use	0	0	0	0
103	C11.1	1	AS SS	600	0	0	0	0	0	0
104	C11.2	1	SUBSTATION	408	Utility Service	Non Airport Use	0	0	0	0
105	C11.2	1	LS SS	600	Utility Service	0	0	0	0	0
106	E.1	1	AERO VINTAGE	1999	Transport Use	Hangars (Storage of Aircraft)	2	0.5	1999	0
107	PH.1	1	HELIPORT	6220	Transport Use	Heliport	1	0.2	1244	0
108	PH.2	1	HELIPORT	6220	Transport Use	Heliport	1	0.2	1244	0
109	PH.3	1	HELIPORT	992	Transport Use	Heliport	1	0.5	496	0
110	PH.4	1	HELIPORT	992	Transport Use	Heliport	1	0.5	496	0
111	PH.5	1	HELIPORT	8938	Transport Use	Heliport	1	0.506265384	4525	0
112	A08.3	4	CARPARK / EVTOL	19590	Multiple Parking Garage	Non Airport Use	0	0	0	1100
113	F01	1	SERVICE STATION	9075	Consent Use	Non Airport Use	1	0.15	1361	0
114	"00"	1	LANDSCAPED AREA	0	Consent Use	Non Airport Use	0	0	0	0
115	"00"	4	LANDSCAPED AREA	16538	Consent Use	Non Airport Use	0	0	0	0
			TOTAL	**736791**				**TOTAL**	**350000**	**8410**

Appendix C



SITE PLAN - PHASE 1

0 62.5 m 125.0 m 250.0 m

SCALE: 1:5000

GENERAL NOTES

* ALL BUILDING WORK AND BUILDING REQUIREMENTS ARE TO BE CARRIED OUT IN STRICT ACCORDANCE WITH THE REQUIREMENTS OF THE NATIONAL BUILDING REGULATIONS AND BUILDING STANDARDS ACT (No 103 OF 1977).
* THIS DRAWING IS NOT TO BE SCALED. USE FIGURED DIMENSIONS ONLY.
* ALL DIMENSIONS AND LEVELS, ETC., TO BE CHECKED ON SITE, BEFORE ANY WORK IS COMMENCED.
* ANY DISCREPANCIES, QUERIES, ETC., RELATED TO THIS DRAWING ARE TO BE REFERRED TO CAPEX PROJECTS, BEFORE ANY WORK IS COMMENCED.
* REINFORCED CONCRETE AND STRUCTURAL STEELWORK IS TO BE IN ACCORDANCE WITH THE STRUCTURAL ENGINEER'S DESIGN AND SPECIFICATIONS.

DRAINAGE NOTES

* ALL DRAINAGE RUNS TO BE ACCESSIBLE ALONG THEIR ENTIRE LENGTH.
* V.P.'s TO BE CARRIED UP TO 2m ABOVE ANY WINDOW OR DOOR OPENING IN THE BUILDING OR ANY OTHER BUILDING WITHIN A DISTANCE OF 6m.
* INSPECTION EYES (i.e.'s) TO BE PROVIDED AT ALL BENDS AND JUNCTIONS OF SOIL AND WASTE PIPES.
* RODDING EYES (r.e.'s) TO BE PROVIDED AT HEADS OF DRAINS AND AT A MAXIMUM OF 25m SPACINGS ALONG RUNS OF DRAINS.
* MARKED COVERS TO BE PROVIDED AT GROUND LEVEL FOR i.e's BELOW PAVING
* RESEAL TRAPS TO BE PROVIDED TO ALL WASTE FITTINGS.
* SOIL WATER DRAINS PASSING UNDER BUILDINGS TO BE ENCASED IN 150mm CONCRETE ALL ROUND AND BE PROVIDED WITH r.e.'s AS CLOSE TO THE BUILDING AS POSSIBLE AT BOTH ENDS.
* SOIL WATER PIPES HAVING A VERTICAL DROP EXCEEDING 1200mm TO THE MAIN DRAIN TO BE ANTI-SYPHONED.
* ALL BRANCH DRAINS EXCEEDING 6m IN LENGTH TO BE VENTED.
* uPVC PIPES ARE TO BE LAID IN ACCORDANCE WITH THE MANUFACTURERS TECHNICAL SPECIFICATIONS.

FIRE DEPARTMENT'S REQUIREMENTS

* ALL WORK IS TO COMPLY WITH SABS 400.
* a) EXTINGUISHERS TO BE INSTALLED IN ACCORDANCE WITH SABS 0105.
b) HOSE REELS TO BE INSTALLED IN ACCORDANCE WITH SABS 543.
c) HYDRANTS TO BE INSTALLED IN ACCORDANCE WITH SABS 1128 PART 1.
* PORTABLE FIRE EXTINGUISHERS TO BE HUNG ON PURPOSE MADE BOARDS AND LOCATED IN SECURE POSITIONS AS INDICATED ON PLAN.
* CLASS "B" FIRE DOORS TO COMPLY WITH SABS 1253 AND TO BE FITTED WITH APPROVED SELF CLOSING OR AUTOMATIC CLOSING DEVICES.
* STRUCTURAL ELEMENTS AND COMPONENTS TO COMPLY WITH TT7.
* FIRE EXIT DOORS ARE TO BE FITTED WITH EMERGENCY EXIT LOCKSETS.
* SYMBOLIC SAFETY SIGNS TO BE IN ACCORDANCE WITH S.A.B.S. CODE 1186 AND POSITIONED AS REQUIRED BY THE FIRE DEPARTMENT.

Rev	Description	Revision Date
9	ISSUED - BOUNDARY FENCE LINE ADJUSTED	2024-08-20
8	ISSUED - PHASE 1 UPDATED	2024-08-19
7	ISSUED FOR COMMENT	2024-08-15
6	ROADS UPDATED	2024-08-15
5	ISSUED FOR REVIEW	2024-08-14
4	Added ATCT and Helipad	2024-05-24
3	FOR REVIEW	2024-04-10
2	FOR REVIEW	2024-04-03
1	FOR REVIEW	2024-04-03

CAPEX PROJECTS
UNIT 10 First Floor
BOSKRUIN BUSINESS PARK
BOSKRUIN
cnr Kelly & Bosbok street
2188

Tel: 011 792 4260/ 8169

CLIENT

CAPE WINELANDS AERO

Client

Engineer

Registration NO: Designer

SACAP NO: ..

CLIENT
ENVIRONMENTAL
CONSULTANT

TITLE
PHASE 1

DRAWING
CWA - PRECINCT PLANS

SIZE		DWG NO	REV
A0		2024-3297 408	9

SCALE 1 : 5000
DATE 2024-08-20
DRAWN BY: CW DENNIS

Appendix D

Geotechnical Reconnaissance Investigation for Proposed Cape Winelands Airport, Fisantekraal, Western Cape.

REPORT: GEOSS Report No: 2022/02-19 ***PREPARED FOR:*** Paul Slabbert PHS Consulting PO Box 1752 Hermanus 7200 082 740 8046 / 028 312 1734 paul@phsconsulting.co.za	***PREPARED BY:*** Shane Teek & Michael Baleta GEOSS South Africa (Pty) Ltd Unit 12, Technostell Building, 9 Quantum Street, Technopark Stellenbosch 7600 Tel: (021) 880-1079 Email: info@geoss.co.za (www.geoss.co.za)

(Version 2.0)

31 May 2022

GROUNDWATER AND EARTH SCIENCES
GEOSS
SOUTH AFRICA (Pty) Ltd

EXECUTIVE SUMMARY

GEOSS South Africa (Pty) Ltd was requested by Mr Paul Slabbert of PHS Consulting, on behalf of Capex Projects, to complete a geotechnical investigation for the proposed Cape Winelands Airport (CWA).

The investigation involved undertaking a desk study, a site walk-over, an intrusive investigation (i.e. trial pit investigation), field and laboratory testing, and compilation and interpretation of the gathered data. This report covers aspects of preliminary road, drainage, foundation and pavement design and construction.

The most pertinent findings highlighted in this report are as follows:

- Five Geotechnical Zones have been delineated based on the investigation results:
    - A – Residual materials derived from granitoid sources.
    - B – Residual Materials derived from pelitic sources.
    - C – Area falling within Zones A and B with residual soils exhibiting characteristics of potentially expansive materials, and/or soils that are prone to settlement.
    - D - Areas of relatively deep/thick transported aeolian sand.
    - E – Areas of surficial ferricrete and/or silcrete.
- From a geotechnical standpoint, site development should proceed.
- Potential geotechnical challenges are associated with the intended development.
- All materials encountered in the trial pits classified as soft to intermediate excavation (SANS 1200D). The hardpan ferricrete horizons may require rock-breaking apparatus in areas of the site.
- A series of site-specific follow-up geotechnical investigations will be required prior to the construction of individual structures.
- In the case of structures with heavy structural loadings, where deeper foundations/piling are/is required, it would be prudent to consider a series of exploratory drilling as part of the site-specific investigations to determine whether core stones exist at depth, particularly in areas underlain by residual granitoids.
- A perched groundwater table was intersected on-site at between 0.85 and 1.4 mbgl. Excavations deeper than 1.0 mbgl will require battering to ensure safe working conditions. Final designs will have to cater for aggressive and corrosive groundwater and/or soil conditions. Drainage precaution will be required.
- The foundation solutions adopted for each structure on-site will depend on the cost of implementation, and the risk associated with the said solution.
- Due to the variation in topography within the northern extent of the property, considerable fill will be required
- During construction, potential geotechnical variations in the subsurface should be inspected and approved by a suitably qualified professional.

Ooooo OOO ooooO

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LIST OF MAPS AND FIGURES

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ABBREVIATIONS & SYMBOLS

BH	Borehole
CBR	California bearing ratio
CGS	Council for Geoscience
c'	Effective cohesion (kPa)
DCP	Dynamic Cone Penetrometer
DWS	Department of Water Affairs and Sanitation
EAM	Engineering and Asset Management
EC	electrical conductivity
EOH	End of hole
kPa	Kilopascals
LL	Liquid Limit
LS	Linear Shrinkage
L/s	Litres per second
m	metres
MCCSSO	Moisture content, colour, consistency, structure, soil type, and origin.
MDD	Maximum Dry Density
mm	millimetre
MOD	Modified AASHTO
mS/m	milli-Siemens per metre
NGA	National Groundwater Archive
NHBRC	National Home Builders Registration Council
OMC	Optimum moisture content
PI	Plasticity index
SABS	South African Bureau of Standards
SANS	South African National Standards
TLB	Tractor loader backhoe
Q3	Third quartile
φ'	Effective angle of internal friction

GLOSSARY OF TERMS

Quartile: Equal groups into which a population can be divided according to the distribution of values of a particular variable. Here, the third quartile represents the value under which all data points (within the given group) fall.

Dynamic Cone Penetrometer: Device with a 20 mm 60° cone driven into the ground by an 8 kg weight dropped through 575 mm. The penetration resistance is recorded in mm/blow. This provides an indication of soil consistency (relative density).

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Review: **D.Barrow (31 May 2022)**
B.Sc., M.Sc., Pr. Sci. Nat.
SACNASP No.: 400289/13
Hydrogeologist and Director

Suggested citation for this report:

GEOSS (2022). Geotechnical Reconnaissance Investigation for Proposed Cape Winelands Airport, Fisantekraal, Western Cape. Report Number: 2022/02-19. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.

Cover photo:

Photo south-eastern corner of the site, near TP04.

GEOSS project number:

2021_09-4505 (Phase E)

1. INTRODUCTION

1.1 Terms of Reference

GEOSS South Africa (Pty) Ltd was requested by Mr Paul Slabbert of PHS Consulting, on behalf of Capex Projects, to complete a geotechnical investigation for the proposed Cape Winelands Airport (CWA). The site that has been proposed to be upgraded and developed is located at the existing Fisantekraal airfield, some 2 km north-east of the township of Fisantekraal (**Map 1**).

1.2 Objectives and Methodology

The primary aim of the geotechnical investigation was to establish the soil conditions and associated soil engineering properties across the site. The intention of this report is to enable preliminary design of the proposed development. The aim of this investigation was met by undertaking of a desk study, a site walk-over, and intrusive investigation (i.e. trial pit investigation), field and laboratory testing and compilation and interpretation of the gathered data. This report covers aspects of road, pavement and foundation construction, drainage, and excavatability of the substratum.

1.3 Proposed Development

CWA is proposed to be built on the existing Fisantekraal Airfield which is an old South African Air Force airfield built circa 1943. It's existing foot print covers approximately 150 ha. Several of the neighbouring properties have been acquired therefore taking the proposed development area up to 660 ha. There are currently four concrete strips of 90m width each, in varying lengths between 700m and 1500m.

A site development plan has been provided which is included in **Appendix F** with the following information about the proposed facility:

- Runways (to be developed in phases).
- Taxiways.
- Roads.
- Stormwater lines and stormwater management system.
- Hangars.
- Aprons.
- Commercial/Industrial/Retail facilities.
- Hotel/Accommodation.
- Control Tower.
- Rescue & Firefighting facilities.
- Terminal buildings.
- Aviation Fuel Farm.
- Retail Service Station.
- Admin and office space.

- Electric Charging Stations.
- Renewable energy alternatives.
- Outdoor Media, e.g., signage and billboards.

In-depth descriptions of the above components of the project have been presented in GEOSS (2022).

Further, a possible extension has been proposed, and at this stage, for planning purposes, the additional area has been preliminarily investigated from a geotechnical standpoint. The possible extension is proposed to comprise the following elements:

- 3.0 km runway.
- Development of a full commercial terminal on the East of runway 01/19.
- Bulk still to be determined.
- Site plan still to be determined.
- Largest aircraft operable would be a Boeing 777 or Airbus A350.
- Commencement date would depend on demand.

1.4 *Preliminary Loading*

At present, because the project is in the planning phase the proposed structures and their final loadings and ultimate locations are still being finalised, the loading conditions are unknown. For the sake of this report, loadings of between 100 and 250 kPa have been used for preliminary modelling. Specific details pertaining to the proposed structures are not available at present.

1.5 *SANS 10160-5 Classification Category*

Based on the information available for the proposed structures and the conditions encountered on-site, the site can be classified as 'Category 2', i.e. the proposed development includes "conventional structures and foundations for which design methods are well established, where there are no exceptional risks in terms of overall stability or difficult ground conditions (e.g. conventional buildings on spread footings, rafts or piled foundations" (Day and Retief, 2009). This classification is defined by the following:

- The site presents no abnormal risks
- Routine field and laboratory tests have yielded estimated design parameters.
- No quantitative design has been presented by the Structural Engineer.
- Supervision/QC and follow up testing may be required prior to, or at the construction stage.
- Monitoring program - only if considered appropriate.

1.6 *Scope and Limitations of Assessment*

The geotechnical investigation had one primary aim, to determine the geotechnical character of the site.

1.7 ***Information Available***

Ahead of the preparation of this report, the document titled “Cape Winelands Airport Development Project Description”, dated 19 April 2022, was provided.

During the planning, desk study and compilation of the report, data was acquired from the following geological, geotechnical and hydrogeological sources:

- The 1: 50 000 geological series map – Sheet 3318DC Bellville.
- The 1: 50 000 geotechnical series map – Sheet 3318DC Bellville.
- The 1: 50 000 topocadastral map – Sheet 3318DC Bellville.
- The 1: 250 000 geological series map – Sheet 3318, Cape Town.
- The 1: 500 000 hydrogeological map – Sheet 3126, Cape Town.

Map 1: Locality map showing the location of the proposed Cape Winelands Airport, Western Cape.

2. SETTING

2.1 *Site Location and Description*

The site that has been proposed for development is situated some 2 km north-east of the existing Fisantekraal township, and approximately 25 km northeast of Cape Town International Airport (**Map 1**). The site is mainly surrounded by cultivated land, livestock farms and poultry farms. Some areas are also used for recreational activity, and a waste water treatment facility is also located to the north-west of the boundary.

The Cape Winelands Airport (CWA) development is proposed to be constructed across several farm portions, including those presently occupied by the existing Fisantekraal airfield. The proposed CWA is to fall across several properties with a total cumulative extent of approximately 885 ha (Cape Farm Mapper, 2022). The proposed development extends across the following Farm portions (area of each farm shown in brackets):

- 23/724 (31.2 ha).
- RE/724 (42.3 ha).
- 10/724 (114.0 ha).
- 4/474 (36.5 ha).
- RE/474 (402.4 ha).
- 7/942 (257.8 ha).

2.2 *Topography, Existing Infrastructure and Site History*

The topography of the site and surrounds is characterised by typical grass-covered low-relief rolling hills. The typical on-site elevation is between 90 - 130 m above mean sea level (mamsl). With natural slope surfaces rarely exceeding 12° (Stapelberg, 2009). In this region, there is a low drainage density (Stapelberg, 2009). Drainage channels and small tributaries usually occupy the lower-lying areas between the low-relief hills.

The area that is presently occupied by the airfield is characterised by generally flat terrain, with little undulation. The northern extent of the proposed development area (i.e. region earmarked for future development of extended runway) is characterised by undulous terrain with rolling hills.

2.3 *Climate*

The Fisantekraal area experiences a Mediterranean Climate with mild wet winters and warm dry summers. **Figure 1** shows the monthly average air temperature and **Figure 2** shows the monthly median rainfall and evaporation distribution for the Fisantekraal area (Schulze, 2009). The long term (1950 – 2000) mean annual precipitation for the Fisantekraal area is 532 mm/a. The rainfall typically exceeds evaporation rates in the winter months between May and August.

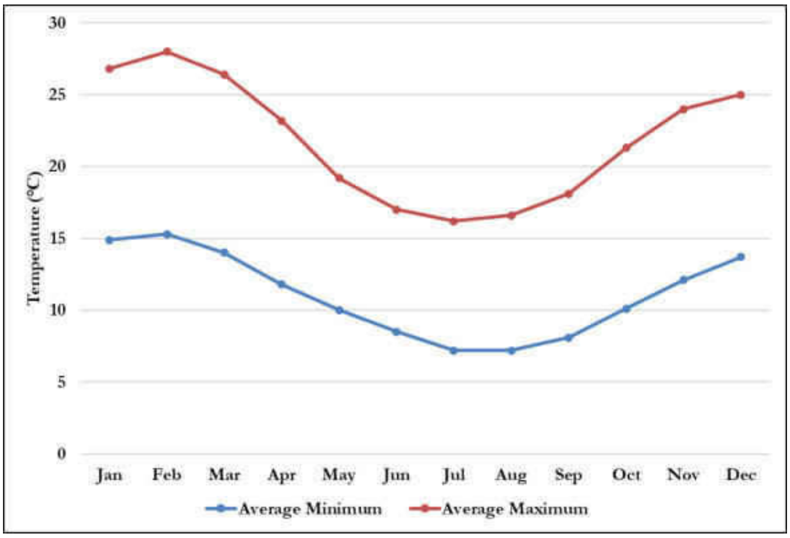


Figure 1: Monthly average air temperature for the Fisantekraal area (Schulze, 2009).

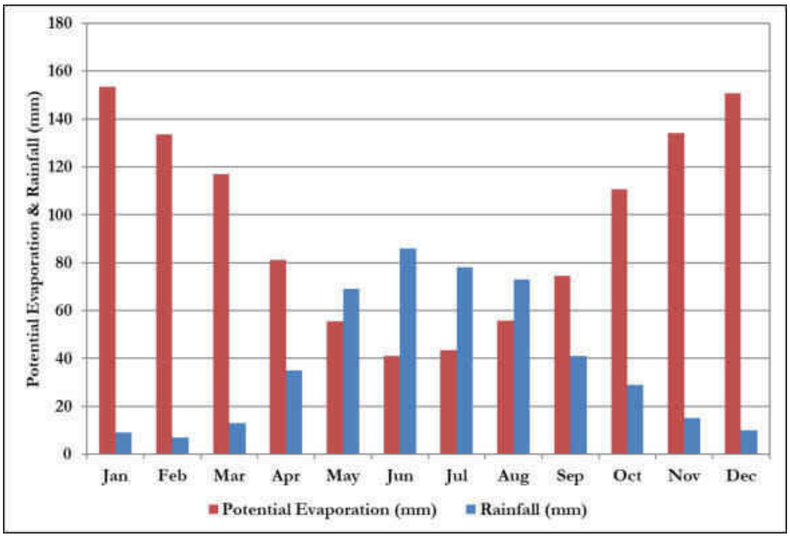


Figure 2: Monthly average air temperature for the Fisantekraal area (Schulze, 2009).

2.4 *Behaviour of Existing Structures*

The structures on site were briefly examined for any typical tell-tale signs of geotechnical risks/problem soils, e.g. settlement/differential heave. The structures on the site are located predominantly in the south-eastern extent of the property, none of these showed clear evidence of typical foundation-related cracks. It is important to note that none of these structures appear to be heavily loaded. In the north-western extent of the site; however, the structures located on the Remainder of Erf 724 did show signs of foundation related cracks (**Appendix C**).

2.5 *Weinert 'N' Value*

The present and past climate is a useful indicator of the typical soil conditions that may be encountered on a particular site (Weinert, 1975). Weinert (1975) developed a general model to categorise the climate of southern Africa based on what he termed the 'N'-value **Figure 3**.

The Weinert 'N'-value for the project area is shown to be less than 5 (Brink, 1983; Stapelberg, 2009). Weinert (1975) showed that where 'N'-values are less than 5, chemical decomposition is the dominant mode of rock weathering and relatively thin transported soil cover can be expected with deep residual profiles. Where pedocretes are developed they are generally ferricrete (Brink, 1983).

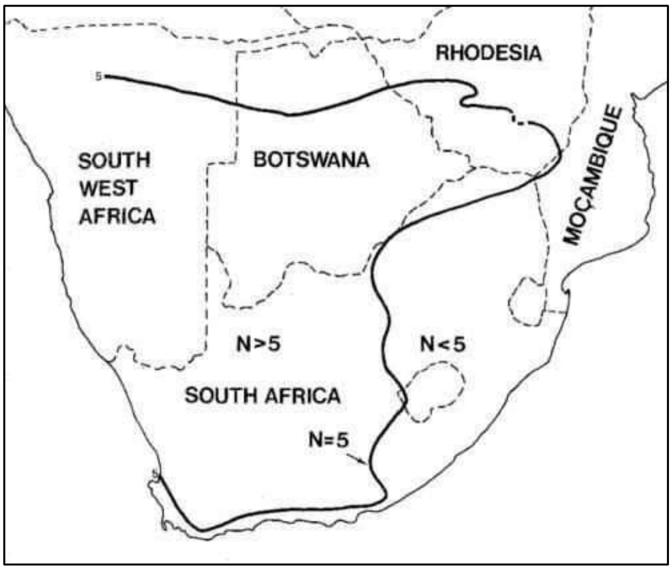


Figure 3: Climatic 'N' value = 5 plotted for southern Africa (after Weinert, 1967).

2.6 Geology & Engineering Geology

The Council for Geoscience (CGS) has mapped the area at a scale of 1: 250 000 (3318, Cape Town). The geological setting is shown in **Map 3** and the main geology of the area is listed in **Table 1**. The geology underneath the proposed Cape Winelands Airport is shale of the Tygerberg Formation (Nt), which is part of the Malmesbury Group and it is the basement rock of the area. Regionally the Malmesbury Group is overlain by different (younger) quaternary formations (Qgg, Qg, Qf and Qs).

The bedrock in the region is shown to be predominantly Malmesbury Group (Nt) rocks; these are often associated with overlying ferricrete gravels/nodules. The Malmesbury Group rocks typically dip steeply to the northwest (Stapelberg, 2006). Rapid transitions occur within this unit between easy-weathering siltstone/phyllite to more competent greywacke/sandstone. This can lead to large differences in depth of weathering/depth and development of the soil profile over relatively short distances (Stapelberg, 2006).

Although intrusions of the Cape Granite Suite are not indicated (**Map 3**), indications of minor intrusive, or fault-bounded bodies of granite occur in this region (Stapelberg, 2006). These are considered extensions/satellite intrusions of the Kuilsriver–Helderberg pluton.

Table 1: Geological formations within the study area.

Code	Formation/Pluton	Group/Suite	Description
〰	Alluvium	Quaternary Group	Unconsolidated sand
Qgg	-		Gravelly clay/loam soil
Qg	-		Loam and sandy loam
Qf	-		Limestone and calcrete
Qs	Springfontyn Formation		Light-grey to pale red sandy soil
Cpo	Populierbos Formation	Klipheuwel Group	Shale, mudstone and sandy shale, mainly reddish
Cm	Magrug Formation		Conglomerate, grit and sandstone, often reddish brown
Nf	Franschhoek Formation	Malmesbury Group	Grey, feldspathic conglomerate, grit and sandstone, with minor shale
Nt	Tygerberg Formation		Nt - Greywacke, phyllite and quartzitic sandstone, interbedded lava and tuff
Nm	Moorreesburg Formation		Greywacke and phyllite with beds and lenses of quartz schist, limestone and grit; quartz-sericite schist with occasional limestone lenses

Note: N/A – Not Applicable.

2.7 Geotechnical Conditions

The geotechnical conditions of the region were mapped at 1:50 000 scale by the CGS in 2006 (3318DC Bellville - Geotechnical Series), see **Map 4**. The geotechnical series provide an indication of the likely soil conditions and construction constraints at a particular location, for example, the soil beneath the site has been classified (according to the CGS) as 'M8', indicating that "*some precautionary measures needed to overcome engineering-geological problems*". Potential problems/conditions that may be experienced with subsoils of this classification are shown in **Table 2**. Note that the map codes in the legend correspond to the map codes shown in **Table 2.**

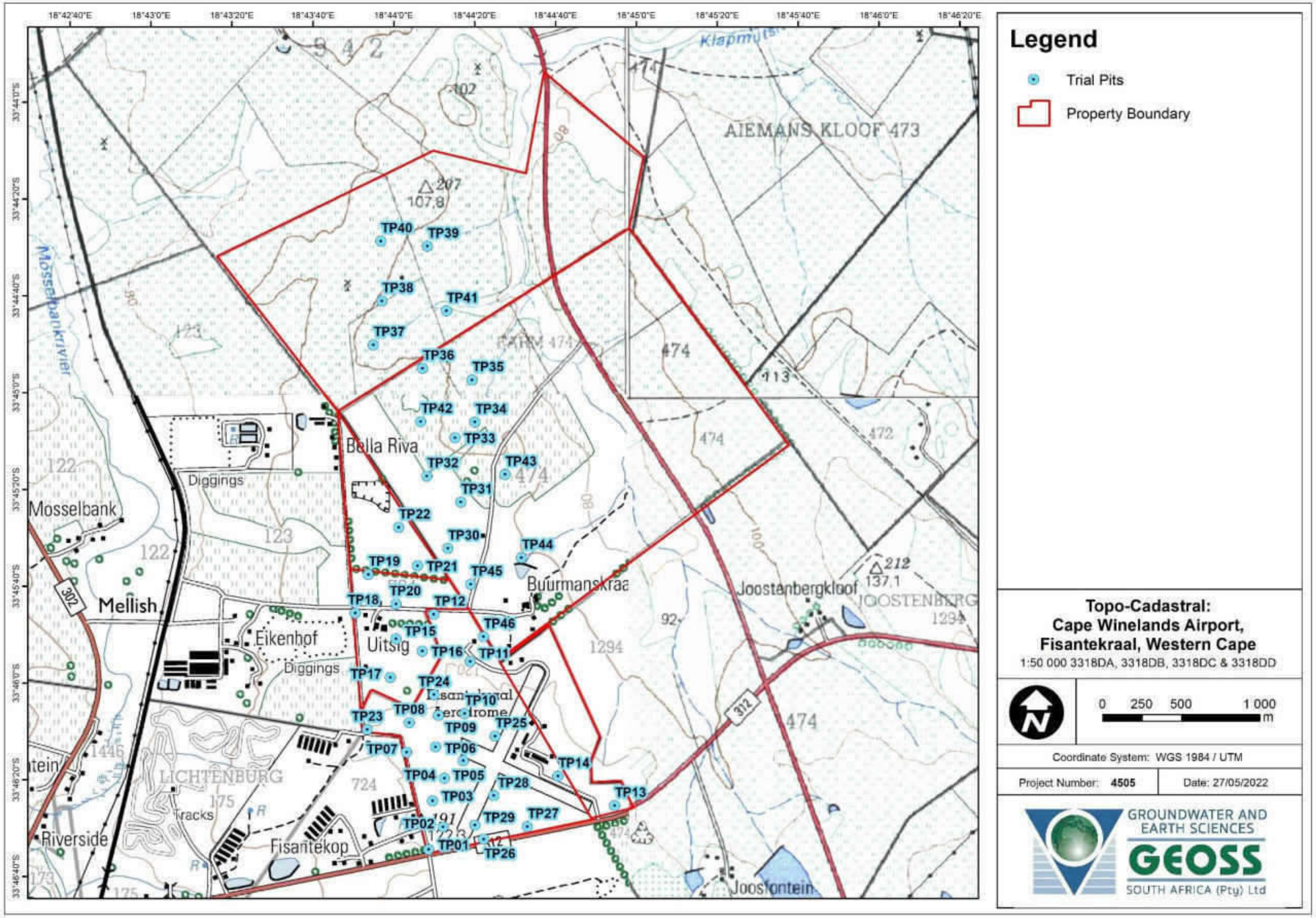
Table 2: Potential geological constraints in the region of the site (after CGS, 2009).

Geotechnical Condition/ Property	Description	Severity Class / Resulting Cost Implication
Permeability (Map Code: Per)	Permeability measures the flow of water through saturated soil. This is determined by the grain size and shape and the degree of compaction of the soil.	Low permeability (< 3 x 10 cm/s)
Shallow water table (Map Code: Sha)	Water table occurring at shallow depth - often seasonal.	Moderate
Loose sand (consolidation) (Map Code: Con)	Material susceptible to excessive consolidation when used as foundation horizon. Non-cohesive sands.	Low
Active clay (Map Code: Act2-Act3)	The degree of expansion experienced when dry clayey soils are moistened to full saturation. In addition to the activity, the clay horizon depth and thickness contribute towards determining the amount of surface movement (expansion/contraction).	The residual soils of the Tygerberg Formation may exhibit low to medium expansiveness. Medium cost implications may be incurred due to this type of material

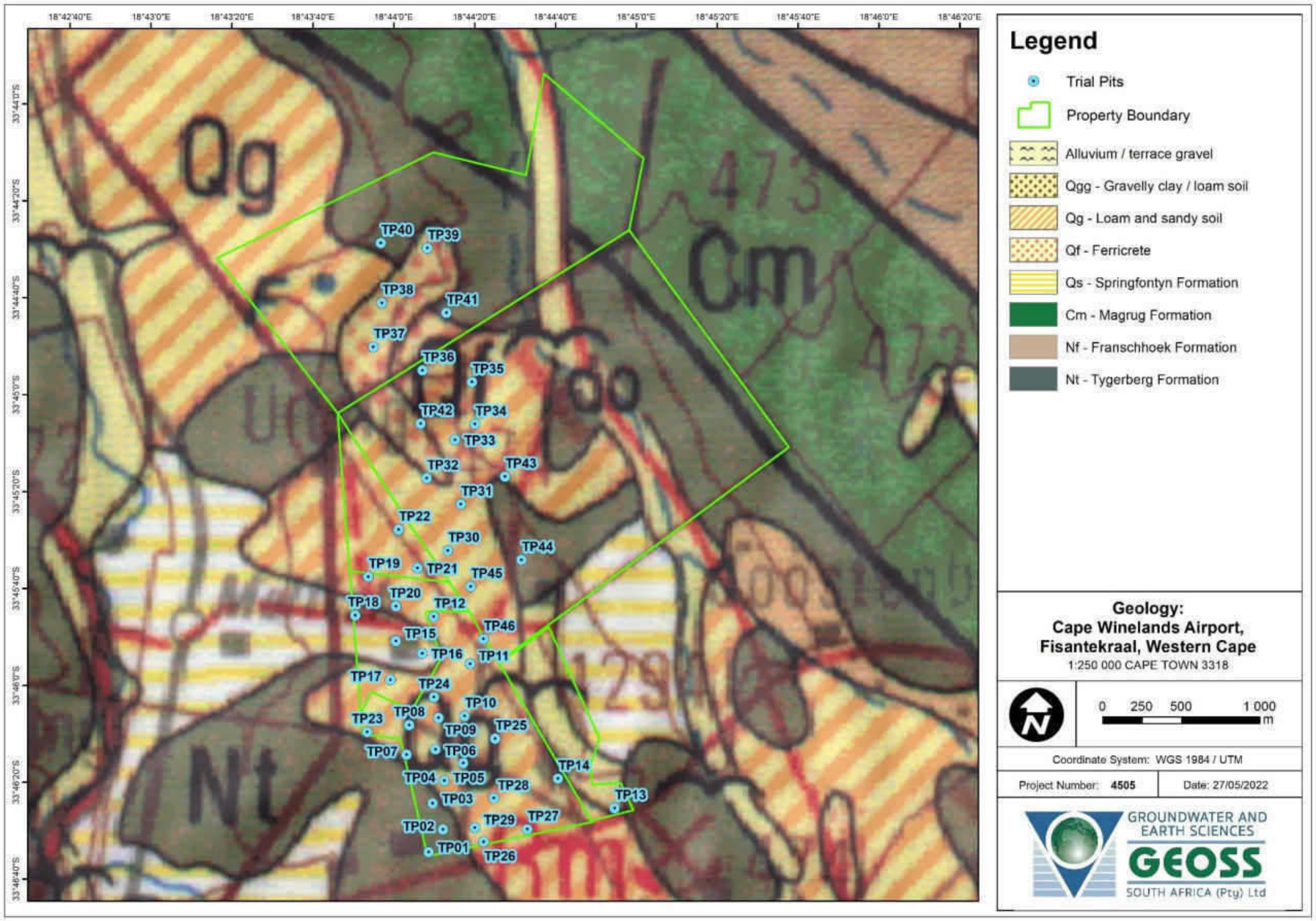
Selected results from Stapelberg (2009) have been presented in **Table 14** that were collected in the region (**Appendix G**). Relative to the existing CWA infrastructure Sample 5/3 is located to the north on Erf RE/474; Sample 5/8 within the development area on Erf 10/724, and; Sample 5/10 to the south on Erf 4. Of interest is the variation indicated between the lithologies, i.e., soils of granitic/intrusive (Cape Granite Suite) and pelitic/sedimentary (Malmesbury Group) origin. Similar conditions were encountered during the undertaking of the field investigation. The representative trial pit logs devised by F. Stapelberg were also consulted during compilation of this report.

2.8 Hydrogeology

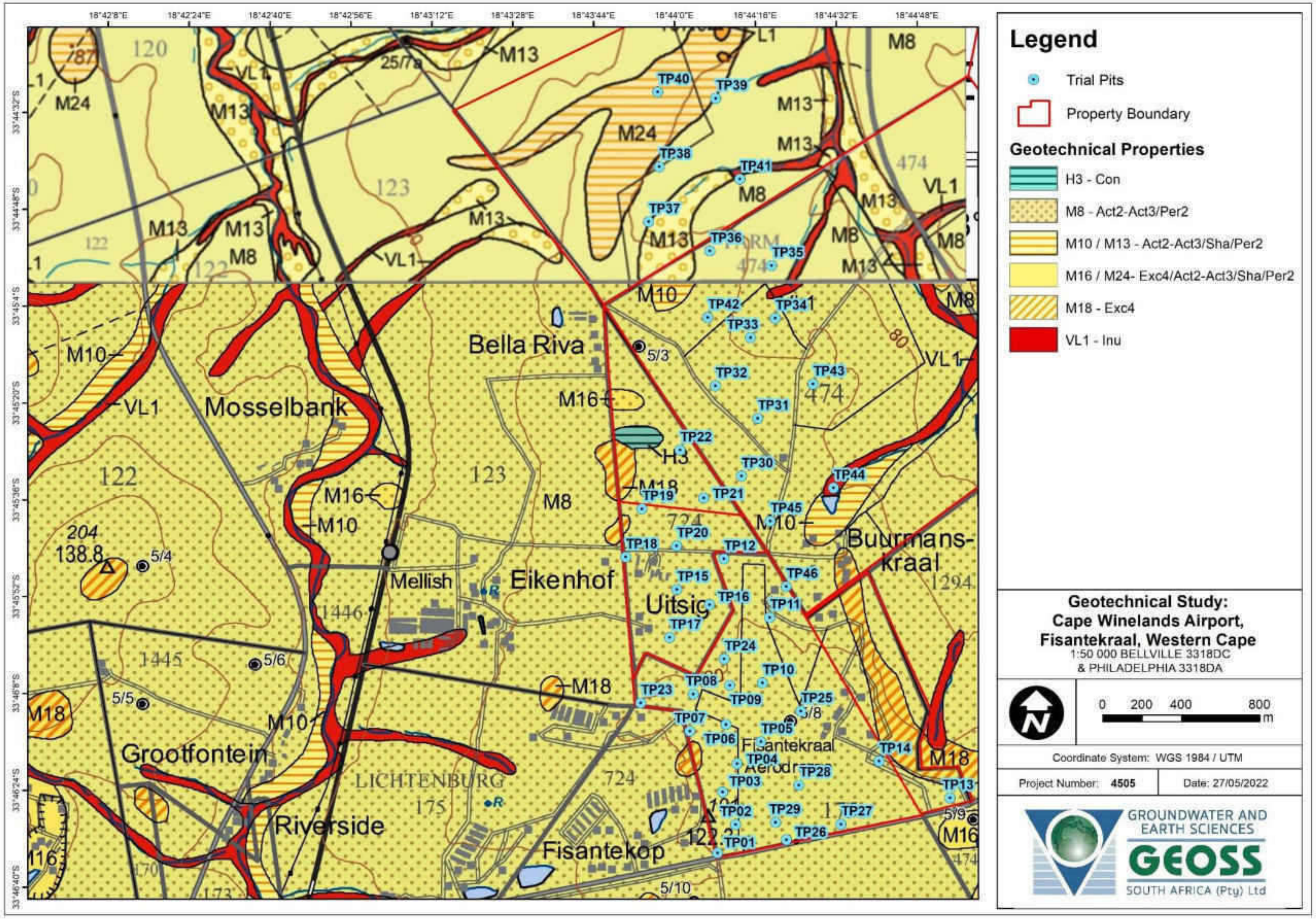
The regional aquifer directly underlying the site is classified by the Department of Water Affairs and Forestry (DWAF, 2002) as a fractured aquifer with an average yield potential that range from 0.5 – 0.5 L/s. A fractured aquifer describes an aquifer where groundwater only occurs in narrow fractures within the bedrock. The groundwater quality for study area ranges from “ideal” to “poor” with an associated electrical conductivity (EC) of between 70 – 1000 mS/m generally improving in quality (i.e. reducing EC) toward the south (DWAF, 2002). This information was derived from regional datasets. For more information on the groundwater status of the site, consult GEOSS (2022).



Map 2: Topocadastral map showing the locations of trial pits in relation to the proposed Cape Winelands Airport and surrounds.



Map 3: Geological setting of the area (3318DC – Bellville, GCS 1984).



Map 4: Geotechnical conditions of the site and surrounds showing the positions of the trial pits (3318DC – Bellville, GCS 2008).

3. INVESTIGATION METHODOLOGY

The geotechnical assessment has been undertaken primarily to characterise the engineering properties of soils underlying the site, confirm the local geology and the hydrogeological conditions. This investigation was also aimed to identify any potential geotechnical risks or 'problem soils' that may be present beneath the site.

The procedure adopted for this study involved a desktop study followed by site work. The initial desktop study involved gathering and reviewing all relevant data to the project. During this time, the GEOSS internal database was consulted, and geotechnical and hydrogeological investigation reports for work previously undertaken in the area were reviewed.

A site visit was then conducted to verify as much of this data as possible, collect additional data and make on-site observations (e.g. describe and document soil profiles), and collect representative soil samples from the trial pits to be submitted for laboratory analysis.

The following tasks were conducted on site, these are discussed and included in this report:

- A total of forty six (46) trial pits were excavated using a JCB 3DX Super Tractor Loader Backhoe. An image of the TLB is supplied in **Appendix C**.
    - Twenty nine (29) trial pits (TP01 to TP29) were excavated over a three (3) day period, from the 25 to the 27 January, during the summer of 2022.
    - Seventeen (17) trial pits (TP30 to TP46) were excavated over a two (2) day period, on 13 and 14 April, during the Autumn of 2022.
- The soil profiles exposed were described in terms of standard terminology as recommended by Jennings et al. (1973) and SAIEG (2001). A representative photograph of each trial pit has been supplied (**Appendix A**) and the trial logs have been captured using a commercially available hatching software dotPLOT (**Appendix B**). The spatial locations of the 29 trial pits is shown in relation to the topocadastral series map (**Map 2**).
- Dynamic Cone Penetrometer (DCP) tests were conducted adjacent to several trial pits to confirm and analyse representative soil consistencies / relative density across the site.
- Bulk samples of the dominant soil types were extracted from to best represent the soil profile(s) on-site. The following laboratory tests were undertaken on the collected bulk samples, and the results are presented in **Section 4**:
    - Foundation Indicators (Grading analysis, Hydrometer Analysis, Atterberg Limits);
    - Moisture/Density relationship (Mod. AASHTO)
    - California Bearing Ratio (CBR);
    - Basson Index test (on groundwater sample collected from TP25).
- A single undisturbed sample was collected, and the are presented in **Section 4**:

All of the collected data was analysed and interpreted to assess the potential geotechnical risks associated with the intended development, general recommendations have been made, and guidance on preliminary foundation solutions have been presented.

4. RESULTS

4.1 Field Investigation

The geotechnical reconnaissance investigation involved a site walk over, the excavation of a total of forty-six (46) trial pits and the performance of thirty five (35) drop-weight cone penetrometer (DCP) tests across the site. Excavation and documenting of trial pits TP01 to TP29 took place between 25 and 27 January 2022; and trial pits TP30 to TP46 between 13 and 14 April 2022. The reconnaissance investigation sought to identify and confirm hydrological, hydrogeological and geotechnical features of interest. Relevant surface features were also documented, trial pits excavation was supervised and notes were made on the relative ease of excavation, exposed soil profiles were documented, and representative bulk soil samples were extracted from the exposed soil profiles (**Table 7**). Following excavation of the trial pits each exposed soil profile was logged and photographed (**Appendix A & Appendix B**).

The locations of the trial pits and DCP tests are listed in **Table 7**; spatial locations of the trial pits are shown in on the aerial imagery in **Map 5**. The DCP tests were labelled according to the trial pits next to which they were conducted. The DCP tests were conducted in selected horizons within the trial pits to confirm the soil consistencies recorded during profiling. The DCP results are elaborated upon in **Section 4.3.**

Once the trial pits were logged, DCP tests were conducted and representative soil samples were collected, the general soil conditions across the site were evaluated.

4.2 General Soil Profile & Geotechnical Zones

Following the completion of trial pits, DCP testing and the site walkover, the site was divided into several zones which exhibit similar soil profile characteristics based on the descriptions of the material encountered in the trial pits. Five Geotechnical Zones were delineated, based on laboratory tests and observations made in the trial pits, the Zones have been named and are defined by the following:

- Zone A: Weathered relics fault-bounded blocks/satellite intrusions of the Kuilsriver-Helderberg granitoid of the Cape Granite Suite which is of igneous origin (**Table 3**).
- Zone B: Weathered Tygerberg Formation of the Malmesbury Group rocks of pelitic/sedimentary origin (**Table 4**).
- Zone C: Areas exhibiting characteristics of potentially expansive material, or material prone to settlement, derived from sediments of either the Kuilsriver-Helderberg intrusion or the Weathered sediments of the Tygerberg Formation (or a combination of both) (**Table 5**).
- Zone D: Areas of relatively deep transported aeolian sand (**Table 6**).
- Zone E: Areas with visible ferricrete and/or silcrete present on surface/in outcrop (**Figure 58**).

Note that the descriptions contained in the tables set out below are based on disturbed samples excavated from the trial pits. The Geotechnical Zones are shown spatially in **Map 6.**

Table 3: Generalised soil profile for Geotechnical Zone A.

Depth (mbgl)	Generalised Soil Profile
0.0 – 0.1/0.9	Pale grey to grey-brown to black (humified) intact to slightly voided very loose to medium dense SAND to gravelly SAND. Transported/hillwash. Note: (i) Roots generally present in upper 200 to 500 mm of horizon. (ii) Often includes ferricrete nodules and/or gravels. (i) Poorly developed in areas.
0.0/0.1 – 0.3/1.4	Red-, yellow- and/or orange-brown medium dense to very dense intact partially cemented NODULAR to HARDPAN FERRICRETE in a sandy matrix. Pedogenic. Note: (i) Many times induced refusal. (ii) Nodular and Hardpan horizons often exhibiting honeycomb texture.
0.3/1.4 – 0.6/1.4	Yellow-/orange-/grey-brown very loose to medium dense intact to pinholed sandy fine GRAVEL. Transported. Note: (i) Often partially cemented. (ii) Poorly developed or not present in places. (iii) Typically encountered beneath the ferricrete horizon, except for in TP24.
0.6/1.4 – 0.8/2.2+	Grey to white blotched/streaked/speckled/strained red-yellow-orange firm to very stiff intact to fissured/shattered gravelly sandy SILT/sandy SILT/sandy clayey SILT/silty CLAY to medium dense to very dense silty SAND or gravelly silty SAND. Residual. Note: (i) Often contains ferricrete nodules which increases the gravel content. (ii) Believed to be derived from weathered granitic Kuilsriver-Helderberg Pluton rocks. (iii) Perched water table at between 0.85 and 1.4 mbgl.

Table 4: Generalised soil profile for Geotechnical Zone B.

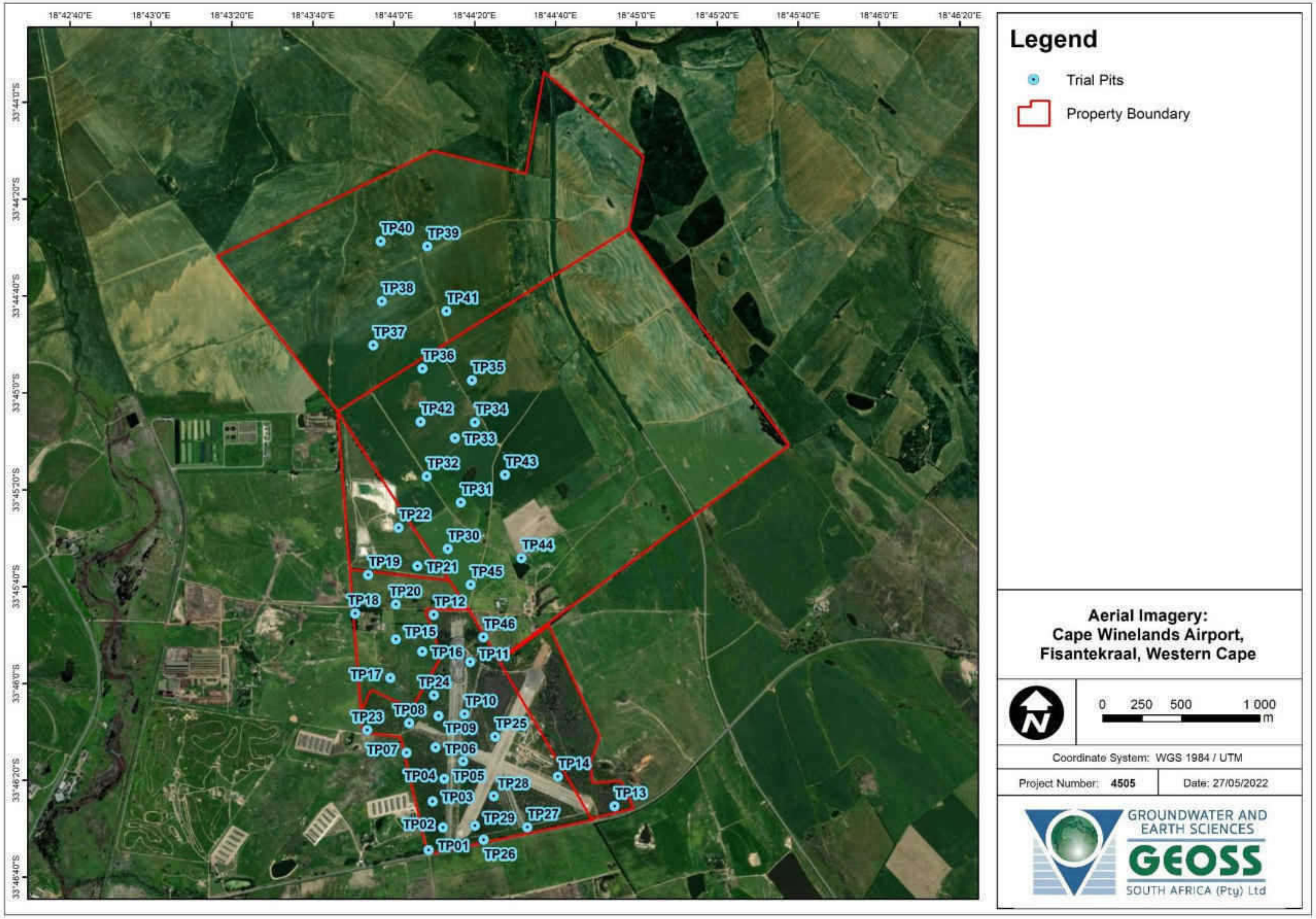
Depth (mbgl)	Generalised Soil Profile
0.0 – 0.15/0.6	Light brown to black (humified) very loose to medium dense intact to slightly voided SAND with variable amounts and sizes of ferricrete nodules and/or gravels. Transported/hillwash.
0.15/0.6 – 0.25/0.9	Red-, yellow- and/or orange-brown medium dense to very dense intact partially cemented NODULAR to HARDPAN FERRICRETE in a sandy matrix. Pedogenic. Note: (i) Many times induced refusal. (ii) Nodular and Hardpan horizons often exhibiting honeycomb texture. (iii) This could be considered an extension of the uppermost horizon as the ferricrete nodule concentration typically increases with depth.
0.25/0.9 – 1.6+	Grey-orange very dense intact gravelly clayey to silty SAND. Residual. Note: (i) Usually encountered in the southern areas. (ii) Believed to underly hardpan ferricrete. OR Grey blotched/streaked/speckled brown-orange-red and yellow firm to very stiff slightly shattered/fissured silty CLAY. Residual. Note: Believed to be derived from pelitic Malmsbury Group rocks.

Table 5: Generalised soil profile for Geotechnical Zone C.

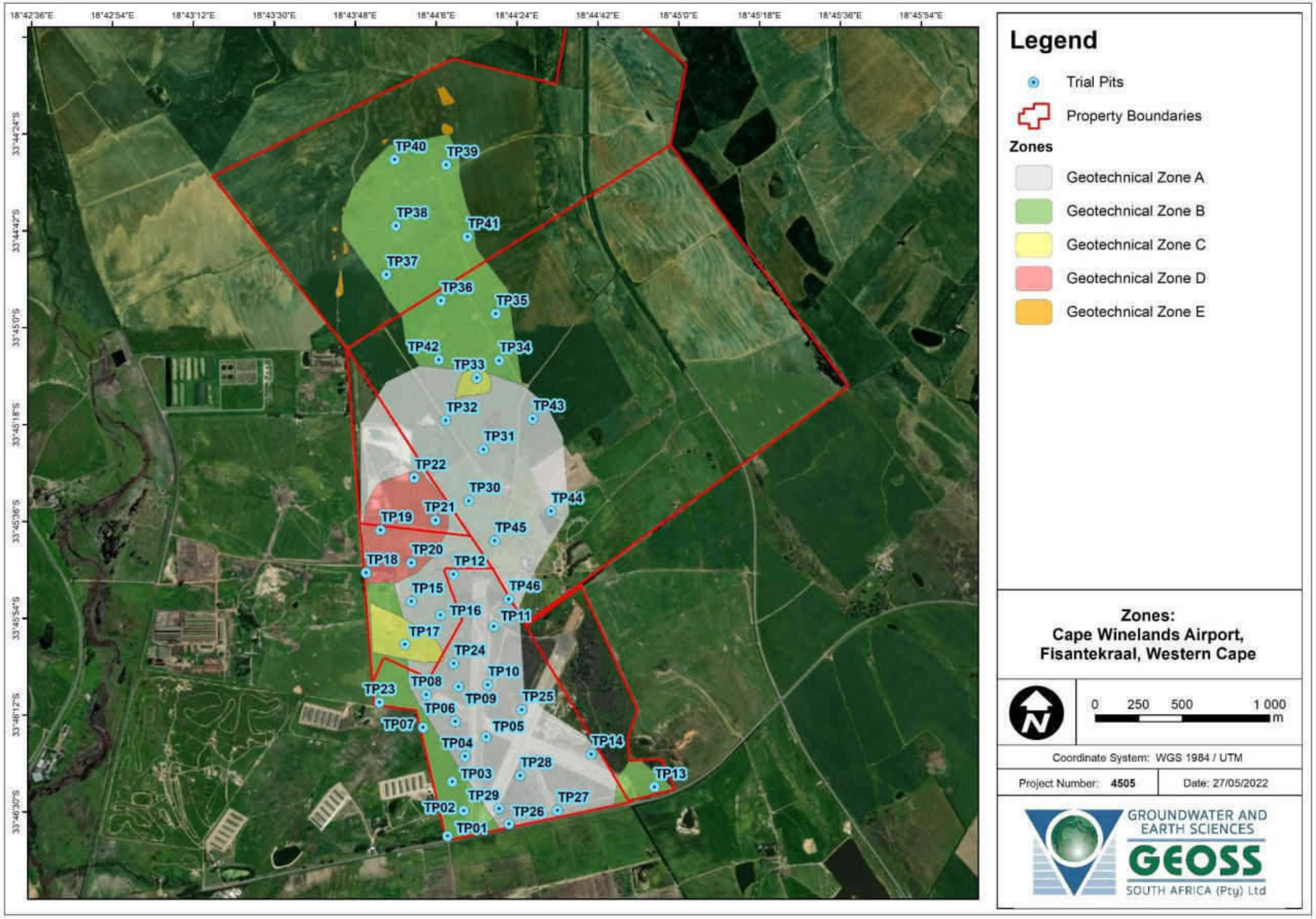
Depth (mbgl)	Generalised Soil Profile
0.0 – 0.1/0.9	Light brown to black (humified) very loose to medium dense intact to slightly voided SAND with variable amounts and sizes of ferricrete nodules and/or gravels. Transported/hillwash. OR Pale grey to grey-brown to black (humified) intact to slightly voided very loose to medium dense SAND to gravelly SAND. Transported/hillwash. Note: (i) Roots generally present in upper 200 to 500 mm of horizon. (ii) Often includes ferricrete nodules and/or gravels. (i) Poorly developed in areas.
0.1/0.9 – 0.3/1.4	Red-, yellow- and/or orange-brown medium dense to very dense intact partially cemented NODULAR to HARDPAN FERRICRETE in a sandy matrix. Pedogenic. Note: (i) Many times induced refusal. (ii) Nodular and Hardpan horizons often exhibiting interlocked honeycomb texture. (iii) This could be considered an extension of the nodular horizon as the ferricrete nodule concentration typically increases with depth.
0.3/1.4 – 0.6/1.4	Yellow-/orange-/grey-brown very loose to medium dense intact to pinholed sandy fine GRAVEL. Transported. Note: (i) Most often overlies sediments of weathered residual Malmesbury Group.
0.6/1.4 – 0.8/2.2+	Grey blotched/streaked/speckled brown-orange-red and yellow shattered/fissured firm to very stiff silty CLAY. Residual. Note: (i) Typically derived from Malmesbury Group. OR Grey to white blotched/streaked/speckled/strained red-yellow-orange firm to very stiff intact to shattered/fissured sandy SILT/sandy clayey SILT/silty CLAY Note: (i) Typically derived from Kuilsriver-Helderberg Pluton.

Table 6: Generalised soil profile for Geotechnical Zone D.

Depth (mbgl)	Generalised Soil Profile
0.0 - >0.5	Yellow-brown loose to medium dense slightly voided to intact medium SAND. Transported. Note: (i) Area of substantial transported cover. (ii) Underlain by either Malmesbury Group or Cape Granite residual soils and/or bedrock. (iii) Fine grass roots in upper 0.5 m.



Map 5: Aerial imagery showing trial pit positions in relation to the property boundaries.



Map 6: Aerial imagery showing interpreted Geotechnical Zone boundaries.

4.3 DCP Test Results

Drop-weight cone penetrometer (DCP) tests were undertaken at selected locations across the site (**Table 7**). A summary of the DCP test data collected on site is shown in **Figure 4.** The DCP tests undertaken within the uppermost (<1 mbgl) transported/hillwash material revealed a high degree of variability. The consistency of the mostly cohesionless SAND with ferricrete and/or gravel showed variation between very loose and very dense (or very soft and very stiff; **Figure 4**). The variation is believed to be due to the considerable variation in depth at which the NODULAR to HARPAN FERRICRETE pedogenic was intersected (ranging from surface to about 1.1 mbgl. The NODULAR to HARPAN FERRICRETE pedogenic horizon exhibited variation in consistency between loose and very/extremely dense (or soft to very stiff; **Figure 4**). Generally, the greater the degree of cementation was greater the consistency was greater. The material underlying the ferricrete ranged from mostly granular to mostly cohesive materials with consistencies ranging between medium dense and dense or firm and very stiff (**Figure 4**).

To gain an appreciation of the general consistencies of the materials beneath the site, the third quartile (Q3) of the DCP data was plotted with depth increments of 0.3 mbgl (**Figure 4**). These data show that for the same units described above (that 75% of all data points/on average) range in consistency as indicated below (the bounds of consistencies shown in brackets are displayed on figure):

- Transported materials (assumed to be ~0.3 mbgl): loose (or firm).
- Mostly ferricrete horizons (assumed to be between 0.3 and 1.0 mbgl): medium dense (or very stiff).
- Mostly residual materials (assumed >1.5 mbgl): stiff to very stiff; increasing with depth (medium dense to very dense with depth).

The high degree of variability (and outliers) displayed by most (if not all) horizons is likely due to notes mentioned above as well as the disturbed nature of some of the soils when undertaking the DCP tests. Disturbance is due to excavation of the respective horizons, e.g. to expose the underlying material beneath the nodular to hardpan ferricrete horizon the TLB excavated the ferricrete out exposing and disturbing the uppermost surface of the underlying material.

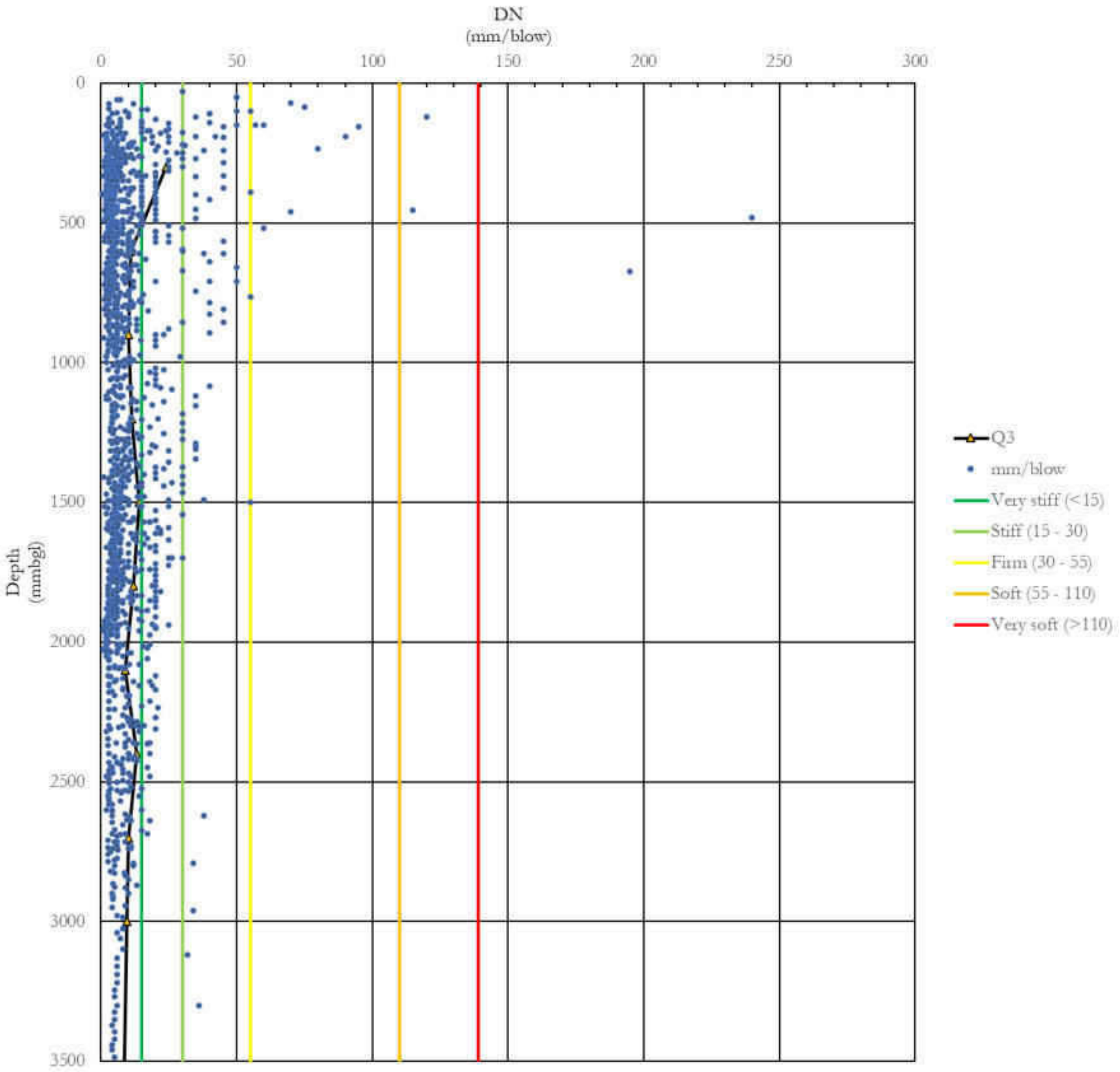


Figure 4: DCP Test results plotted with the third quartile (Q3) of all tests undertaken; cohesive material interpretation boundaries shown.

4.4 Laboratory Test Results

A total of sixteen (16) bulk disturbed soil samples were collected from selected trial pits and submitted to a commercial laboratory for analysis. The laboratory classification tests served to determine the general mechanical/engineering properties of the soils encountered on-site. The samples were analysed for the following:

- Foundation Indicators (particle size/grading, hydrometer, and Atterberg Limits tests) (**Table 8**) and/or;
- Moisture density relationships, Specific Gravity (SG) and California Bearing Ratios (**Table 9**).
- Double oedometer analysis (**Appendix E**).

The single double oedometer test sought to determine the compressibility and heave properties of the residual material, as a typical example for the area. It should be noted; however, that conditions may vary locally.

Further, groundwater was intersected in two trial pits TP15 and TP25 in January 2022, and in a single trial pit TP33 in April 2022. A single groundwater sample was collected from TP25 and was submitted to a commercial laboratory for chemical analysis (**Appendix E**). A summary of the results is contained in **Table 10**. The pH of the groundwater sample is 6.7, which classes the water as moderately aggressive (Basson 1989). The Final Aggressiveness Index of 1777 classes the water as Very highly aggressive (Basson, 1989). Therefore, counter measures will be required, i.e. the concrete of the foundation bases in contact with groundwater will require protection, and any steel reinforcement within such bases should be covered by at least 30 mm of concrete. The advice of a specialist concrete and/or steel technologist/manufacturer should be sought in regard to final designs of cement coating and concrete protection of steel reinforcement. General guides for the assessment of the Final Aggressiveness Index have been presented in **Appendix E & G**.

Table 7: Summary of trial pit data.

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Elevation (mamsl)	TP EOH (mbgl)	Samples	DCP No.:
TP01	-33.7763	18.7356	125	0.7	-	-
TP02	-33.7750	18.7366	127	0.7	-	-
TP03	-33.7735	18.7359	126	0.6	-	-
TP04	-33.7722	18.7367	126	1.8	18589	4
TP05	-33.7712	18.7380	126	0.8	-	-
TP06	-33.7704	18.7361	126	2.0	-	6
TP07	-33.7707	18.7341	123	2.0	-	7
TP08	-33.7690	18.7343	124	1.9	-	
TP09	-33.7686	18.7363	125	0.8	-	-
TP10	-33.7685	18.7381	124	0.8	-	10
TP11	-33.7655	18.7385	123	2.1	-	11
TP12	-33.7628	18.7360	120	2.0	18590; 18591	12
TP13	-33.7738	18.7484	126	1.6	-	-
TP14	-33.7721	18.7445	128	2.0	18592; 18593	14
TP15	-33.7642	18.7334	117	1.7	18594	15
TP16	-33.7649	18.7352	119	1.6	-	-
TP17	-33.7664	18.7330	119	1.9	18595	17
TP18	-33.7627	18.7306	122	1.2	18596; 18597	18
TP19	-33.7605	18.7315	117	0.8	-	-
TP20	-33.7622	18.7334	120	0.8	-	-
TP21	-33.7600	18.7349	119	2.2	-	21
TP22	-33.7578	18.7336	119	1.8	18598	22
TP23	-33.7694	18.7314	121	1.9	-	23
TP24	-33.7674	18.7360	123	2.0	-	24
TP25	-33.7698	18.7402	125	1.4	18599; 18600	25
TP26	-33.7757	18.7394	128	1.7	18601	26
TP27	-33.7750	18.7424	127	1.9	-	27
TP28	-33.7732	18.7401	126	1.75	-	28
TP29	-33.7749	18.7388	126	0.8	-	-
TP30	-33.7590	18.7370	115	1.5	-	30
TP31	-33.7564	18.7379	113	3.0	-	31
TP32	-33.7549	18.7356	112	2.4	-	32
TP33	-33.7527	18.7375	103	2.5	-	33
TP34	-33.7518	18.7389	97	3.0	20003	34
TP35	-33.7493	18.7387	94	1.6	-	35
TP36	-33.7487	18.7353	105	1.5	-	36
TP37	-33.7473	18.7319	99	1.5	-	37
TP38	-33.7448	18.7325	100	1.4	-	38
TP39	-33.7417	18.7356	97	1.6	-	39
TP40	-33.7414	18.7324	107	2.1	20001	40
TP41	-33.7454	18.7369	89	1.7	-	41
TP42	-33.7517	18.7351	111	1.5	20002	42
TP43	-33.7548	18.7409	106	2.0	-	43
TP44	-33.7596	18.7420	104	1.6	-	44
TP45	-33.7611	18.7386	116	2.0	-	45
TP46	-33.7641	18.7394	120	1.6	-	46

Note: EOH – End of Hole.

Table 8: Summary of grading analysis.

Sample No. (TP##)	Depth (m)	Soil Type	Grading Analysis				LS %	LL %	PI %	Pot. Exp.	GM	USCS
			Clay %	Silt %	Sand %	Gravel %						
18589 (TP4)	1.7	Red-white sandy clayey SILT	17	19	47	17	8.1	33	15	Low	1.10	SC
18590 (TP12)	0.0 – 0.6	Brown gravelly SAND	2	7	82	9	0.0	NP	NP	Low	1.42	SP
18591 (TP12)	0.75 – 1.2	Yellow-brown/orange gravelly SAND	2	5	66	27	0.0	NP	NP	Low	1.82	SP
18592 (TP14)	0.0 – 0.45	Orange-brown sandy GRAVEL	1	3	34	62	0.0	NP	NP	Low	2.35	SP
18593 (TP14)	1.5 – 2.0	Red-grey gravelly silty SAND	12	11	58	19	7.9	32.2	15.7	Low	1.44	SC
18594 (TP15)	0.9 – 1.7	Orange-grey gravelly silty SAND	16	11	61	12	6.0	27	9.8	Low	1.17	SC
18595 (TP17)	0.0 – 1.9	Brown SAND	3	3	93	1	0.0	NP	NP	Low	1.13	SW
18596 (TP18)	0.2 – 0.6	Brown sandy GRAVEL	6	1	32	61	0.0	NP	NP	Low	2.29	GP
18597 (TP18)	0.6 – 1.0	Red-brown silty CLAY	55	30	11	4	18.9	79.9	41.8	V.High	0.25	MH or OH
18598 (TP22)	0.5 – 2.0	White-grey silty CLAY	24	74	1	1	6.2	48	16.8	Med.	0.04	ML or OL
18599 (TP25)	0.0 – 0.7	Reddish-brown gravelly SAND	3	5	47	45	0.0	NP	NP	Low	2.02	SP - SC
18600 (TP25)	0.9 – 1.4	Orange-grey sandy SILT	15	18	60	7	4.5	24	8.6	Low	1.06	SC
18601 (TP26)	1.0 – 1.7	Orange-grey gravelly silty SAND	12	10	66	12	7.3	36.9	13	Low	1.38	SC
20003 (TP34)	1.2	Brown sandy CLAY	44	7	49	-	9.2	43.5	19.2	Low		
20001 (TP40)	0.5 – 1.1	Orange clayey SILT	19	62	18	1	7.8	28.8	14.6	Med.		
20002 (TP42)	0.8	Grey-orange clayey SILT	24	69	5	2	7.6	34.6	15.6	Med.		

NOTES: LL - Liquid Limit LS - Linear Shrinkage USCS – Unified Soil Classification System
NP – Non-plastic GM – Grading Modulus Pot. Exp. – Potential Expansiveness
PI - Plasticity index

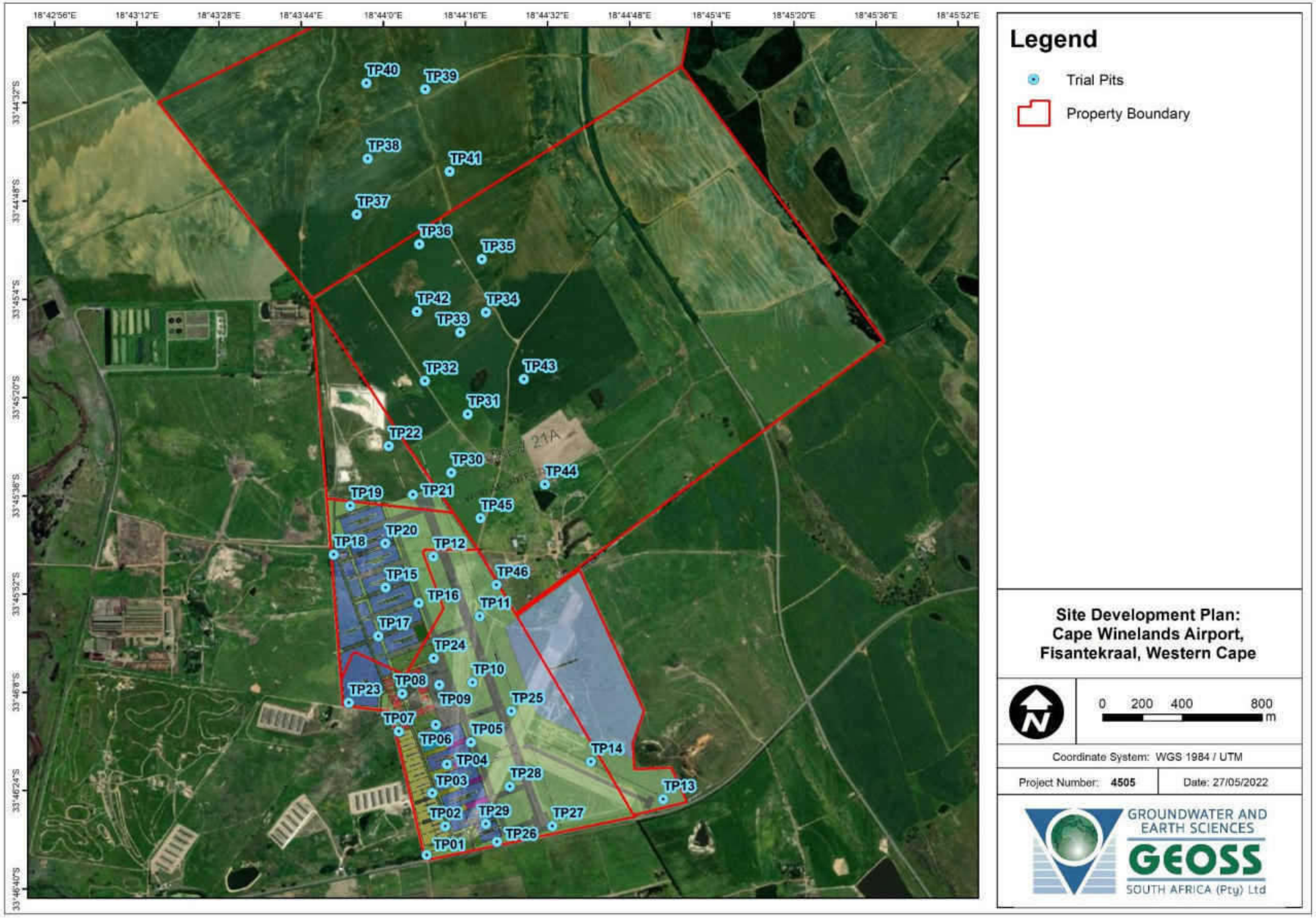
Table 9: Summary of CBR and moisture density analyses.

Sample No. (TP##)	Sample depth (mbgl)	CBR @ (##%)					Gs	MDD kg/m³	OMC %	NMC %
		100	98	95	93	90				
18589 (TP4)	1.7	4	3	2	1	1	2.660	2102	10.2	1.5
18590 (TP12)	0.0 – 0.6	17	14	10	8	5	2.604	1909	12.1	2.1
18591 (TP12)	0.75 – 1.2	16	13	9	7	5	2.577	2030	9.2	1.2
18592 (TP14)	0.0 – 0.45	75	50	40	30	21	2.604	2120	8.3	1.2
18593 (TP14)	1.5 – 2.0	19	14	8	5	3	2.632	2025	12.2	4.2
18594 (TP15)	0.9 – 1.7	17	11	5	3	2	2.660	2022	12.5	7.3
18595 (TP17)	0.0 – 1.9	14	10	7	6	4	2.577	1808	12.3	4.5
18596 (TP18)	0.2 – 0.6	50	39	26	20	13	2.632	2240	7.3	4.5
18597 (TP18)	0.6 – 1.0	1	1	1	1	1	2.747	1788	14.3	15.8
18598 (TP22)	0.5 – 2.0	1	1	1	1	1	2.747	1745	13.4	15.6
18599 (TP25)	0.0 – 0.7	27	20	13	10	6	2.577	2047	9.2	4.4
18600 (TP25)	0.9 – 1.4	14	12	9	7	5	2.632	2143	8.2	4.5
18601 (TP26)	1.0 – 1.7	15	11	8	6	4	2.632	2008	12.4	5.9
20003 (TP34)	1.2	-	-	-	-	-	2.747	-	-	13.5
20001 (TP40)	0.5 – 1.1	-	-	-	-	-	2.660	-	-	15.7
20002 (TP42)	0.8	-	-	-	-	-	2.688	-	-	11.4

NOTES: CBR - California bearing ratio	Gs – Specific Gravity	MDD - Maximum Dry Density
OMC - Optimum moisture content	NP – Non-plastic	NMC – Natural Moisture Content

Table 10: Summary of Basson Index analyses results.

Sample No. (Trial Pit No.)	4505_C_TP25 (TP25)
Depth (mbgl)	0.85
pH	6.7
EC (mS/m)	31.8
Chloride as Cl	31
Sulphate as SO_4	34
Langelier Index	-2.0
Leaching Index	1772
Ryznar Index	10.7
Corrosivity Ratio	2.5
Spalling Index	5
Final Aggressiveness Index	1777



Map 7: Aerial map showing locations of trial pits superimposed on the Site Development Plan.

5. GEOTECHNICAL INTERPRETATION & RECOMMENDATIONS

5.1 Site Geology and Soils Profile

Based on the following:

- Published geological data,
- Geological, geotechnical and geophysical investigations undertaken by GEOSS in the region, and;
- Geotechnical reconnaissance investigations carried out by the Council for Geoscience in the area,

the site is known to be situated an area that typically shows surficial sandy and/or loamy quaternary/transported sediments of variable thickness and quantities of quartzitic sand and ferricrete gravel (which may also be present at the surface). These more recent deposits overly a basement rocks that are of variable origins, i.e. either of igneous (granitic) or sedimentary (pelitic).

5.2 Groundwater and drainage

Groundwater was intersected in trial pits TP14 and TP25 in February 2022; and in TP33 in April 2022. General seepages were encountered at 1.5, 0.9, and 1.4 mbgl, respectively in TP14, TP25, and TP33. These seepages were observed to emanate from the lower transported sandy angular fine GRAVEL unit, which typically occurred beneath the pedogenic horizon. The perched water table rose to 1.0 and 0.85, respectively for TP14 and TP25 after approximately 1 hour of the trial pits remaining open.

Although groundwater/seepage was not encountered in the other trial pits excavated across the site, the development of a perched water table should not be discounted; particularly after periods of heavy rainfall, or following a winter season of above average annual rainfall. Due to occurrence of perched water table and low permeability of substratum across the site - storm water that cannot be directed to natural topographic run-offs will need to be directed to appropriately designed & engineered soakaways.

Open excavations in sand-dominated materials exceeding 1 m in depth should be shored to 30°, and excavations in cohesive soils can be battered to 45°.

Stormwater should be directed to municipal stormwater infrastructure, or an appropriately designed stormwater soakaway.

5.3 Slope stability and bracing

It is important to mention that beneath a depth as shallow as 0.85 mbgl groundwater seepage is encountered. This induces slumping/collapse of the granular mostly cohesionless material horizons. Excavations should be suitably battered for foundation placement, additional support in the form of sand bags (placed at toe of excavations) or other suitable temporary support measures may be required.

Hazardous conditions must be expected when the trenches are exposed to wet weather conditions. Collapse of the sidewalls normally occurs without any warning. Safe working conditions must therefore be ensured in all trenches deeper than 1.0 mbgl, or beneath the nodular to hardpan ferricrete horizons. This can be achieved by either shoring the sidewalls or battering them back at a safe angle, e.g. 30° for mostly cohesionless materials and 45° for materials which are largely cohesive.

5.4 Excavation Conditions

5.4.1 Transported materials

The granular surficial gravelly sands are classified as soft excavation in terms of SANS 1200D.

5.4.2 Pedogenic materials

The pedogenic material encountered in the trial pits is variably cemented across the site. In general, the pedogenic material classifies as soft to intermediate excavation (SANS 1200D). Indurated hardpan ferricrete horizons may require pneumatic/hydraulic rock-breaking apparatus (e.g. a Montabert) during excavation.

5.4.3 Residual materials

Residual horizons showed excavation of soft to intermediate with depth (SANS 1200D).

5.5 Preliminary Foundation Modelling

5.5.1 Pad foundations

Based on the observations made in the trial pits, the results of the dynamic cone penetrometer tests, and preliminary modelling, the maximum bearing capacities have been calculated based on Meyerhoff method (**Table 11**). The following parameters were used during the preliminary modelling:

- Friction angle (φ'): 33°
- Cohesion (c'): 0 kPa
- Bulk unit weight: 19.5 kN/m^3
- Saturated unit weight: 21 kN/m^3
- Water table depth: 0.5 mbgl (worst case).
- Founding depth: 1.0 mbgl.

Table 11: Allowable bearing capacities

Pad Dimension (m²)	Allowable Bearing Capacity (kPa)
0.75	278
1.00	282
1.25	291
1.50	301
2.00	325

The final depth and design of the founding(s) should be subject to the discretion of the engineer and based on site specific geotechnical investigations for each of the structures as per the SAICE code of practice.

5.5.2 Strip footings

The nodular to hardpan ferricrete horizons will very likely provide more than adequate bearing capacity for typical supporting infrastructure, e.g. single story masonry structures. However, due to the laterally discontinuous nature of the ferricrete horizon, site specific investigations should be conducted for such structures.

5.5.3 Anticipated settlements

Estimated immediate settlements range between 17 and 29 mm, depending on the loads imposed on the founding stratum (**Table 12**).

Table 12: Estimated immediate settlement results

	Settlement (mm) for a given pressure (*kPa*) :		
Pad dimensions (m²)	***150***	***200***	***250***
2.0	16.6	22.7	28.9

5.5.4 Anticipated heave

The area delineated as 'Geotechnical Zone D', has been interpreted to be potentially expansive, based on observations made in the trial pits and the characterisation test results obtained from the laboratory. Anticipated heave was calculated based on the Weston (1980) method of heave determination. Weston's method of heave determination is based on the weighted liquid limit, moisture content and overburden pressure the material is subjected to, the following percentage swell can be expected at the surface (**Table 13**). The predicted heave varied between 0.05% and 50% of the layer thickness. It is important to point out that heave has been predicted by Weston (1980) outside the region delineated as potentially expansive due to elevated liquid limits of the residual material encountered in TP4 (sample 18598).

Table 13: Anticipated heave at given pressures and layer thicknesses for pad footings.

Pressure (kPa)		1	1	1	50	50	50	200	200	200
Layer thickness beneath footing (mm)		*500*	*1000*	*2000*	*500*	*1000*	*2000*	*500*	*1000*	*2000*
TP04 (1.7m)	Heave at surface (mm)	249	499	998	55	110	220	32	65	129
TP14 (1.5 – 2.0)		5	9	18	1	2	4	1	1	2
TP15 (0.9 – 1.7)		3	5	10	1	1	2	0	1	1
TP18 (0.6 – 1.0)		180	360	721	40	80	159	23	47	93
TP22 (0.5 – 2.0)		33	67	134	7	15	30	4	9	17
TP25 (0.9 – 1.4)		5	9	19	1	2	4	1	1	2
TP26 (1.0 – 1.7)		4	7	15	1	2	3	0	1	2

Potentially expansive materials were also encountered within the region that has been proposed for future development, i.e. within trial pits TP30 to TP46. The materials tested showed low to medium potential expansiveness, which are similar to the results presented in the table above. Structures should be preliminarily designed accordingly.

5.5.5 Compressibility Index

A sample of undisturbed residual material was extracted at a depth of 0.8 mbgl from trial pit TP42. This sample was submitted to an accredited laboratory for the determination of compressibility and expansive properties. The coefficient of volume compressibility (M_v) of this sample was computed based on the results of the saturated double oedometer test:

$M_v = 0.0004431\ m^2/kN$

A stress increment of 100 kN/m^2 was used to determine the above result (Knappett and Craig, 2012).

5.6 Sub-Grade Modulus

5.6.1 Transported Materials

The modulus variation (n_h) of the sand-dominated materials is anticipated to be as low as 2.5 MN/m^3, or less, to about 20.0 MN/m^3 with depth. Based on the modulus of variation the expected modulus of subgrade reaction (k_h) can be calculated for piles using the following formula:

$$k_h = {}^{n_h x\, Z}/_{B}$$

Where, Z is the depth in metres and B is the pile breadth (m) (after, Franki 2019).

5.6.2 Transported Materials

The modulus subgrade reaction of the firm mostly cohesive residual materials is anticipated to be greater than 18 MN/m^3, increasing proportionally with increased consistency (after, Franki 2019).

5.7 *Reuse of in-situ soil*

5.7.1 Material classifications according to TRH14

The transported materials encountered in Geotechnical Zone D do not meet the classification criteria of G9 materials, due to insufficient CBR values at 93% Mod AASHTO density.

The transported sediments mixed with considerable proportions of ferricrete nodules and gravels classify as at least G8. With increasing proportions of ferricrete nodules this CBR value is anticipated to increase.

The residual materials encountered in all of the trial pits classify as G9 or worse due to the often low CBR values.

5.7.2 Runway & Layer Works

Regarding the preparation of the runway, all surficial materials (0 – 0.2 mbgl) containing vegetation or other organics must be removed and either spoiled off site, or stockpiled for later incorporation in future landscaping operations. The resultant surface (that is free of organics) should be 'ripped and mixed' to a depth of about 0.5 m below the prepared surface of the transported horizon, which is devoid of organics. This serves to blend the remaining transported sediments and nodular ferricrete horizon (refer to samples 18599, 18596, 18590, 18592). The ripped and mixed material should be placed in 150 mm thick layers and compacted to at least 95% MOD AASHTO density. The resultant surface must yield a minimum CBR value of 15 (once compacted). The resultant prepared surface is anticipated to serve as an appropriate lower and upper subbase. The project engineer is to advise on the final design for the subbase, base and seal for runway and taxiing areas according to expected design air traffic loadings.

The resultant densities achieved for the respective layer works horizons should checked in 10 m intervals using a Troxler density device, for the length of the runway.

It is important to mention that material encountered in the northern extent of the property, i.e. north of trial pits TP12 and TP15, residual materials possess considerably greater cohesive components, which dramatically reduce the CBR values (TP18 to TP22, refer samples 18591, 18597, 18598). For reference see **Table 7**. Such cohesive materials should be removed and spoiled off site.

The ripped and compacted material from the southern extent of the site should be sufficient to infill the resultant 'void' created by the removal of the spoiled mostly cohesive material in the northern extent of the present site. Further, any additional material required to supplement the construction of the runway and taxiing area, could be sourced from south- and north-western portions of the site, particularly from excavations required for the construction of the commercial and aviation development areas in the southwestern portion of the site.

Reuse of excavated material for general pavement construction should be at the site engineers' discretion, and is expected to only be suitable for LSSG course. The following generalised layer works are recommended:

Seal	Cape Seal	13/19 mm	to be specified by engineer
Base	Imported G2/G3	150 mm	100% MMD
Subbase	Imported G5	150 mm	95% MDD
USSG	Imported G7	150 mm	93% MDD
LSSG	Imported / in-situ G7	150 mm	100 % MMD

6. CONCLUSIONS

This report summarises the results from a Phase I Geotechnical Investigation that aimed to determine and classify the engineering properties on the site proposed for development, and to provide preliminary recommendations for the geotechnical design and further investigations required for the proposed structures. The most pertinent findings from this Phase I investigation are as follows:

- The site is covered by a surficial horizon of mostly cohesive transported soil, which is underlain by a laterally discontinuous and variably cemented nodular to hardpan ferricrete pedogenic horizon. These strata are underlain by residual materials derived from either the Cape Granite Suite or the Malmesbury Group.
- From a geotechnical standpoint, site development should proceed; however, there are potential geotechnical challenges with development of this site. There is a great degree of variability within the composition of the residual materials, and consequently, there are areas across the site that present a risk of highly expansive soils, and may be subject to high consolidation.
- Due to the variation in topography within the northern extent of the property, considerable fill will be required, should the development be extended from the present level at which the Fisantekraal Airport is situated. In this case a suitable granular fill will need to be imported; materials could be sourced locally, but would need to be sieved and mixed in appropriate proportions.
- The tractor loader backhoe was unable to penetrate materials with consistencies of very dense and/or very stiff, and beyond. However, it is anticipated that in unrestricted excavations, and/or with prior ripping, conventional light earth-moving equipment could carry out the bulk of the earthworks. All materials encountered in the trial pits classified as soft to intermediate excavation (SANS 1200D). The hardpan ferricrete horizons may require rock-breaking apparatus in areas of the site.
- A series of site-specific follow-up geotechnical investigations will be required prior to the construction of individual structures, which should include field and laboratory tests to more accurately reflect/characterise the mechanical properties (e.g. consolidation settlement) of the variable residual soils.
- In the case of larger structures, where deeper foundations/piling is required, it would be prudent to consider a series of exploratory drilling to determine whether core stones exist within the areas underlain by residual granite as these may present challenges for construction. Consolidation settlement is anticipated to guide the foundation design of larger structures.
- The site is characterised by a laterally discontinuous perched water table, which may be seasonally exacerbated. The perched groundwater table was intersected on-site at between 0.85 and 1.0 mbgl in trial pits TP14 and TP25, respectively; and at 1.4 mbgl in TP33. Excavations deeper than 1.0 mbgl will require battering to ensure safe working conditions. Excavation required should be undertaken during the summer, when rainfall is at a minimum, which provides for more favourable safe working conditions.
- Final designs should appropriately cater for aggressive and corrosive groundwater and/or soil conditions.

- Drainage precaution will be required on-site, this would entail diverting rainwater away from the perimeter walls of structures and paved areas (i.e. taxi areas and runway) to limit the ingress of moisture into the founding stratum and basecourse horizons.
- Preliminary modelling has been carried out to determine potential bearing capacities, using assumed loads and several foundation dimensions. Structure specific investigations and additional testing would be required to verify these results. The foundation solution that is to be adopted each structure on-site will depend on the cost and of implementation, and the risk associated with the said solution.
- Every effort has been made to ensure the accuracy of the information presented in this report. It must be stressed that naturally occurring materials are never uniform, and results of a field investigation only provide a limited view of the subsurface conditions. Considerable lateral and vertical variation can occur over short distances, and deviations from the presented results may be encountered on-site. Therefore, as a precautionary measure, potential geotechnical variations in the subsurface (i.e. inspection of excavation slopes, pile and founding conditions) should be inspected and approved by a suitably qualified professional.

7. ASSUMPTIONS AND LIMITATIONS

It should be noted that the results of the laboratory analyses presented in this report were undertaken on representative bulk disturbed samples, and therefore, some degree of variability may be encountered on-site. We have assumed that the laboratory results accurately reflect the in-situ conditions.

The results presented are based on trial pits excavated to depths of between 0.6 and 2.2 mbgl, this only provides information at discrete locations across the site, and interpolation was conducted across considerable distances. Geotechnical zones have been delineated using such interpolation, using trial pit, dynamic cone penetrometer and laboratory data; therefore, variation across/within the zone boundaries may be encountered on-site. Geotechnical Zone D was delineated based on two trial pits (TP17 and TP33), which have been interpreted to be transported sediments that had infilled a low-lying areas.

Due to the variability in soil conditions encountered on-site, the results contained in this report cannot be applied to all structures across the site. The settlement results presented reflect settlements expected during the construction period, more investigation should be undertaken prior to modelling of consolidation settlements. Little information is available for the design of the proposed structures, and therefore, the results presented in this report are of a preliminary nature. The results presented are subject to confirmation during site specific investigation and more detailed testing.

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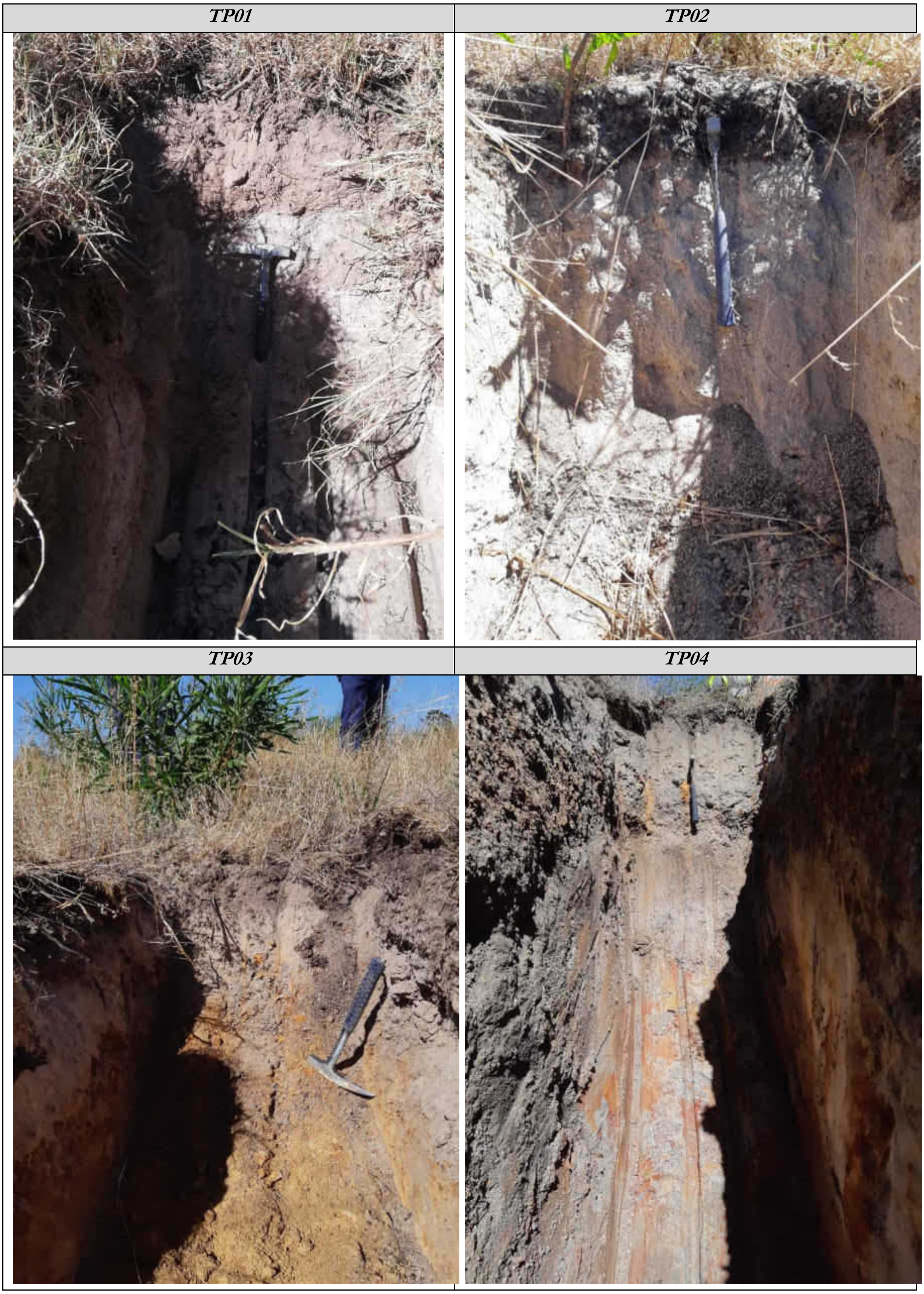
9. APPENDIX A: TRIAL PIT PHOTOS


TP01

TP02

TP03

TP04

Figure 5: TP01 to TP04.

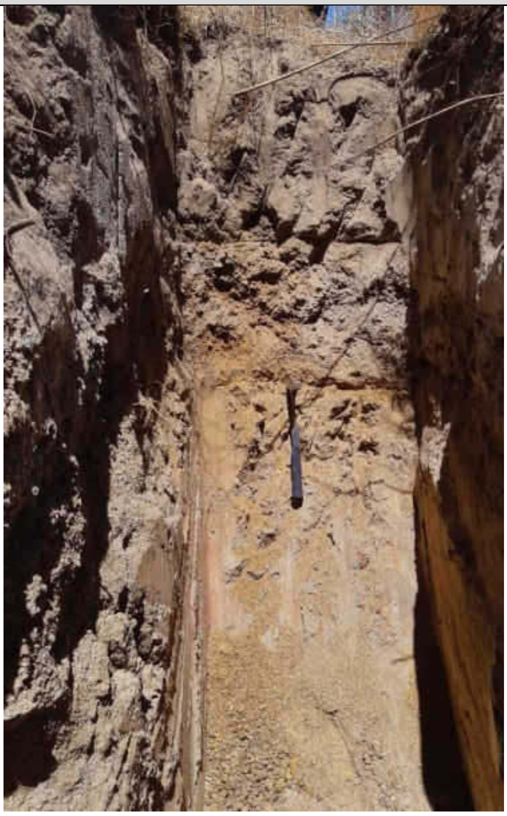
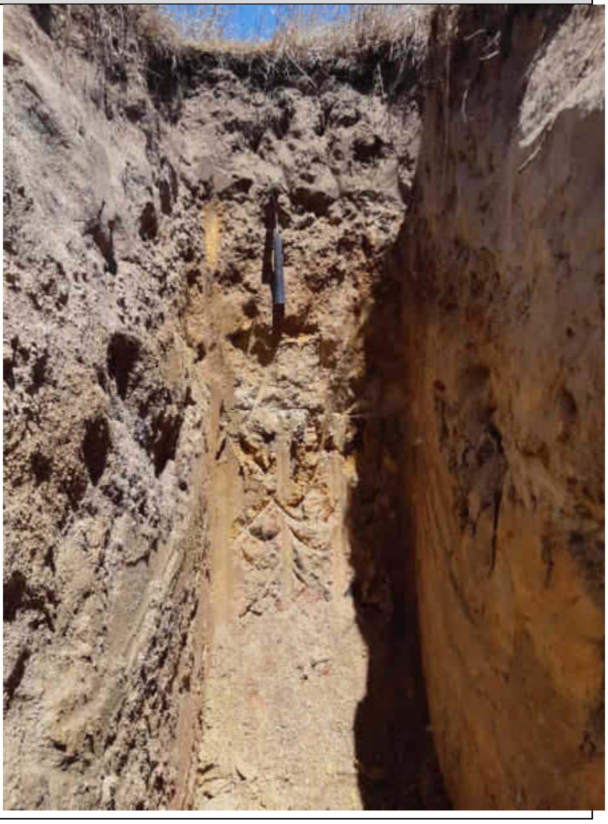
TP05	***TP06***
	
TP07	***TP08***
	

Figure 6: TP05 to TP08.

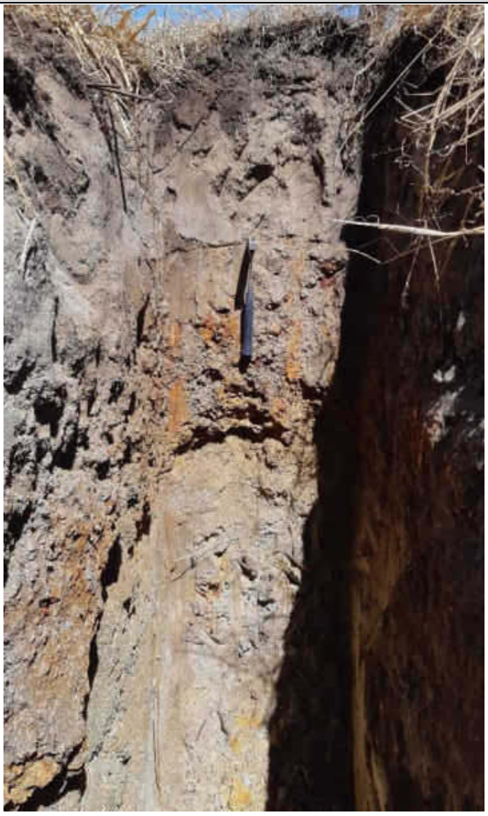
TP09	***TP10***
	
TP11	***TP12***
	

Figure 7: TP09 to TP12.

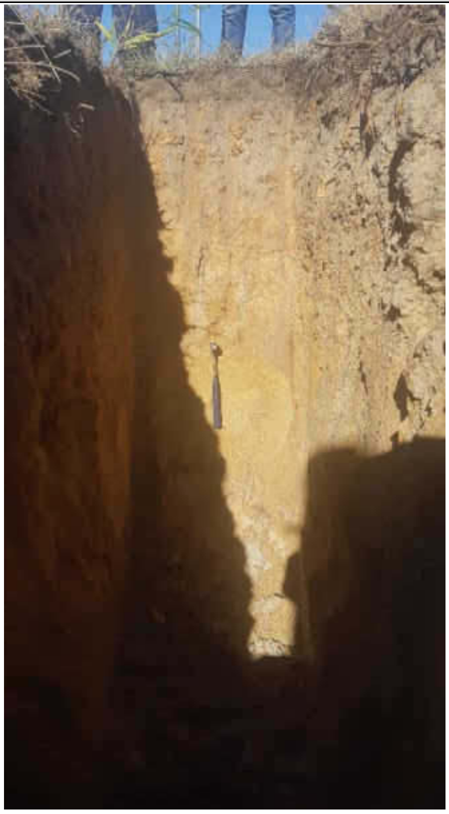
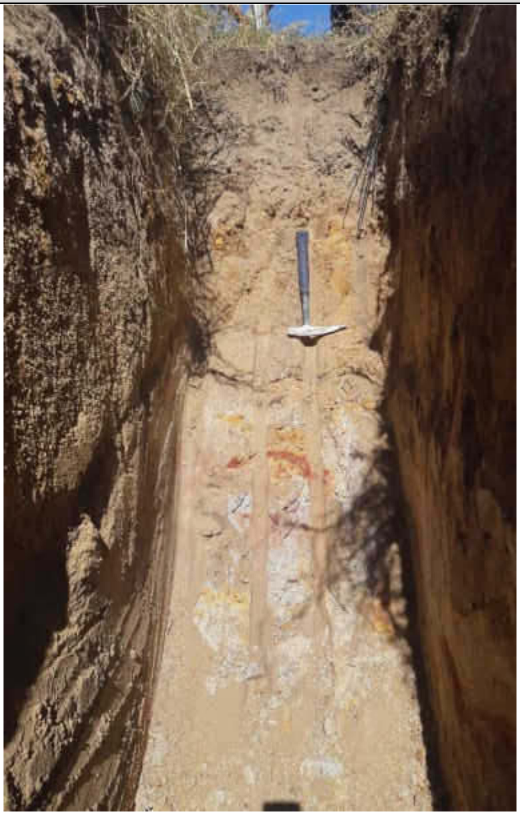
TP13	***TP14***
	
TP15	***TP16***
	

Figure 8: TP13 to TP16.

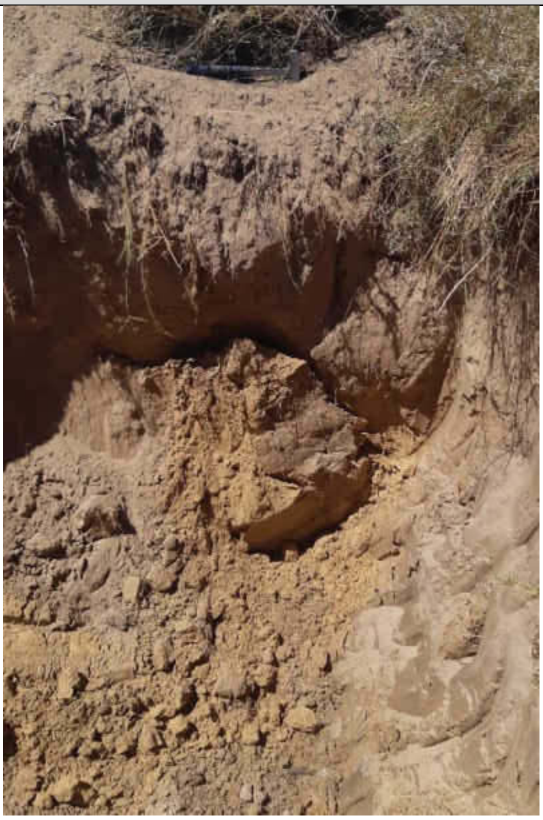
TP17	***TP18***
	
TP19	***TP20***
	

Figure 9: TP17 to TP20.

TP21

TP22

TP23

TP24

Figure 10: TP21 to TP24.

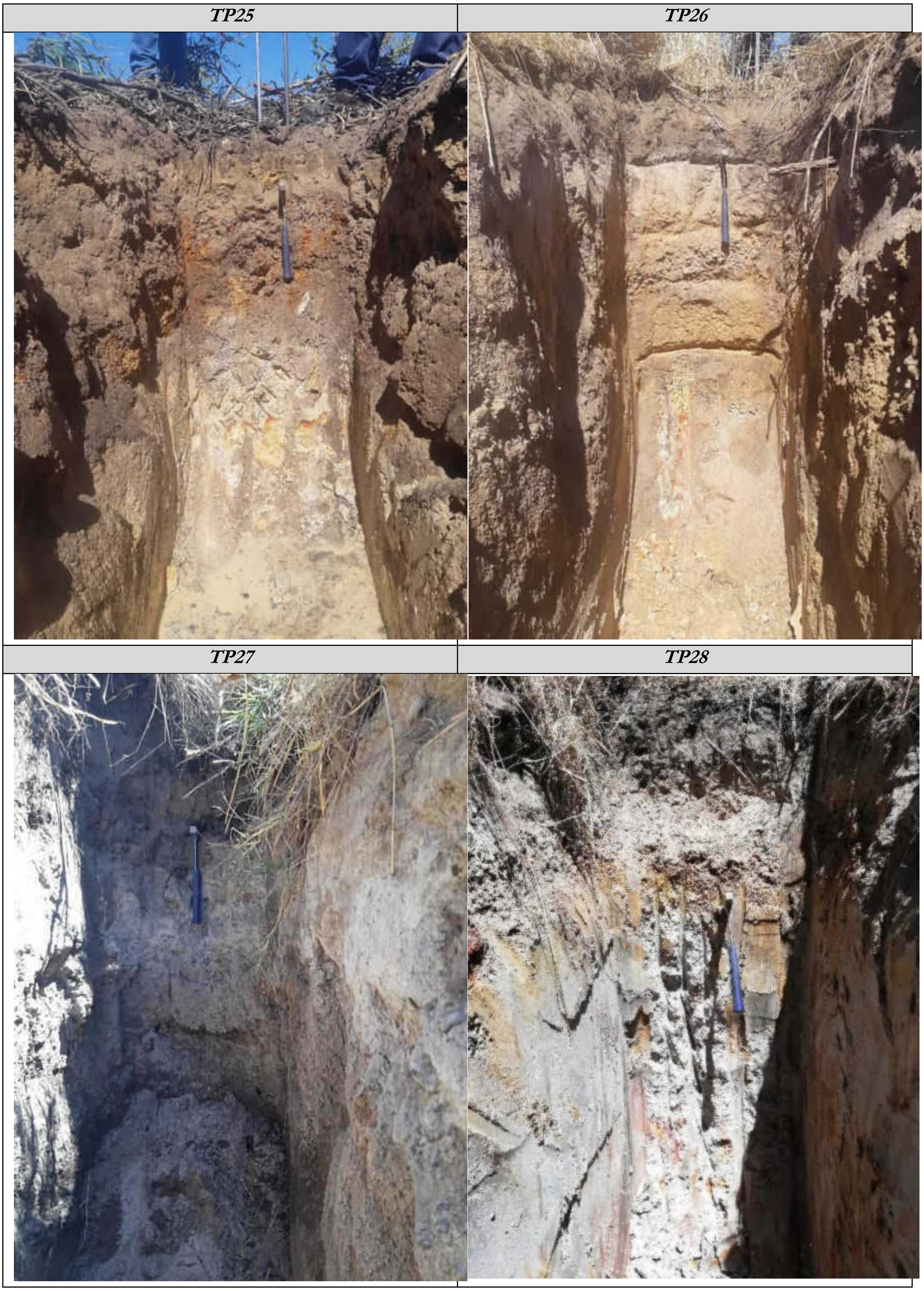


Figure 11: TP25 to TP28.

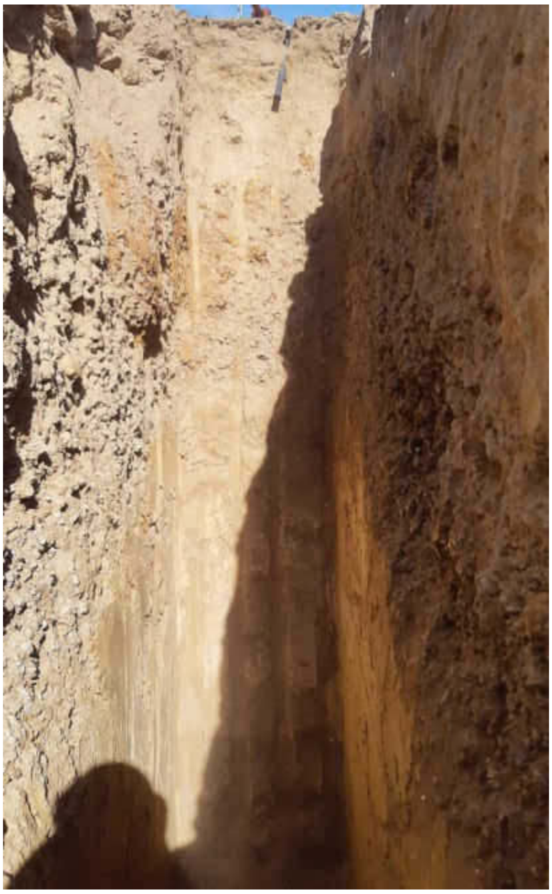
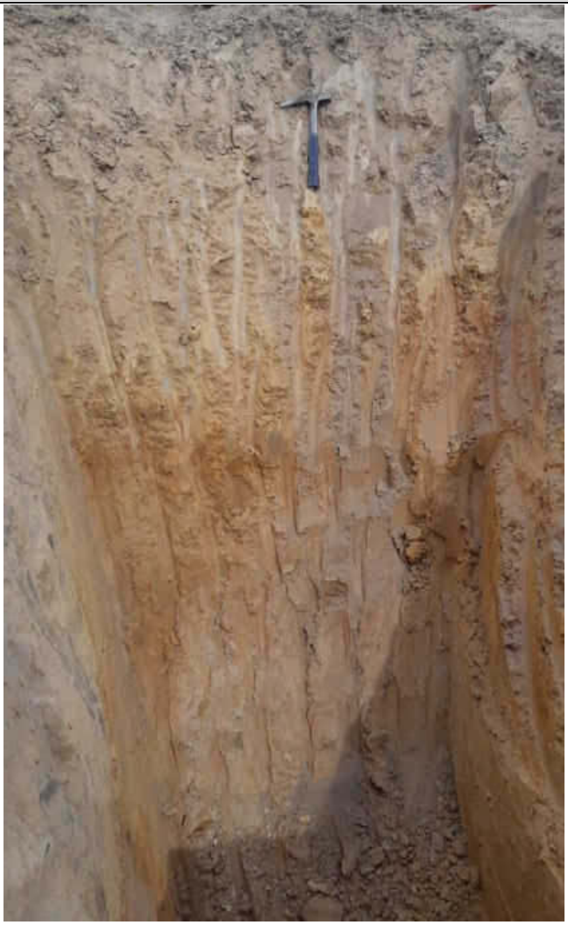
TP29	***TP30***
	
TP31	***TP32***
	

Figure 12: TP29 to TP32.

TP33	***TP34***
	
TP35	***TP36***
	

Figure 13: TP33 to TP36.

TP37	***TP38***
	
TP39	***TP40***
	

Figure 14: TP37 to TP40.

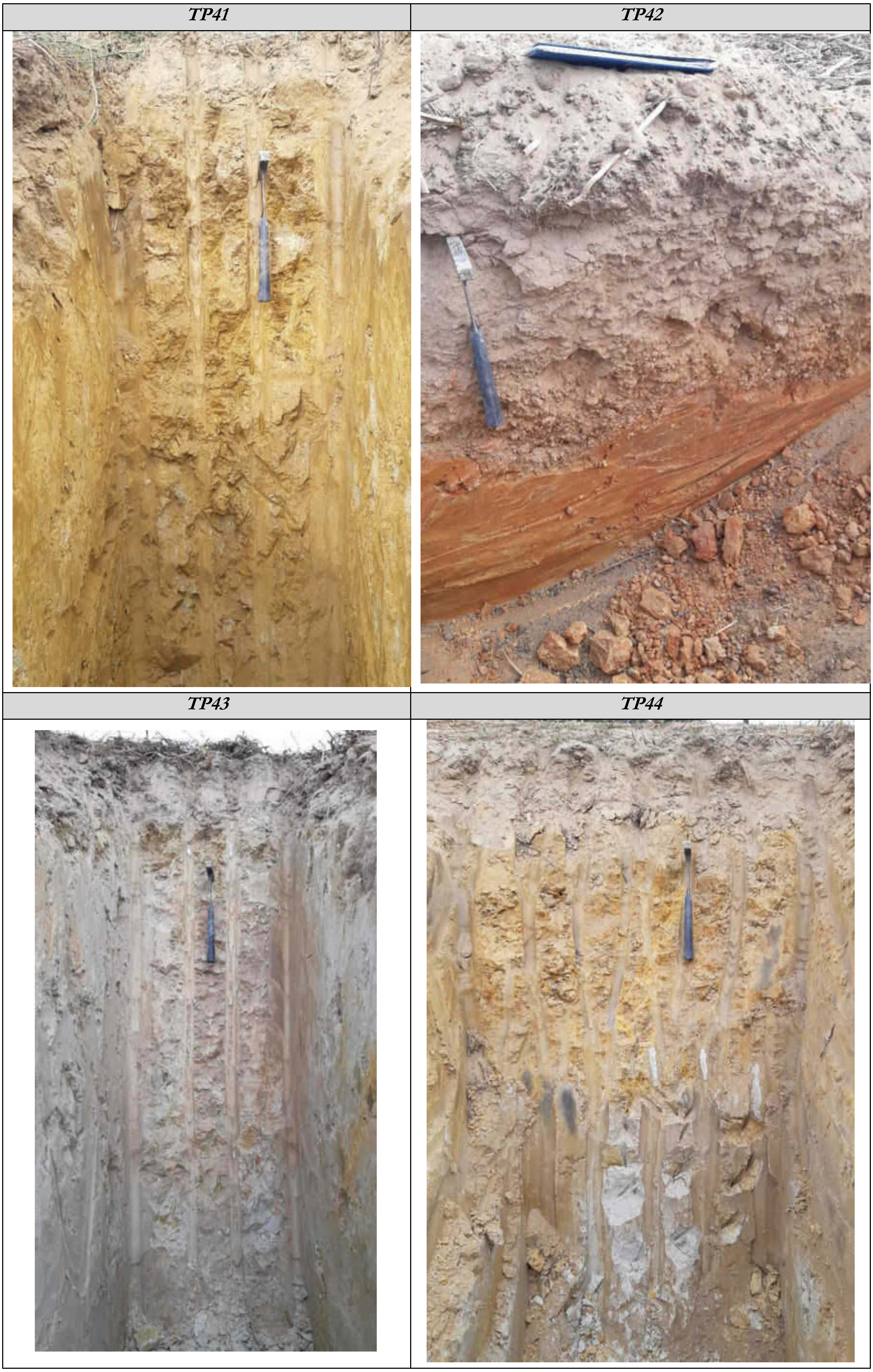


Figure 15: TP41 to TP44.

TP45	***TP46***
No Photo Available	

Figure 16: TP45 to TP46.

10. APPENDIX B: TRIAL PIT LOGS

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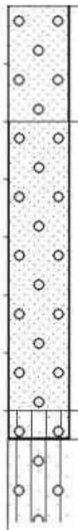
Cape Winelands Airport Fisantekraal

HOLE No: **TP01**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10



0.00	Slightly moist brown black very loose intact gravelly **SAND**. Transported.
0.20	Slightly moist grey medium dense to dense intact gravelly **SAND**. Transported. Note: Occasional ferricrete nodules at base of trial pit.
0.70	Slighly moist grey speckled orange very stiff intact gravelly sandy **SILT**. Residual.
0.75	Refusal on as above, but extremely stiff. Note: (i) Gravel comprises mainly of ferricrete nodules.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

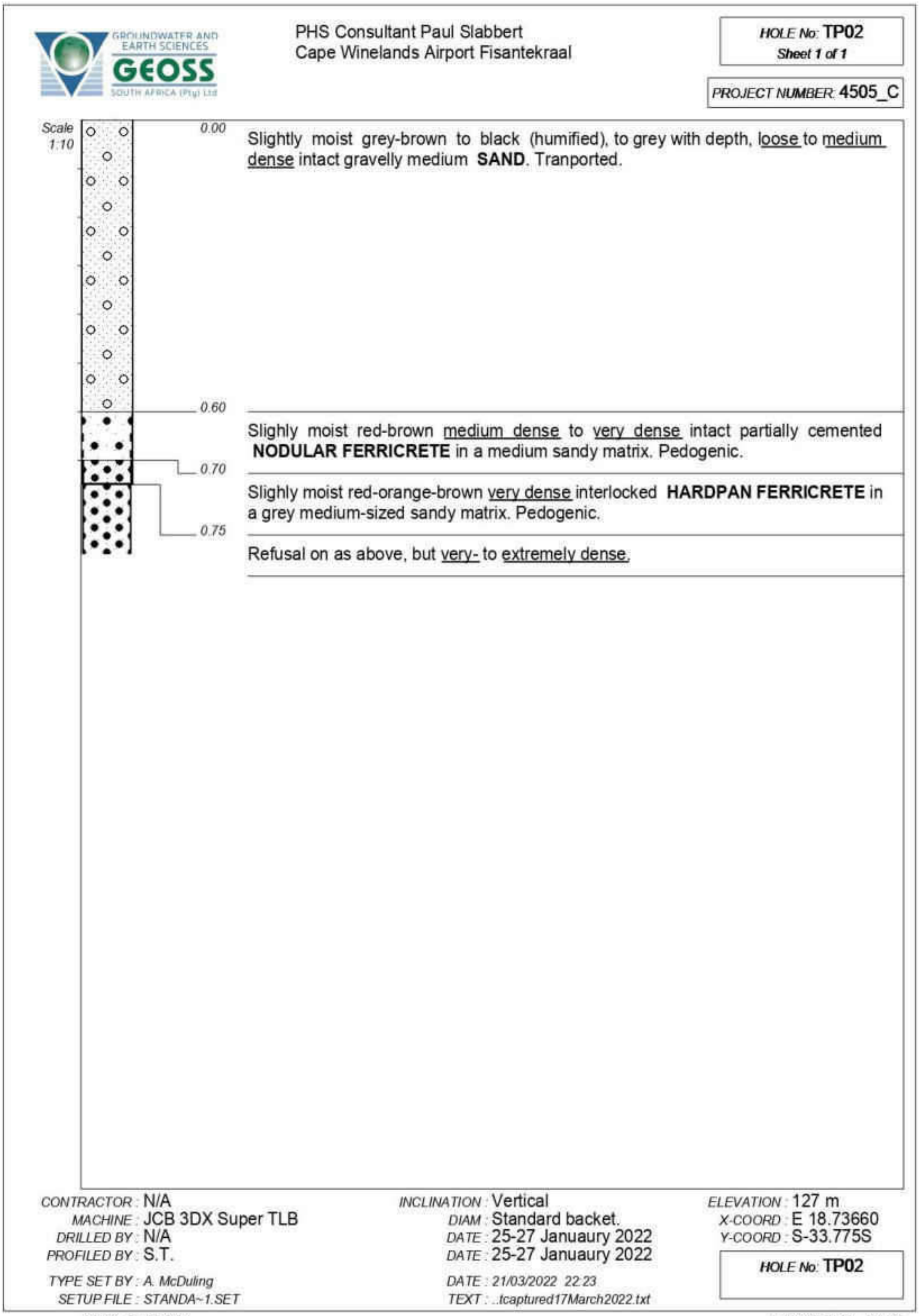
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 125 m
X-COORD : E 18.7356
Y-COORD : S-33.7763

HOLE No: **TP01**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP02**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slighly moist grey-brown to black (humified), to grey with depth, loose to medium dense intact gravelly medium **SAND**. Tranported.
0.60	Slighly moist red-brown medium dense to very dense intact partially cemented **NODULAR FERRICRETE** in a medium sandy matrix. Pedogenic.
0.70	Slighly moist red-orange-brown very dense interlocked **HARDPAN FERRICRETE** in a grey medium-sized sandy matrix. Pedogenic.
0.75	Refusal on as above, but very- to extremely dense.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

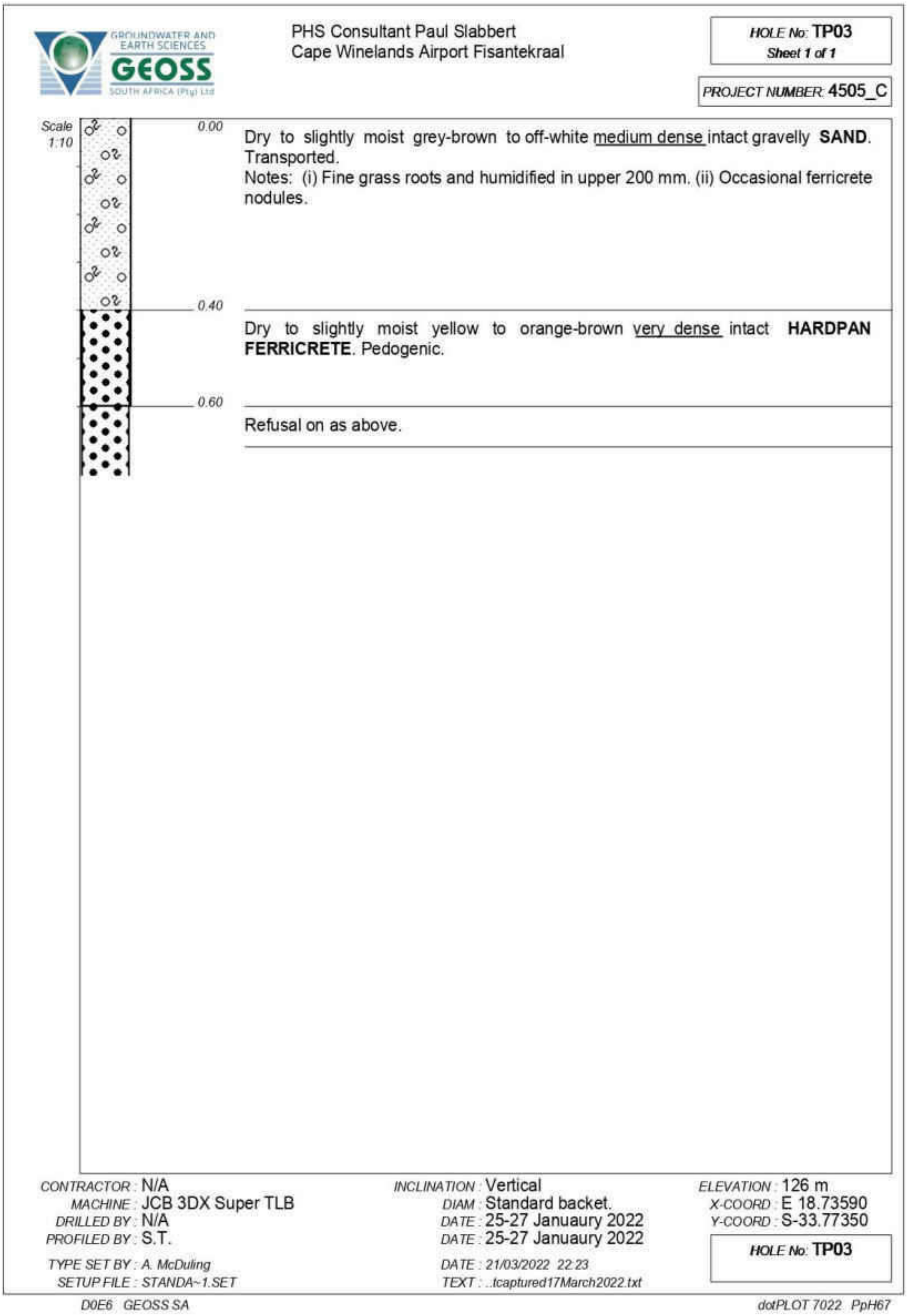
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 127 m
X-COORD : E 18.73660
Y-COORD : S-33.775S

HOLE No: **TP02**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP03**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10

0.00	Dry to slightly moist grey-brown to off-white <u>medium dense</u> intact gravelly **SAND**. Transported. Notes: (i) Fine grass roots and humidified in upper 200 mm. (ii) Occasional ferricrete nodules.
0.40	Dry to slightly moist yellow to orange-brown <u>very dense</u> intact **HARDPAN FERRICRETE**. Pedogenic.
0.60	Refusal on as above.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.73590
Y-COORD : S-33.77350

HOLE No: **TP03**

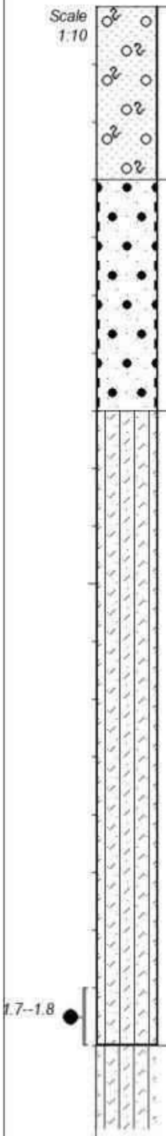
D0E6 GEOSS SA

dotPLOT 7022 PpH67

PHS Consultant Paul Slabbert
Cape Winelands Airport Fisantekraal

HOLE No: **TP04**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**



Depth	Description
0.00	Slightly moist pale grey medium dense intact gravelly **SAND**. Transported. Note: (i) Some scattered fine grass roots in upper 100 mm.
0.30	Dry to slightly moist yellow-orange-brown intact dense partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic. Note: (i) Some large pieces excavated out up to 300 mm in diameter.
0.70	Slightly moist grey blotched yellow & orange stiff intact sandy clayey **SILT**. Residual. Note: (i) Some pockets that largely comprise red-orange silt. (ii) Occasional ferricrete nodules.
1.80	As above, but very stiff.

NOTES

1) Bulk disturbed sample 18589 between 1.7--1.8 mbgl.

CONTRACTOR: N/A
MACHINE: JCB 3DX Super TLB
DRILLED BY: N/A
PROFILED BY: S.T.

TYPE SET BY: A. McDuling
SETUP FILE: STANDA~1.SET

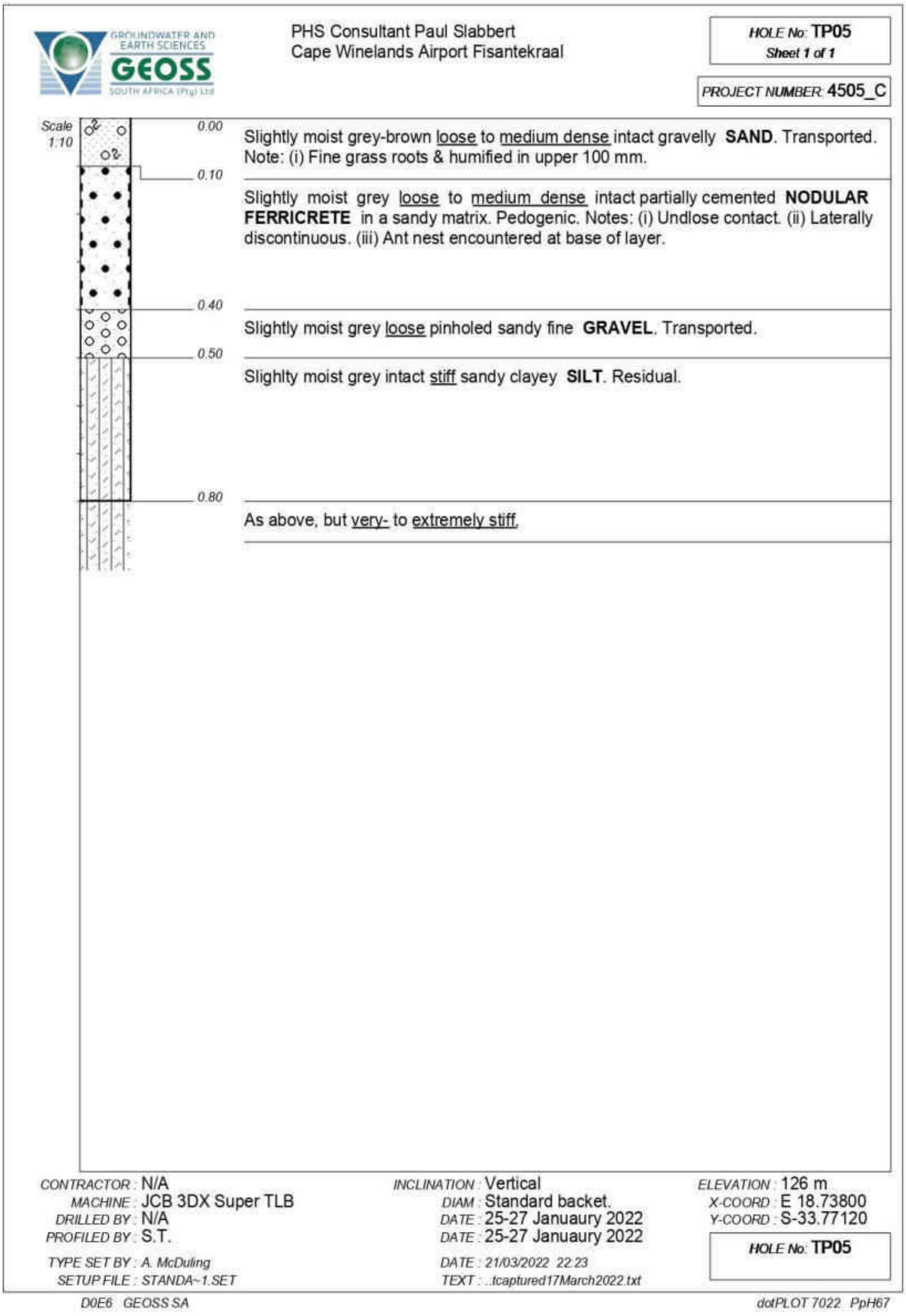
INCLINATION: Vertical
DIAM: Standard backet.
DATE: 25-27 Janauary 2022
DATE: 25-27 Janauary 2022

DATE: 21/03/2022 22:23
TEXT: ..tcaptured17March2022.txt

ELEVATION: 126 m
X-COORD: E 18.73670
Y-COORD: S-33.77220

HOLE No: **TP04**

D0E6 GEOSS SA *dotPLOT 7022 PpH67*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HOLE No: **TP05**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist grey-brown loose to medium dense intact gravelly **SAND**. Transported. Note: (i) Fine grass roots & humified in upper 100 mm.
0.10	Slightly moist grey loose to medium dense intact partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic. Notes: (i) Undlose contact. (ii) Laterally discontinuous. (iii) Ant nest encountered at base of layer.
0.40	Slightly moist grey loose pinholed sandy fine **GRAVEL**. Transported.
0.50	Slighlty moist grey intact stiff sandy clayey **SILT**. Residual.
0.80	As above, but very- to extremely stiff.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

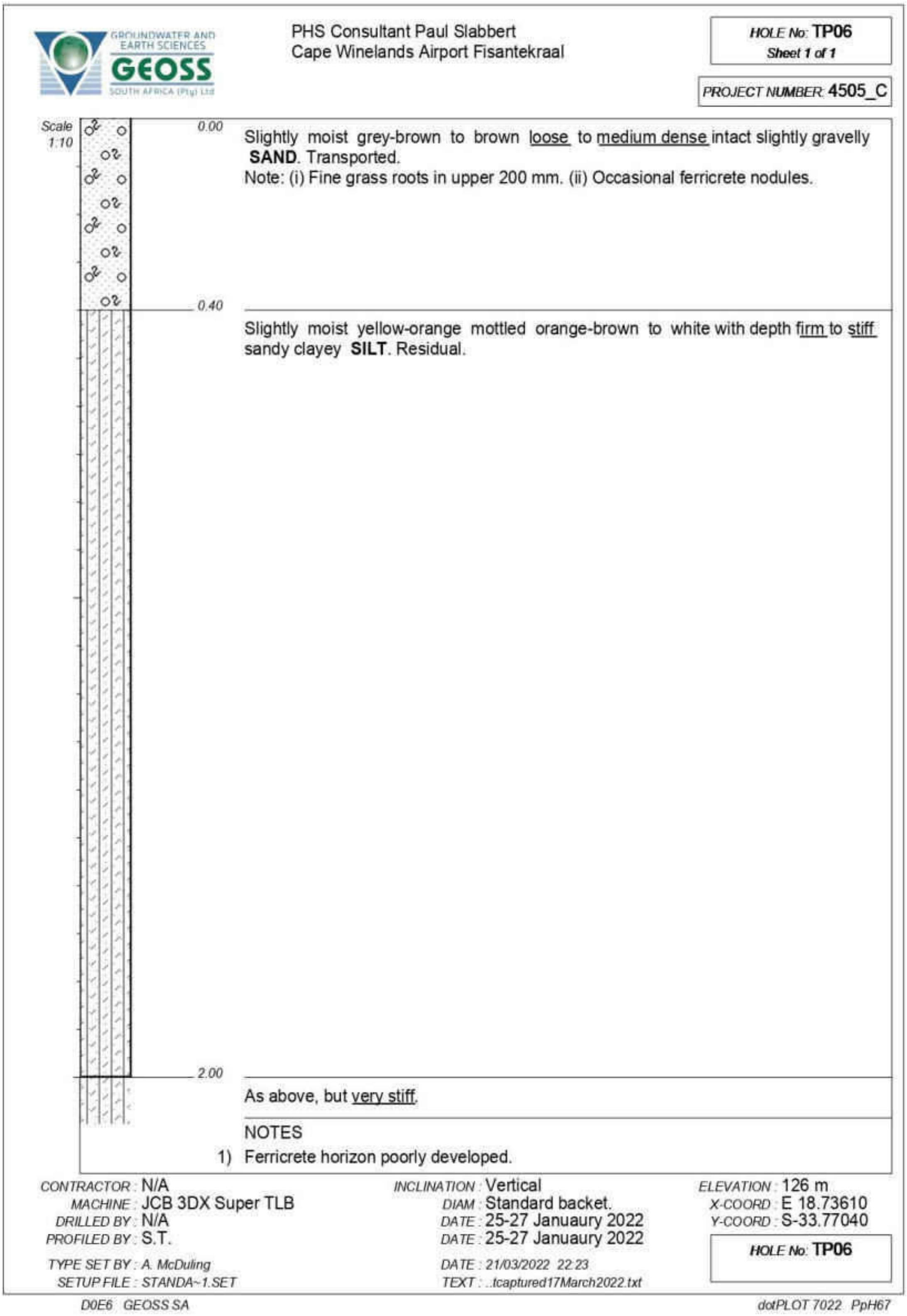
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.73800
Y-COORD : S-33.77120

HOLE No: **TP05**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP06**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00

Slightly moist grey-brown to brown loose to medium dense intact slightly gravelly **SAND**. Transported.
Note: (i) Fine grass roots in upper 200 mm. (ii) Occasional ferricrete nodules.

0.40

Slightly moist yellow-orange mottled orange-brown to white with depth firm to stiff sandy clayey **SILT**. Residual.

2.00

As above, but very stiff.

NOTES

1) Ferricrete horizon poorly developed.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

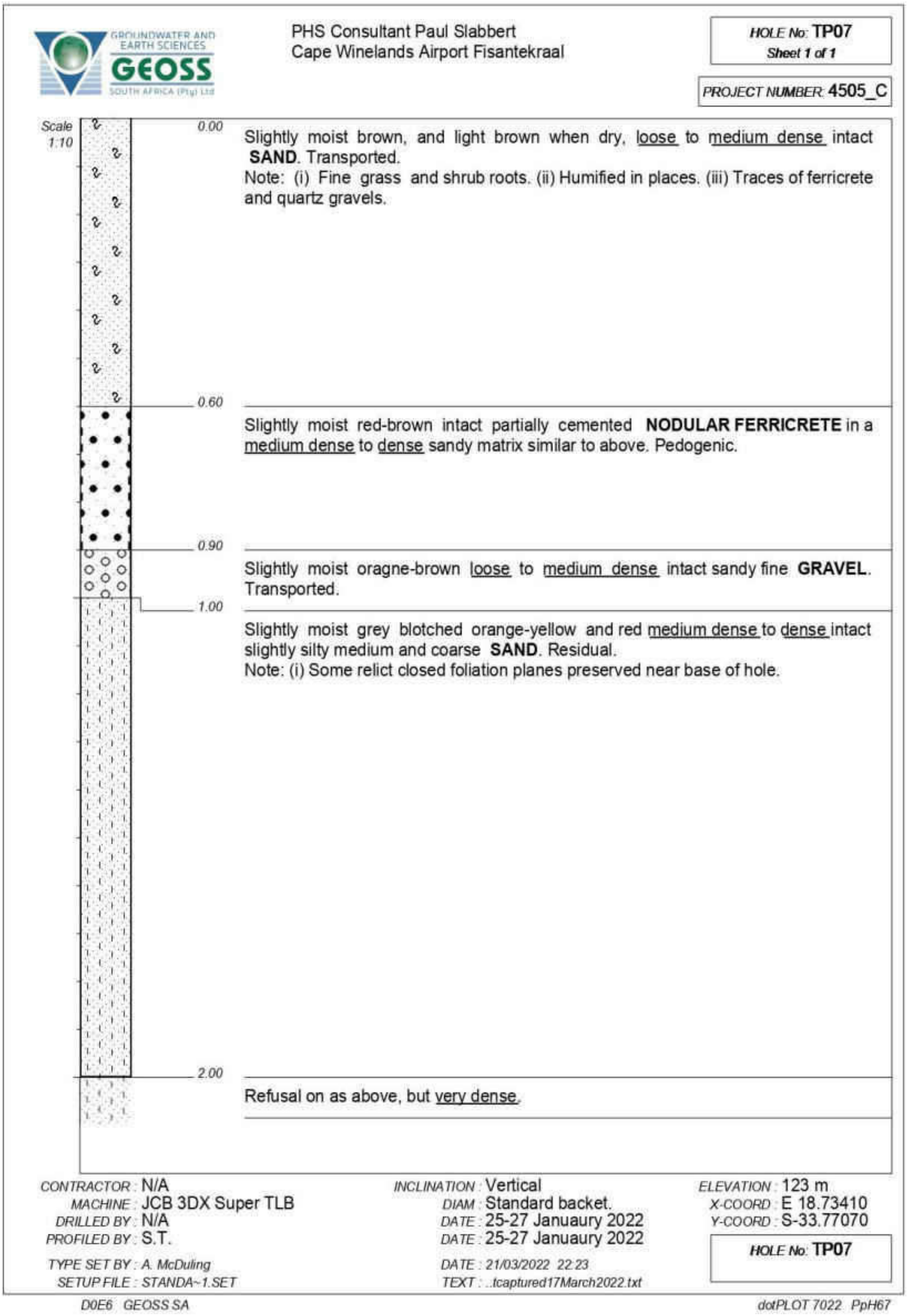
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.73610
Y-COORD : S-33.77040

HOLE No: **TP06**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP07**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist brown, and light brown when dry, <u>loose</u> to <u>medium dense</u> intact **SAND**. Transported. Note: (i) Fine grass and shrub roots. (ii) Humified in places. (iii) Traces of ferricrete and quartz gravels.
0.60	Slightly moist red-brown intact partially cemented **NODULAR FERRICRETE** in a <u>medium dense</u> to <u>dense</u> sandy matrix similar to above. Pedogenic.
0.90	Slightly moist oragne-brown <u>loose</u> to <u>medium dense</u> intact sandy fine **GRAVEL**. Transported.
1.00	Slightly moist grey blotched orange-yellow and red <u>medium dense</u> to <u>dense</u> intact slightly silty medium and coarse **SAND**. Residual. Note: (i) Some relict closed foliation planes preserved near base of hole.
2.00	Refusal on as above, but <u>very dense</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

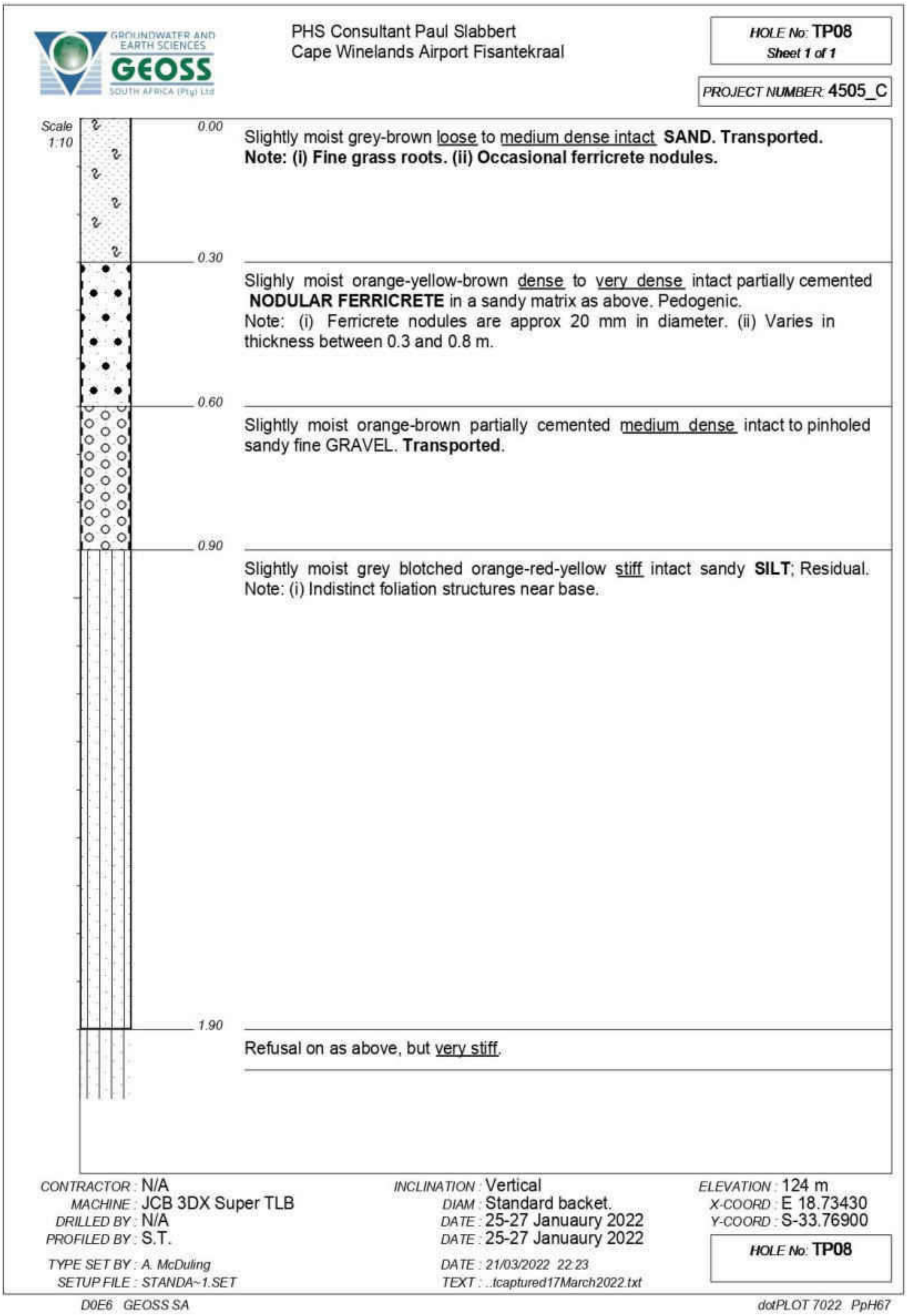
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 123 m
X-COORD : E 18.73410
Y-COORD : S-33.77070

HOLE No: **TP07**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP08**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist grey-brown loose to medium dense intact **SAND. Transported.** **Note: (i) Fine grass roots. (ii) Occasional ferricrete nodules.**
0.30	Slighly moist orange-yellow-brown dense to very dense intact partially cemented **NODULAR FERRICRETE** in a sandy matrix as above. Pedogenic. Note: (i) Ferricrete nodules are approx 20 mm in diameter. (ii) Varies in thickness between 0.3 and 0.8 m.
0.60	Slightly moist orange-brown partially cemented medium dense intact to pinholed sandy fine GRAVEL. **Transported.**
0.90	Slightly moist grey blotched orange-red-yellow stiff intact sandy **SILT**; Residual. Note: (i) Indistinct foliation structures near base.
1.90	Refusal on as above, but very stiff.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

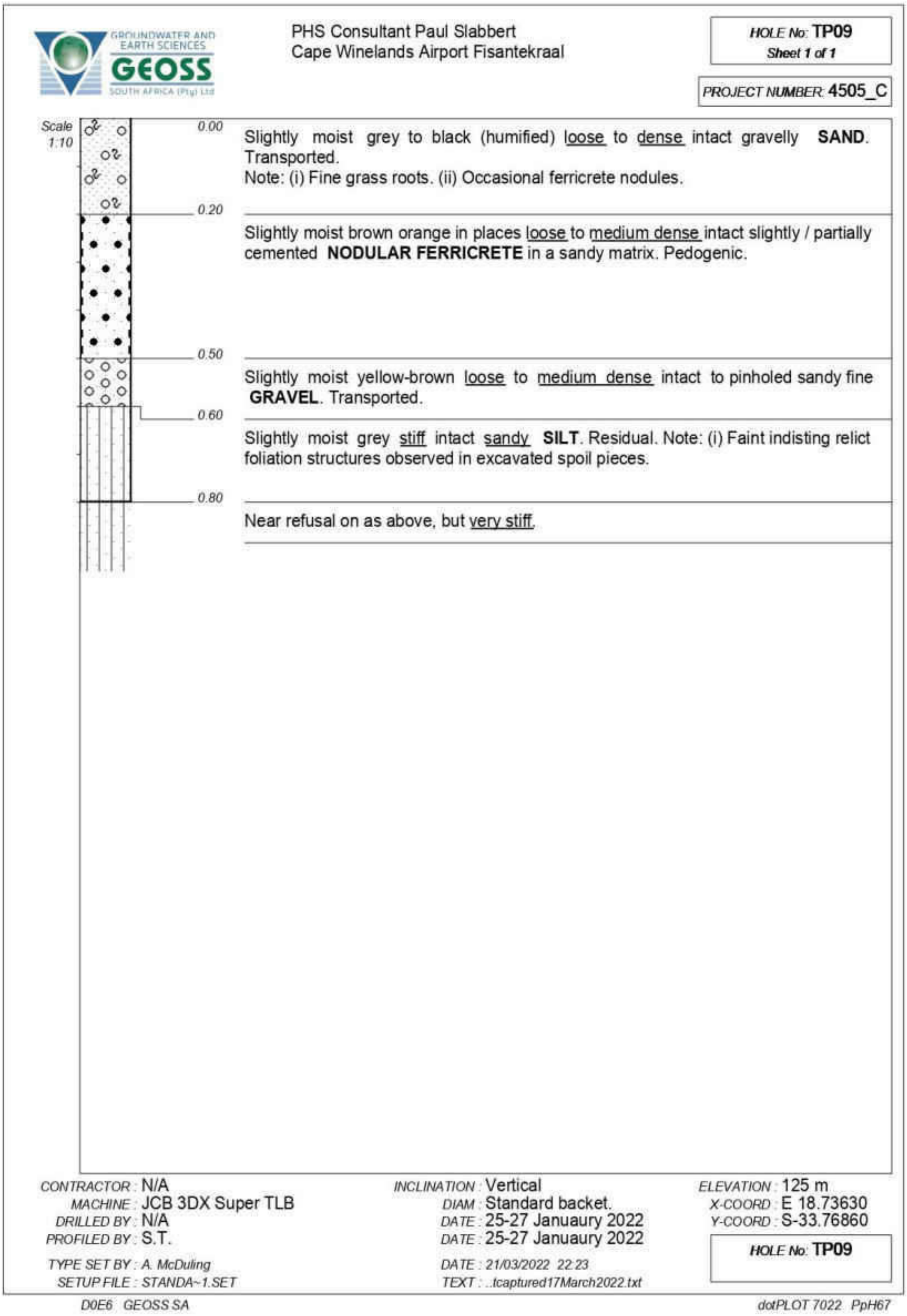
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 124 m
X-COORD : E 18.73430
Y-COORD : S-33.76900

HOLE No: **TP08**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP09**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist grey to black (humified) <u>loose</u> to <u>dense</u> intact gravelly **SAND**. Transported. Note: (i) Fine grass roots. (ii) Occasional ferricrete nodules.
0.20	Slightly moist brown orange in places <u>loose</u> to <u>medium dense</u> intact slightly / partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic.
0.50	Slightly moist yellow-brown <u>loose</u> to <u>medium dense</u> intact to pinholed sandy fine **GRAVEL**. Transported.
0.60	Slightly moist grey <u>stiff</u> intact <u>sandy</u> **SILT**. Residual. Note: (i) Faint indisting relict foliation structures observed in excavated spoil pieces.
0.80	Near refusal on as above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

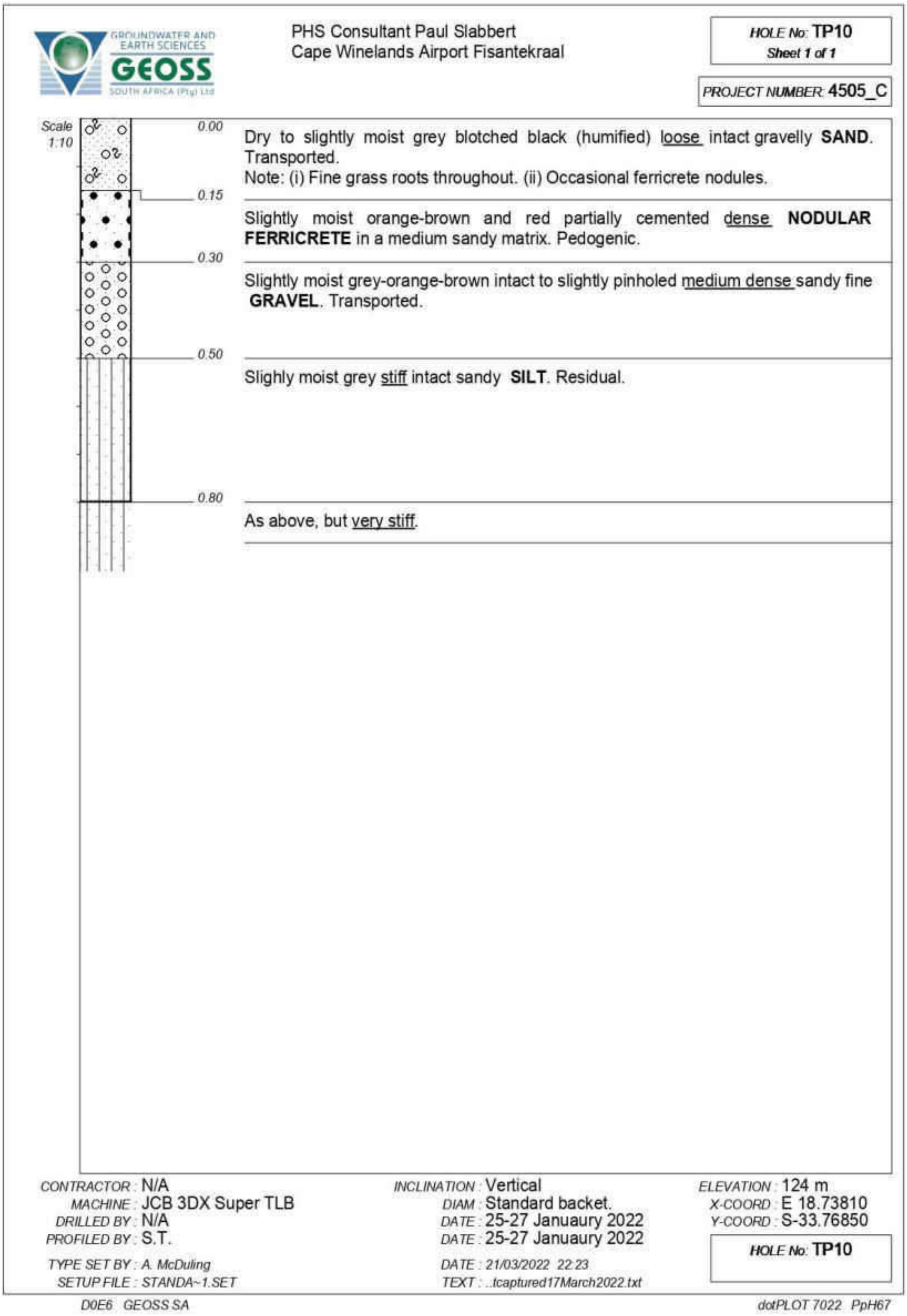
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 125 m
X-COORD : E 18.73630
Y-COORD : S-33.76860

HOLE No: **TP09**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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Cape Winelands Airport Fisantekraal

HOLE No: **TP10**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Dry to slightly moist grey blotched black (humified) loose intact gravelly **SAND**. Transported. Note: (i) Fine grass roots throughout. (ii) Occasional ferricrete nodules.
0.15	Slightly moist orange-brown and red partially cemented dense **NODULAR FERRICRETE** in a medium sandy matrix. Pedogenic.
0.30	Slightly moist grey-orange-brown intact to slightly pinholed medium dense sandy fine **GRAVEL**. Transported.
0.50	Slighly moist grey stiff intact sandy **SILT**. Residual.
0.80	As above, but very stiff.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 124 m
X-COORD : E 18.73810
Y-COORD : S-33.76850

HOLE No: **TP10**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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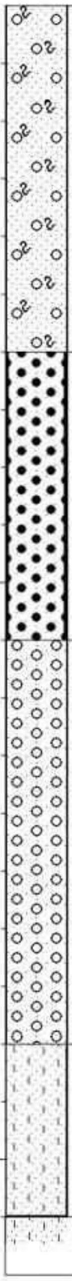
HOLE No: **TP11**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10



0.00	Slightly moist grey-brown blotched black (humified) loose to medium dense intact **SAND** with occasional medium gravel. Transported. Note: (i) Fine roots throughout. (ii) Occasional ferricrete nodules.
0.60	Slightly moist orange-brown-red very dense intact **HARDPAN FERRICRETE** in an orange-grey sandy matrix similar to above. Pedogenic.
1.10	Slightly moist grey-brown loose to medium dense intact sandy fine **GRAVEL**. Transported. Note: (i) Moisture induces clumping. (ii) Occasional ferricrete nodules.
1.80	Slightly moist grey speckled orange-brown and red-brown dense intact silty **SAND**. Residual. Note: (i) Faint relict foliation structures. (ii) Occasional gravel.
2.10	As above, but very dense.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 123 m
X-COORD : E 18.73850
Y-COORD : S-33.76550

HOLE No: **TP11**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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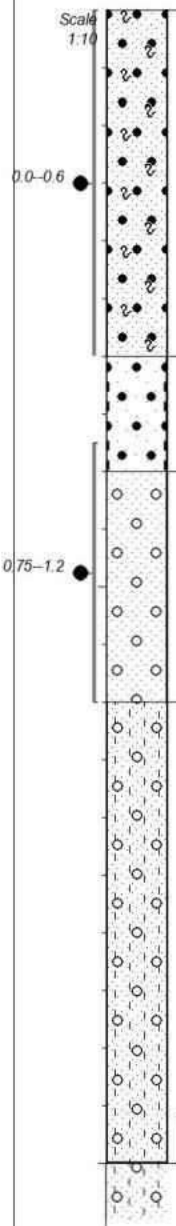
Cape Winelands Airport Fisantekraal

HOLE No: **TP12**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**



0.00

Slightly moist grey <u>loose</u> to <u>medium dense</u> with depth intact gravelly **SAND**. Tranported.
Note: (i) Fine roots. (ii) Occasionally humified. (iii) Gravel comprises mainly medium-sized ferricrete nodules.

0.60

Slightly moist yellow-orange-red <u>medium dense</u> to <u>dense</u> intact partially cemented **NODULAR FERRICRETE** in a grey-orange-brown sandy matrix. Pedogenic.
Note: (i) Undulose contact with adjacent horizons.

0.80

Slightly moist to moist yellow-brown <u>loose</u> pinholed gravelly medium and coarse **SAND**. **Transported**.
Note: (i) Tending to medium and coarse sandy fine GRAVEL.

1.20

Slightly moist orange-grey blotched yellow-brown and red-brown intact <u>dense</u> gravelly silty **SAND**. Residual.

2.00

As above, but <u>very dense</u>.

NOTES

1) Bulk disturbed sample 18590 between 0.0--0.6 mbgl.

2) Bulk disturbed sample 18591 between 0.75–1.2 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 120 m
X-COORD : E 18.73600
Y-COORD : S-33.76280

HOLE No: **TP12**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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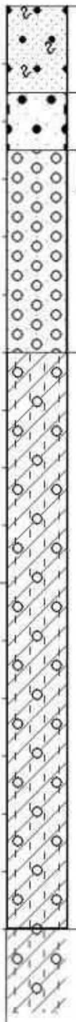
HOLE No: **TP13**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10



0.00	Slightly moist brown <u>loose</u> to <u>medium dense</u> SAND with occasional ferricrete nodules. **Transported**. Note: Abundant roots.
0.15	Slightly moist yellow-red-brown <u>medium dense</u> partially cemented **NODULAR FERRICRETE** in a grey-brown sandy matrix. Pedogenic. Note: (i) Poorly developed.
0.25	Slightly moist <u>loose</u> pinholed sandy fine **GRAVEL**. Transported. Note: (i) Layer thickness variation of between 0.35 and 0.55 m.
0.60	Slightly moist grey streaked orange-red-brown <u>stiff</u> gravelly silty **CLAY**. Residual. Note: (i) Intense smear on trial pit sidewall. (ii) Occasional (ferricrete) gravel protruding from sidewall of trial pit.
1.60	As above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

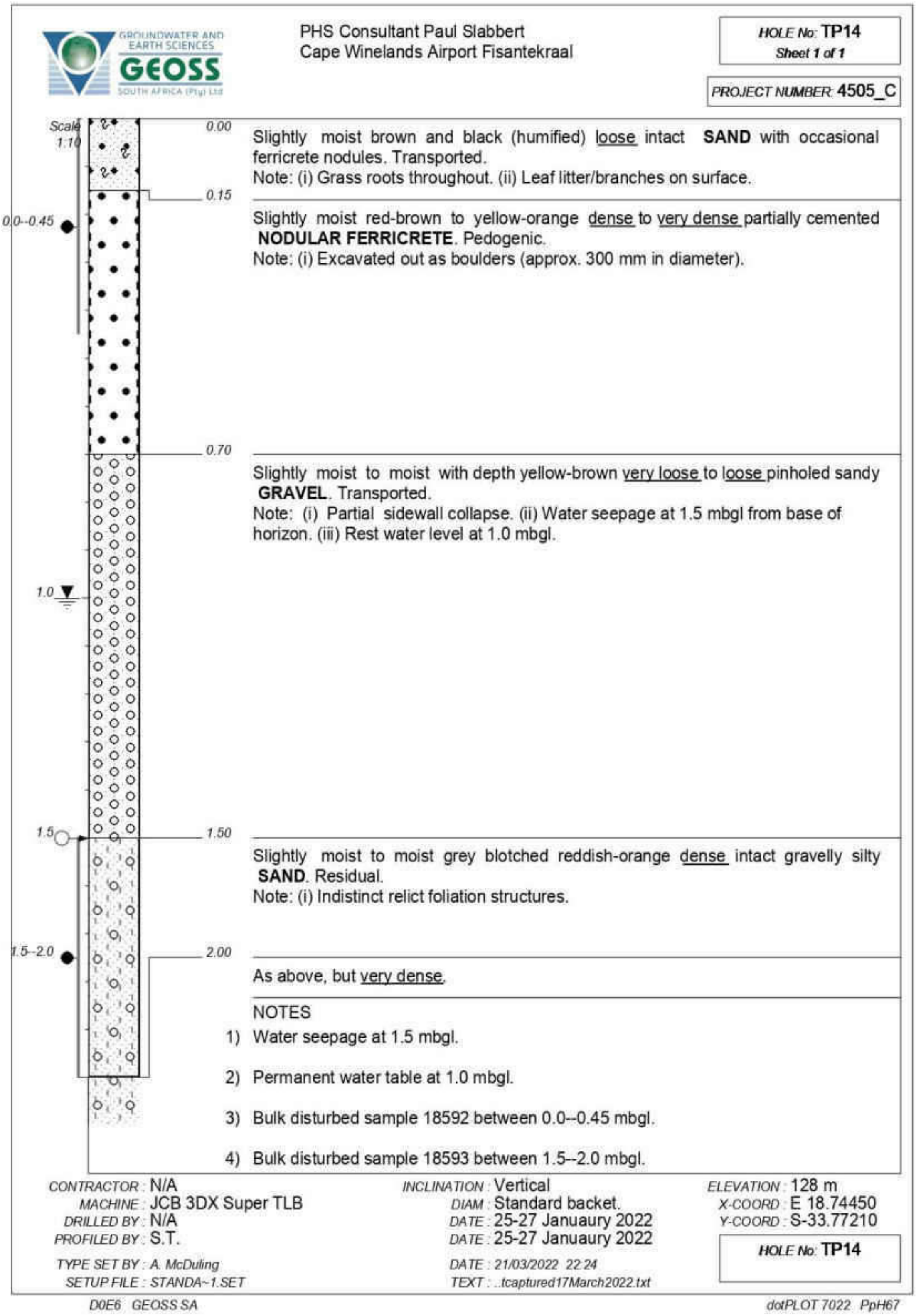
DATE : 21/03/2022 22:23
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.74840
Y-COORD : S-33.77380

HOLE No: **TP13**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP14**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

0.00	Slightly moist brown and black (humified) loose intact **SAND** with occasional ferricrete nodules. Transported. Note: (i) Grass roots throughout. (ii) Leaf litter/branches on surface.
0.15	Slightly moist red-brown to yellow-orange dense to very dense partially cemented **NODULAR FERRICRETE**. Pedogenic. Note: (i) Excavated out as boulders (approx. 300 mm in diameter).
0.70	Slightly moist to moist with depth yellow-brown very loose to loose pinholed sandy **GRAVEL**. Transported. Note: (i) Partial sidewall collapse. (ii) Water seepage at 1.5 mbgl from base of horizon. (iii) Rest water level at 1.0 mbgl.
1.50	Slightly moist to moist grey blotched reddish-orange dense intact gravelly silty **SAND**. Residual. Note: (i) Indistinct relict foliation structures.
2.00	As above, but very dense.

NOTES

1) Water seepage at 1.5 mbgl.
2) Permanent water table at 1.0 mbgl.
3) Bulk disturbed sample 18592 between 0.0--0.45 mbgl.
4) Bulk disturbed sample 18593 between 1.5--2.0 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 128 m
X-COORD : E 18.74450
Y-COORD : S-33.77210

HOLE No: **TP14**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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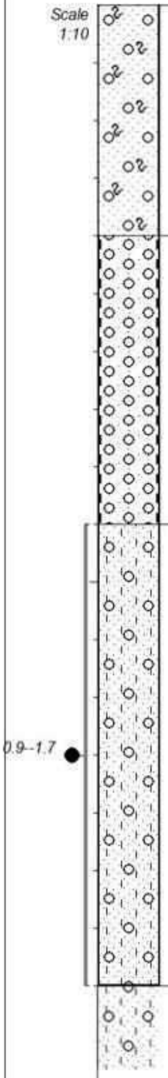
HOLE No: **TP15**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**



0.00	Slightly moist brown and black (humidified) <u>loose</u> to <u>medium dense</u> intact gravelly **SAND**. Transported. Note: (i) Roots throughout. (ii) Occasional ferricrete nodules.variation by approx. 0.3 m.
0.40	Slighly moist brown <u>medium dense</u> intact partially cemented pinholed sandy fine **GRAVEL**. Transported.
0.90	Slightly moist grey streaked red-orange <u>dense</u> to <u>very dense</u> with depth intact gravelly silty medium **SAND**. Residual. Note: (i) Prominent smear on sidewall. (ii) Minor relict foliation structures.
1.70	As above, but <u>very dense</u>.

NOTES

1) Bulk disturbed sample 18594 between 0.9--1.7 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : *A. McDuling*
SETUP FILE : *STANDA~1.SET*

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : *21/03/2022 22:24*
TEXT : *..tcaptured17March2022.txt*

ELEVATION : 117 m
X-COORD : E 18.73340
Y-COORD : S-33.76420

HOLE No: **TP15**

D0E6 GEOSS SA
dotPLOT 7022 PpH67

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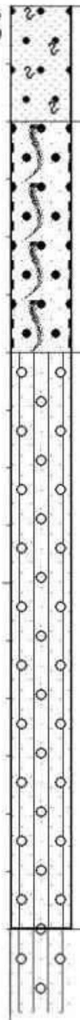
HOLE No: **TP16**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10



0.00	Slightly moist grey-brown <u>loose</u> to <u>medium dense</u> intact **SAND** with occasional ferricrete nodules. Transported. Notes: Roots throughout.
0.20	Slightly moist pockets of yellow-orange <u>dense</u> partially cemented **NODULAR FERRICRETE** in a sandy matrix similar to above. Pedogenic.
0.60	Slightly moist grey blotched red-brown-orange <u>stiff</u> intact gravelly sandy **SILT**. **Residual**. Note: (i) Smear in areas/pockets, potentially due to variation in gravel-sand-silt/clay content. (ii) Tends toward silty SAND. (iii) Quartz grains angular.
1.60	As above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 119 m
X-COORD : E 18.73520
Y-COORD : S-33.76490

HOLE No: **TP16**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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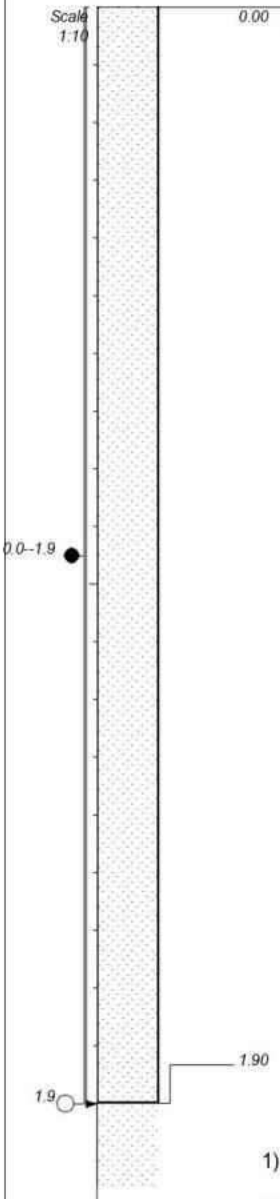
HOLE No: **TP17**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**



Slightly moist to moist with depth yellow-brown medium dense intact to slightly voided medium **SAND**. Transported.
Note: (i) Water seepage at 1.9 mbgl. (ii) Fine grass roots in upper 0.5 m. (iii) Sidewall collapse. (iv) Trial pit located in, what appeared to be in the field, a large-scale depression/localised drainage channel, see loosely defined geotechnical zone associated with this trial pit.

As above.

NOTES

1) Water seepage at 1.9 mbgl.

2) Sidewall collapse below 1.0 mbgl.

3) Bulk disturbed sample 18595 between 0.0--1.9 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

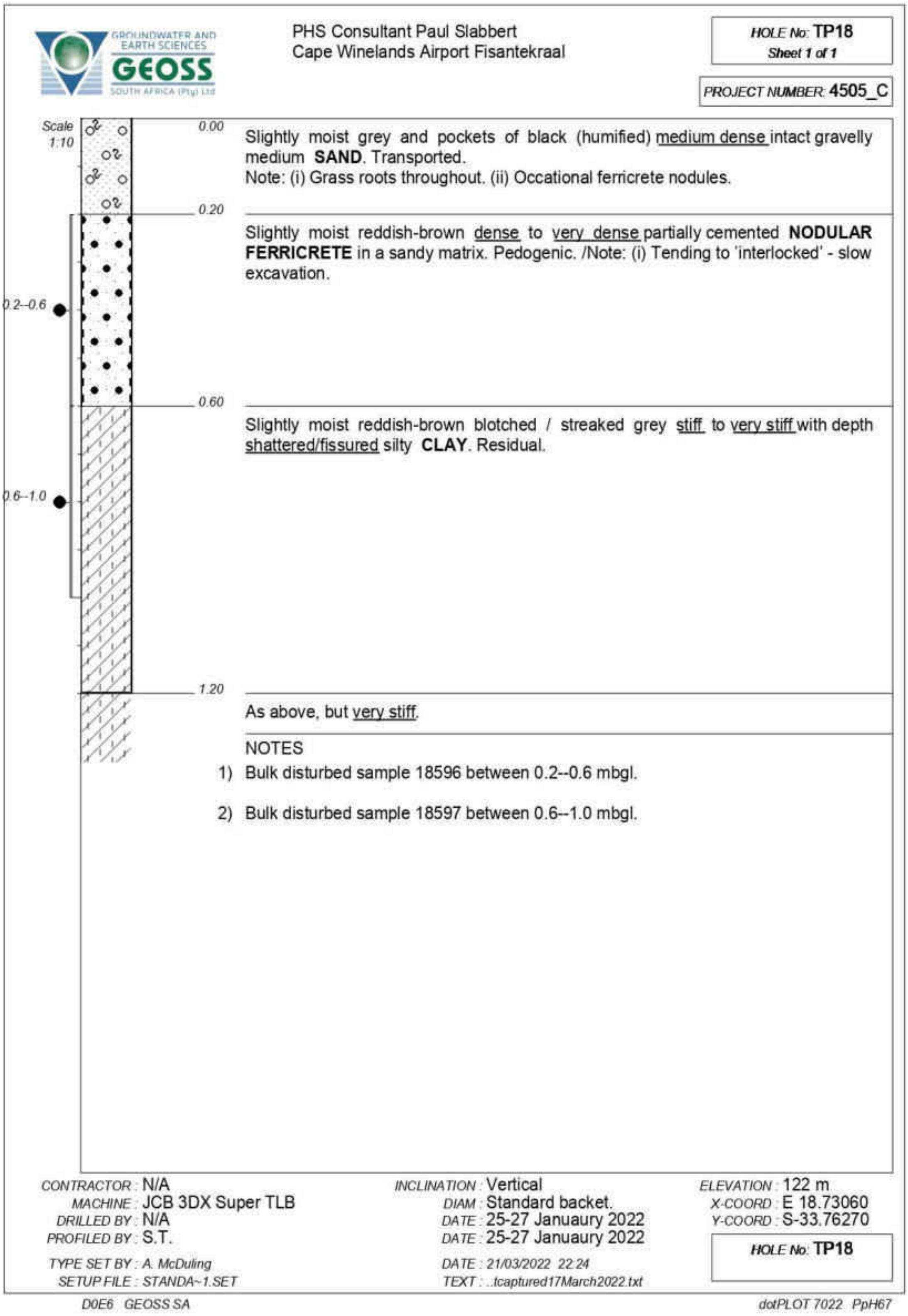
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 119 m
X-COORD : E 18.73300
Y-COORD : S-33.76640

HOLE No: **TP17**

D0E6 GEOSS SA *dotPLOT 7022 PpH67*



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HOLE No: **TP18**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

Depth	Description
0.00	Slightly moist grey and pockets of black (humified) medium dense intact gravelly medium **SAND**. Transported. Note: (i) Grass roots throughout. (ii) Occational ferricrete nodules.
0.20	Slightly moist reddish-brown dense to very dense partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic. /Note: (i) Tending to 'interlocked' - slow excavation.
0.60	Slightly moist reddish-brown blotched / streaked grey stiff to very stiff with depth shattered/fissured silty **CLAY**. Residual.
1.20	As above, but very stiff.

Samples: 0.2–0.6 ●; 0.6–1.0 ●

NOTES
1) Bulk disturbed sample 18596 between 0.2--0.6 mbgl.
2) Bulk disturbed sample 18597 between 0.6--1.0 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

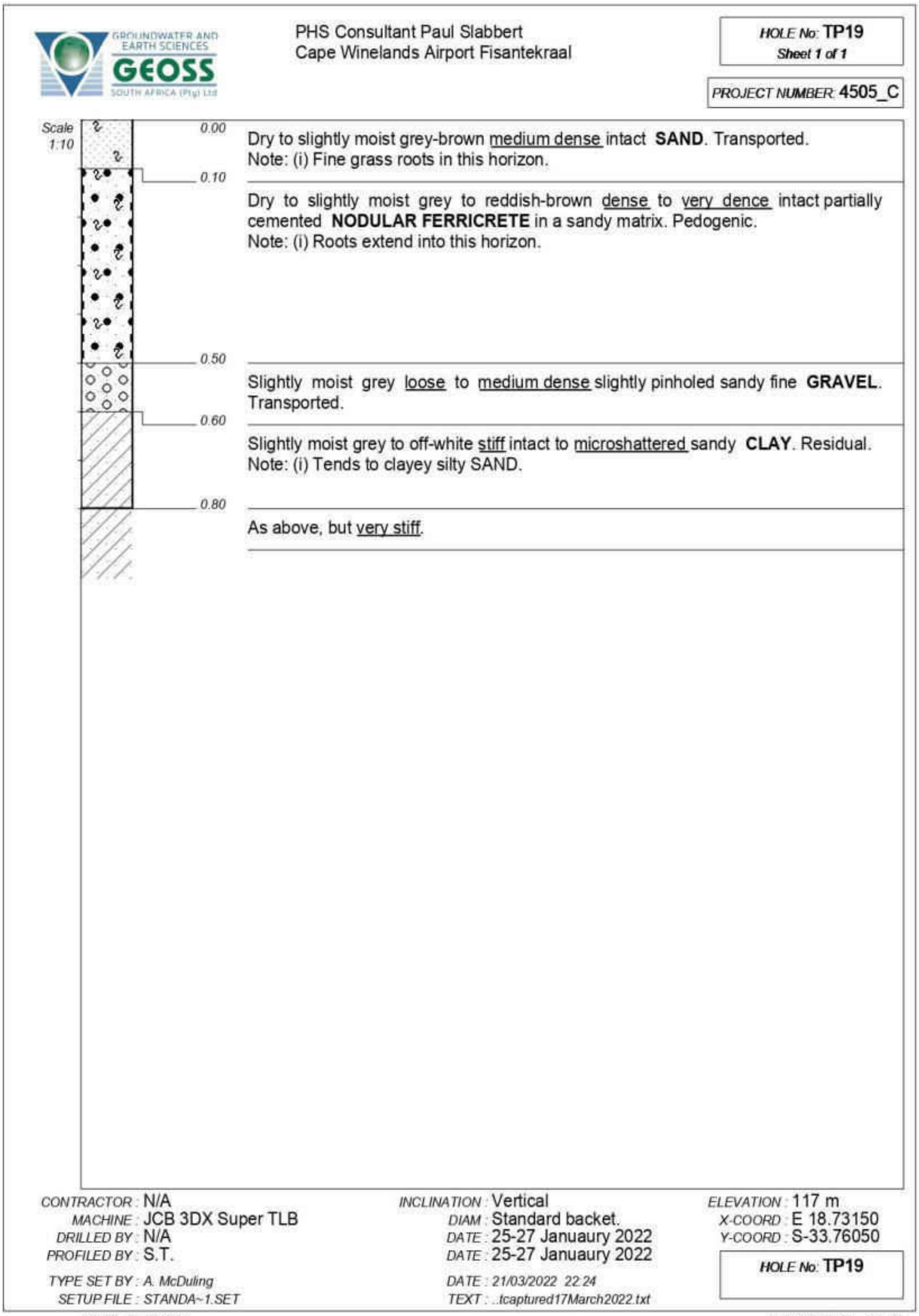
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 122 m
X-COORD : E 18.73060
Y-COORD : S-33.76270

HOLE No: **TP18**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP19**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Dry to slightly moist grey-brown <u>medium dense</u> intact **SAND**. Transported. Note: (i) Fine grass roots in this horizon.
0.10	Dry to slightly moist grey to reddish-brown <u>dense</u> to <u>very dence</u> intact partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic. Note: (i) Roots extend into this horizon.
0.50	Slightly moist grey <u>loose</u> to <u>medium dense</u> slightly pinholed sandy fine **GRAVEL**. Transported.
0.60	Slightly moist grey to off-white <u>stiff</u> intact to <u>microshattered</u> sandy **CLAY**. Residual. Note: (i) Tends to clayey silty SAND.
0.80	As above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

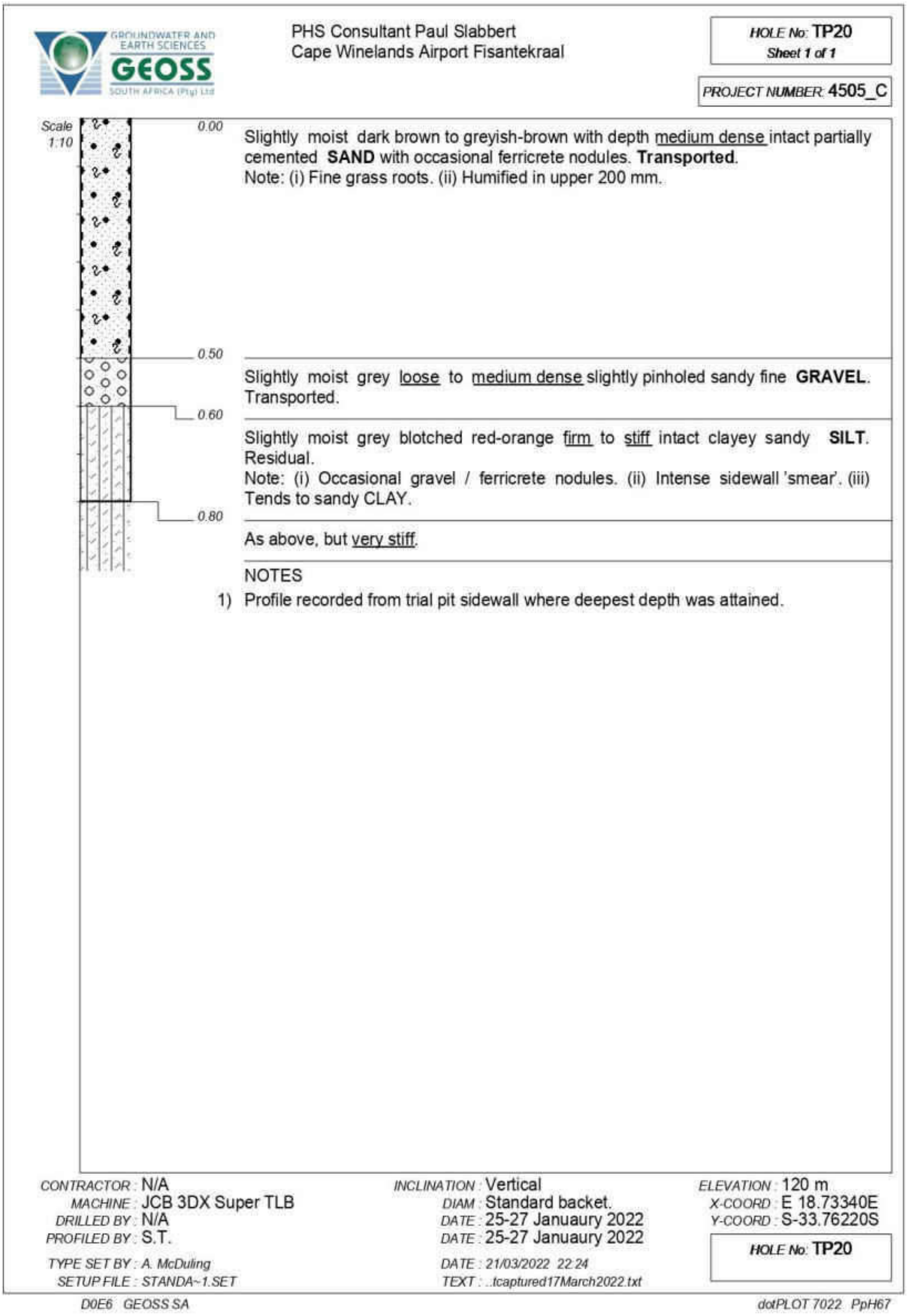
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 117 m
X-COORD : E 18.73150
Y-COORD : S-33.76050

HOLE No: **TP19**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP20**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10

0.00	Slightly moist dark brown to greyish-brown with depth <u>medium dense</u> intact partially cemented **SAND** with occasional ferricrete nodules. **Transported**. Note: (i) Fine grass roots. (ii) Humified in upper 200 mm.
0.50	Slightly moist grey <u>loose</u> to <u>medium dense</u> slightly pinholed sandy fine **GRAVEL**. Transported.
0.60	Slightly moist grey blotched red-orange <u>firm</u> to <u>stiff</u> intact clayey sandy **SILT**. Residual. Note: (i) Occasional gravel / ferricrete nodules. (ii) Intense sidewall 'smear'. (iii) Tends to sandy CLAY.
0.80	As above, but <u>very stiff</u>.

NOTES

1) Profile recorded from trial pit sidewall where deepest depth was attained.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 120 m
X-COORD : E 18.73340E
Y-COORD : S-33.76220S

HOLE No: **TP20**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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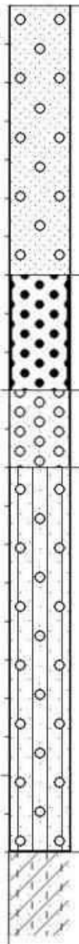
HOLE No: **TP21**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:15



0.00	Slightly moist grey-brown to off-white with depth <u>medium dense</u> slightly pinholed fine gravelly medium and coarse **SAND**. Transported.
0.70	Slightly moist yellow-orange and red-brown <u>very dense</u> partially cemented **NODULAR** to **HARDPAN FERRICRETE**. Pedogenic. Note: (i) Excavates out in boulders. (ii) Tends to 'interlocked' HARDPAN, but laterally discontinuous.
1.00	Slightly moist grey-brown <u>medium dense</u> pinholed sandy fine **GRAVEL**. Transported. Note: (i) Occasional ferricrete nodules.
1.20	Slightly moist orange-brown (khaki) blotched red-brown and grey <u>stiff shattered/fissured</u> gravelly sandy **SILT**. Residual. Note: (i) Sidewall 'smear' more evident with depth, indicative of increased fines with depth/near base of trial pit. (ii) Tending toward sandy CLAY.
2.20	As above, but <u>very stiff</u> slightly sandy silty **CLAY**.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

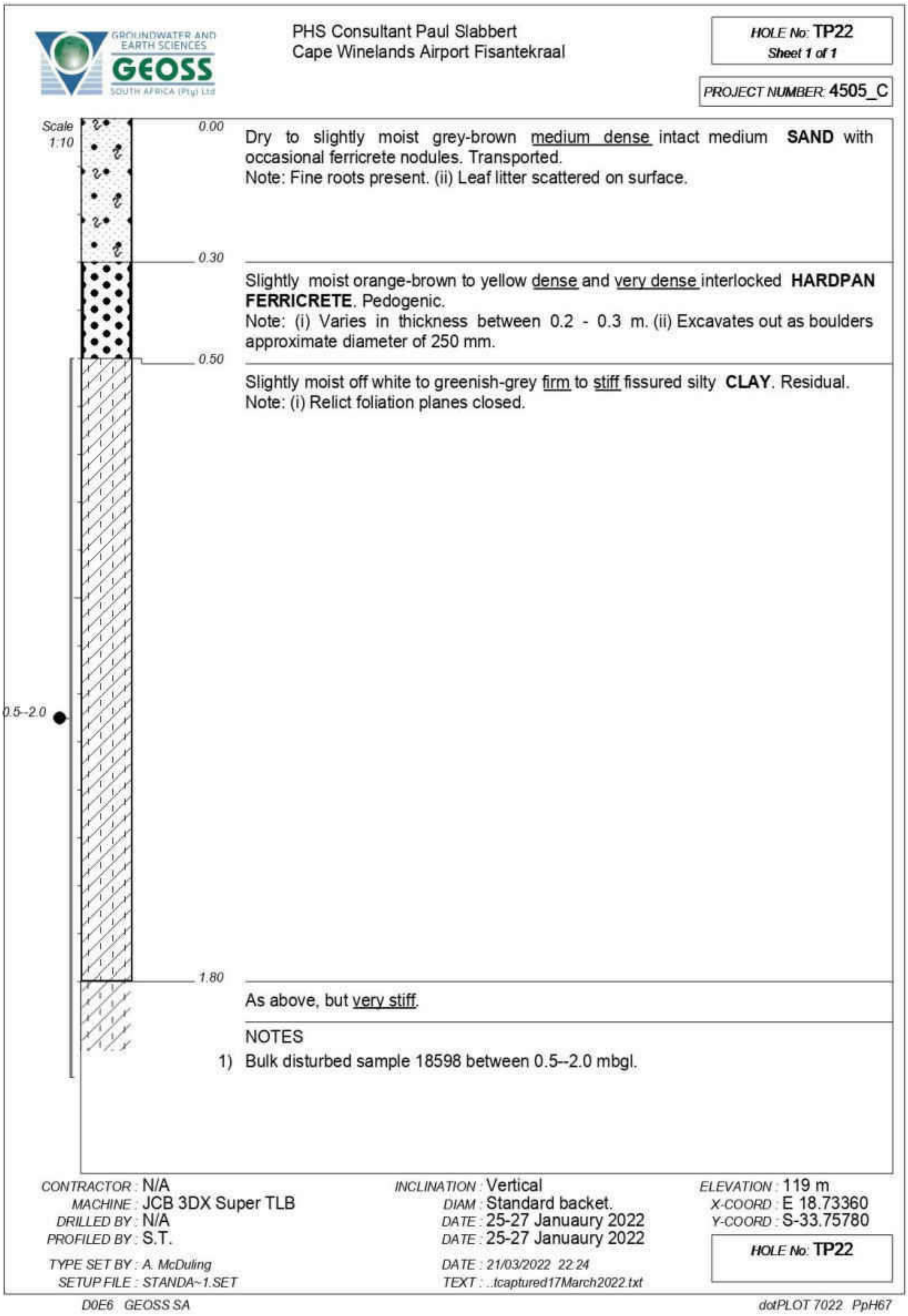
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 119 m
X-COORD : E 18.73490
Y-COORD : S-33.76000

HOLE No: **TP21**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP22**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Dry to slightly moist grey-brown <u>medium dense</u> intact medium **SAND** with occasional ferricrete nodules. Transported. Note: Fine roots present. (ii) Leaf litter scattered on surface.
0.30	Slightly moist orange-brown to yellow <u>dense</u> and <u>very dense</u> interlocked **HARDPAN FERRICRETE**. Pedogenic. Note: (i) Varies in thickness between 0.2 - 0.3 m. (ii) Excavates out as boulders approximate diameter of 250 mm.
0.50	Slightly moist off white to greenish-grey <u>firm</u> to <u>stiff</u> fissured silty **CLAY**. Residual. Note: (i) Relict foliation planes closed.
1.80	As above, but <u>very stiff</u>.

0.5--2.0 ●

NOTES

1) Bulk disturbed sample 18598 between 0.5--2.0 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

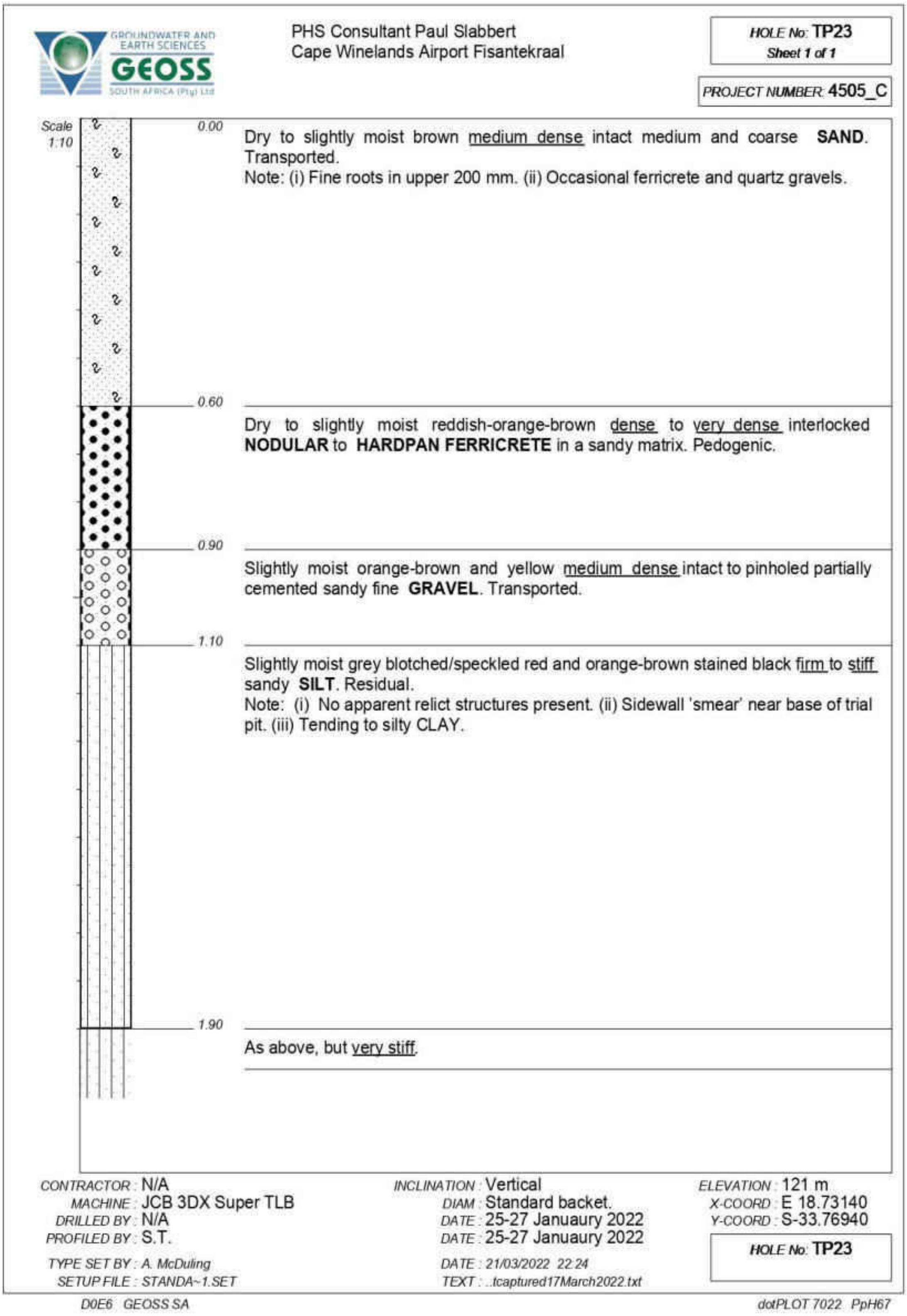
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 119 m
X-COORD : E 18.73360
Y-COORD : S-33.75780

HOLE No: **TP22**

D0E6 GEOSS SA
dotPLOT 7022 PpH67



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HOLE No: **TP23**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10

0.00	Dry to slightly moist brown <u>medium dense</u> intact medium and coarse **SAND**. Transported. Note: (i) Fine roots in upper 200 mm. (ii) Occasional ferricrete and quartz gravels.
0.60	Dry to slightly moist reddish-orange-brown <u>dense</u> to <u>very dense</u> interlocked **NODULAR** to **HARDPAN FERRICRETE** in a sandy matrix. Pedogenic.
0.90	Slightly moist orange-brown and yellow <u>medium dense</u> intact to pinholed partially cemented sandy fine **GRAVEL**. Transported.
1.10	Slightly moist grey blotched/speckled red and orange-brown stained black <u>firm</u> to <u>stiff</u> sandy **SILT**. Residual. Note: (i) No apparent relict structures present. (ii) Sidewall 'smear' near base of trial pit. (iii) Tending to silty CLAY.
1.90	As above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

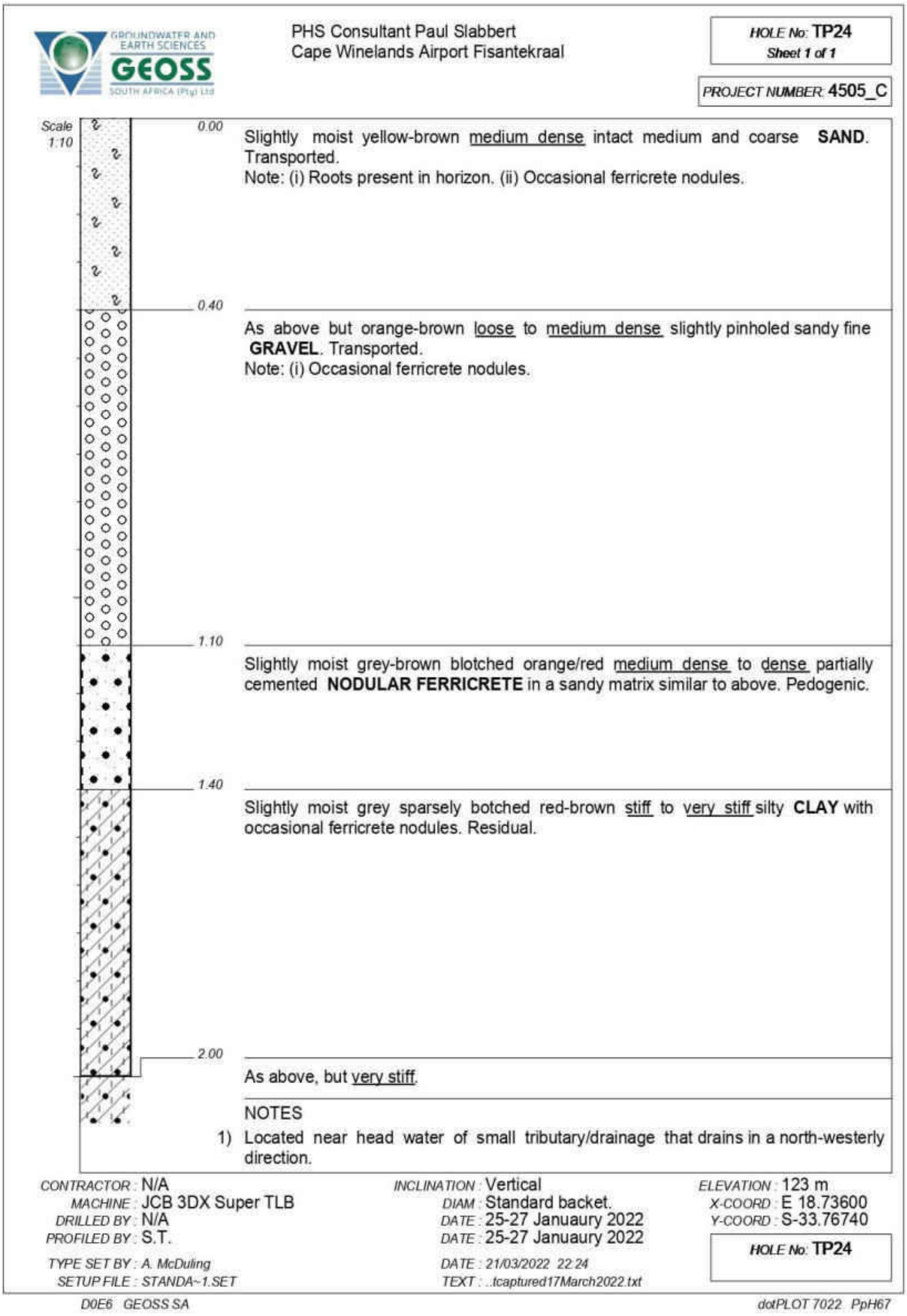
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 121 m
X-COORD : E 18.73140
Y-COORD : S-33.76940

HOLE No: **TP23**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP24**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

Depth	Description
0.00	Slightly moist yellow-brown <u>medium dense</u> intact medium and coarse **SAND**. Transported. Note: (i) Roots present in horizon. (ii) Occasional ferricrete nodules.
0.40	As above but orange-brown <u>loose</u> to <u>medium dense</u> slightly pinholed sandy fine **GRAVEL**. Transported. Note: (i) Occasional ferricrete nodules.
1.10	Slightly moist grey-brown blotched orange/red <u>medium dense</u> to <u>dense</u> partially cemented **NODULAR FERRICRETE** in a sandy matrix similar to above. Pedogenic.
1.40	Slightly moist grey sparsely botched red-brown <u>stiff</u> to <u>very stiff</u> silty **CLAY** with occasional ferricrete nodules. Residual.
2.00	As above, but <u>very stiff</u>.

NOTES

1) Located near head water of small tributary/drainage that drains in a north-westerly direction.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

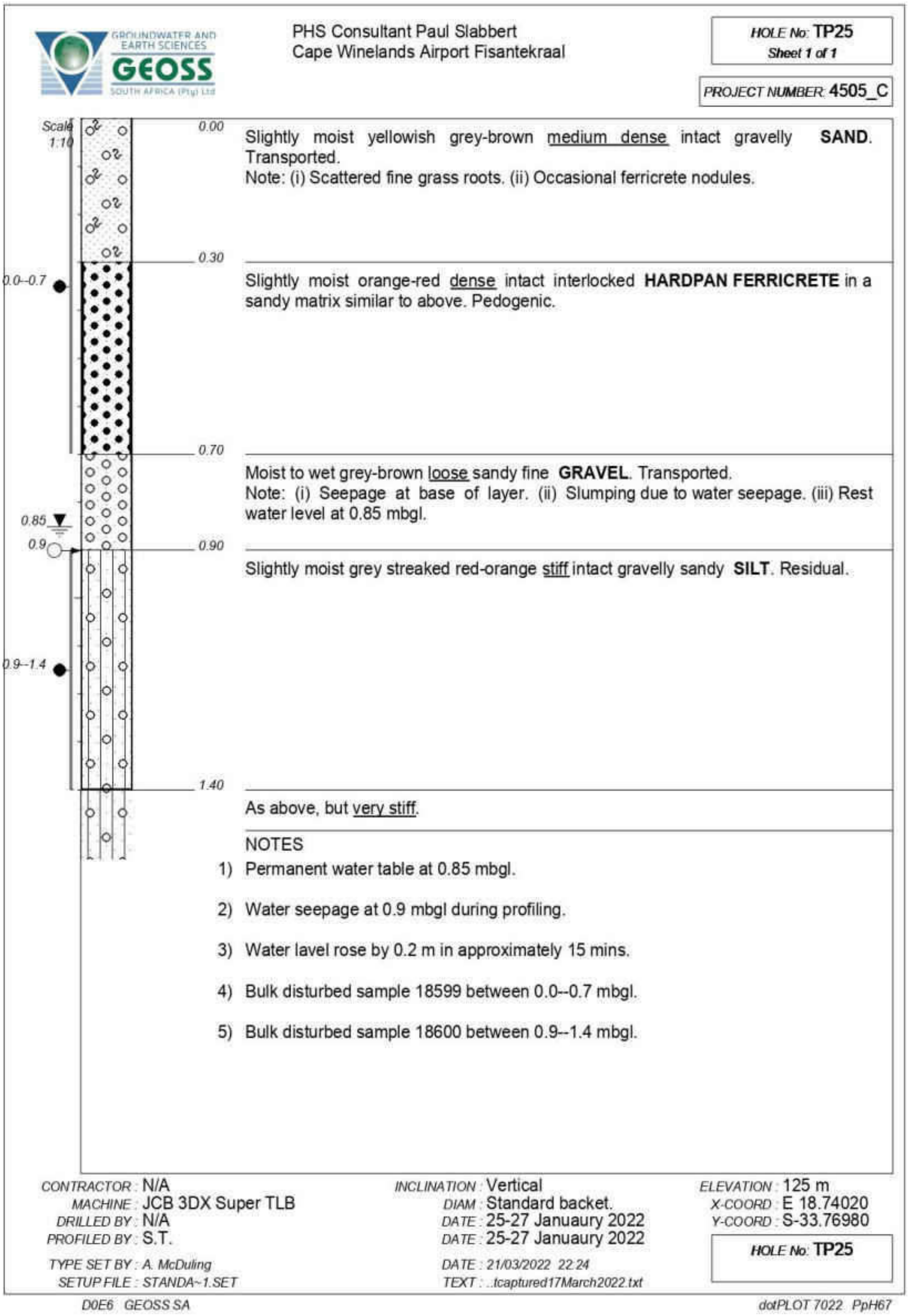
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 123 m
X-COORD : E 18.73600
Y-COORD : S-33.76740

HOLE No: **TP24**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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Cape Winelands Airport Fisantekraal

HOLE No: **TP25**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Depth	Description
0.00	Slightly moist yellowish grey-brown <u>medium dense</u> intact gravelly **SAND**. Transported. Note: (i) Scattered fine grass roots. (ii) Occasional ferricrete nodules.
0.30	Slightly moist orange-red <u>dense</u> intact interlocked **HARDPAN FERRICRETE** in a sandy matrix similar to above. Pedogenic.
0.70	Moist to wet grey-brown <u>loose</u> sandy fine **GRAVEL**. Transported. Note: (i) Seepage at base of layer. (ii) Slumping due to water seepage. (iii) Rest water level at 0.85 mbgl.
0.90	Slightly moist grey streaked red-orange <u>stiff</u> intact gravelly sandy **SILT**. Residual.
1.40	As above, but <u>very stiff</u>.

NOTES

1) Permanent water table at 0.85 mbgl.
2) Water seepage at 0.9 mbgl during profiling.
3) Water lavel rose by 0.2 m in approximately 15 mins.
4) Bulk disturbed sample 18599 between 0.0--0.7 mbgl.
5) Bulk disturbed sample 18600 between 0.9--1.4 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Janauary 2022
DATE : 25-27 Janauary 2022

DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 125 m
X-COORD : E 18.74020
Y-COORD : S-33.76980

HOLE No: **TP25**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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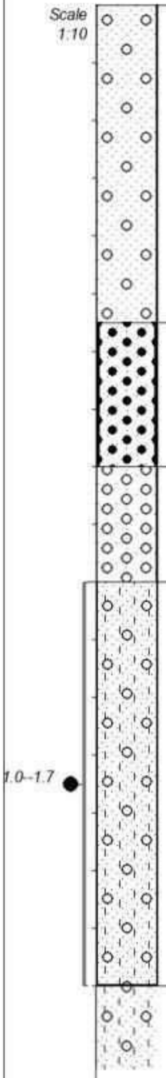
Cape Winelands Airport Fisantekraal

HOLE No: **TP26**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**



0.00	Slightly moist grey-brown to white and yellow loose to medium dense with depth intact gravelly medium **SAND**. Transported. Note: (i) Humified in places. (ii) Occasional ferricrete nodules.
0.55	Slightly moist yellow dense interlocked **HARDPAN FERRICRETE** in a sandy matrix. Pedogenic. Note: (i) Ferricrete nodules approx. diameter of 20 mm.
0.80	Slightly moist yellow medium dense slightly pinholed sandy fine **GRAVEL**. Transported.
1.00	Slightly moist grey with streaked orange-red stiff intact gravelly silty **SAND**. Residual.
1.70	As above, but very stiff.

NOTES

1) Bulk disturbed sample 18601 between 1.0--1.7 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

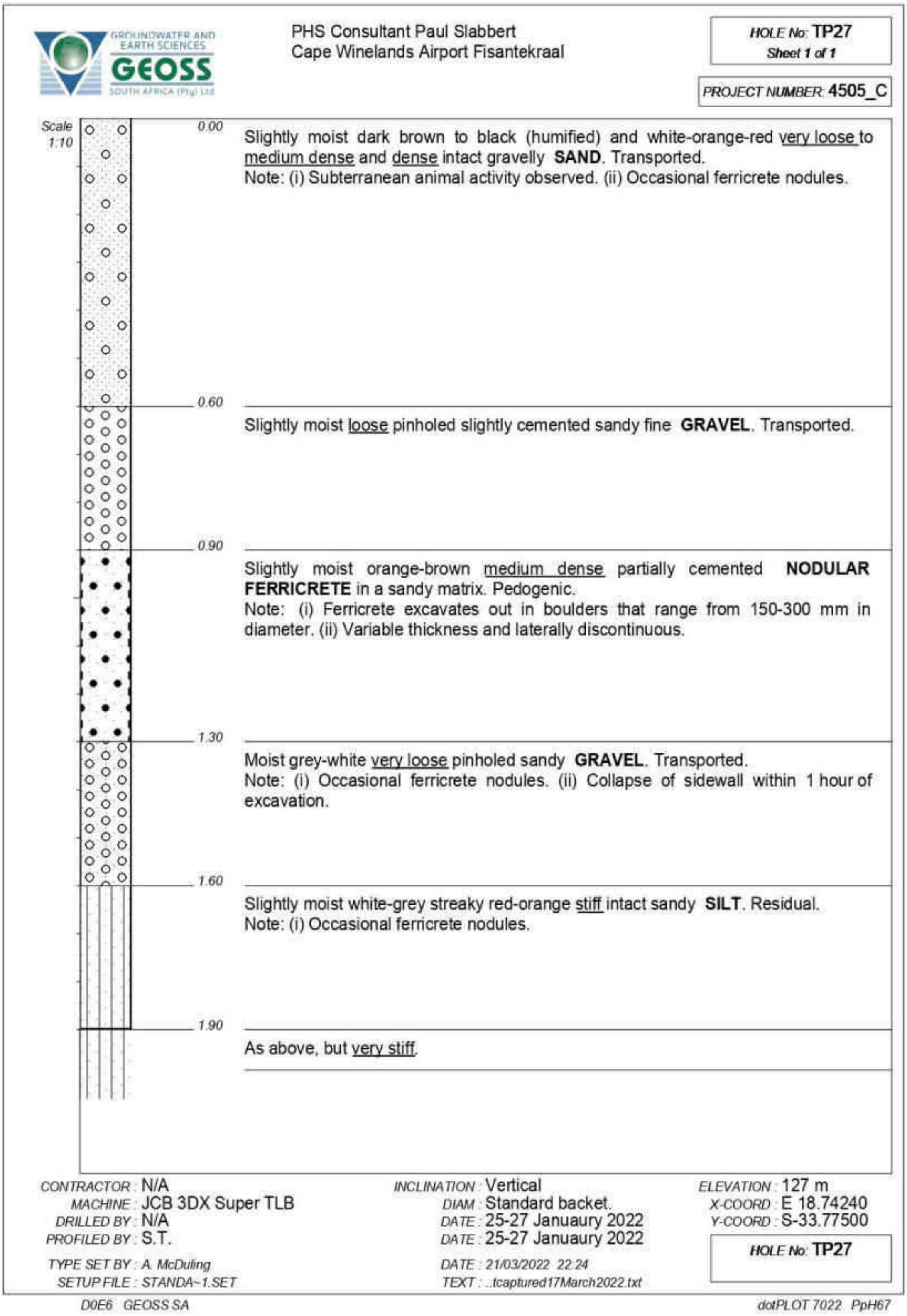
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 128 m
X-COORD : E 18.73940
Y-COORD : S-33.77570

HOLE No: **TP26**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP27**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist dark brown to black (humified) and white-orange-red <u>very loose</u> to <u>medium dense</u> and <u>dense</u> intact gravelly **SAND**. Transported. Note: (i) Subterranean animal activity observed. (ii) Occasional ferricrete nodules.
0.60	Slightly moist <u>loose</u> pinholed slightly cemented sandy fine **GRAVEL**. Transported.
0.90	Slightly moist orange-brown <u>medium dense</u> partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic. Note: (i) Ferricrete excavates out in boulders that range from 150-300 mm in diameter. (ii) Variable thickness and laterally discontinuous.
1.30	Moist grey-white <u>very loose</u> pinholed sandy **GRAVEL**. Transported. Note: (i) Occasional ferricrete nodules. (ii) Collapse of sidewall within 1 hour of excavation.
1.60	Slightly moist white-grey streaky red-orange <u>stiff</u> intact sandy **SILT**. Residual. Note: (i) Occasional ferricrete nodules.
1.90	As above, but <u>very stiff</u>.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

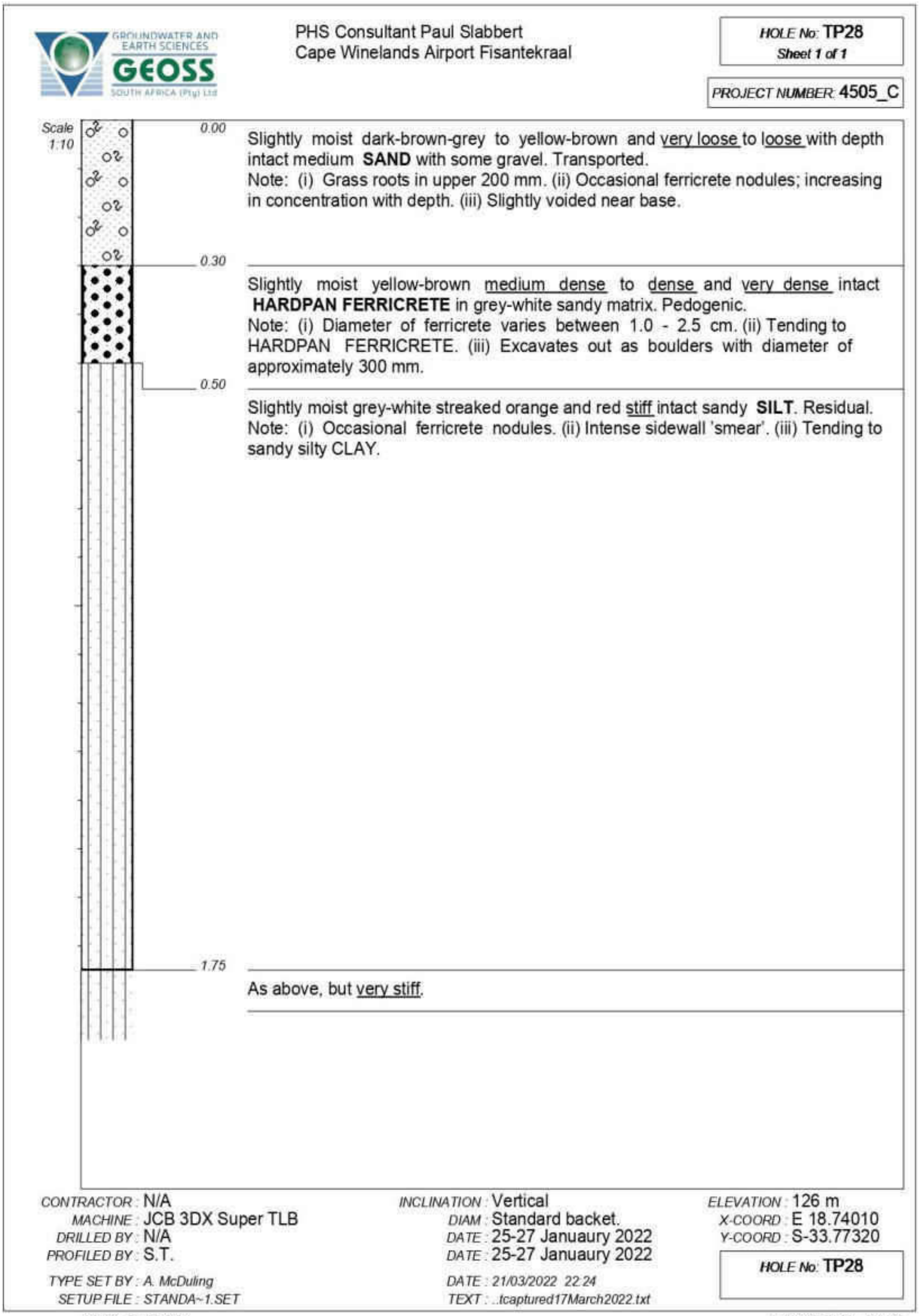
INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 127 m
X-COORD : E 18.74240
Y-COORD : S-33.77500

HOLE No: **TP27**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP28**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale 1:10

0.00	Slightly moist dark-brown-grey to yellow-brown and very loose to loose with depth intact medium **SAND** with some gravel. Transported. Note: (i) Grass roots in upper 200 mm. (ii) Occasional ferricrete nodules; increasing in concentration with depth. (iii) Slightly voided near base.
0.30	Slightly moist yellow-brown medium dense to dense and very dense intact **HARDPAN FERRICRETE** in grey-white sandy matrix. Pedogenic. Note: (i) Diameter of ferricrete varies between 1.0 - 2.5 cm. (ii) Tending to HARDPAN FERRICRETE. (iii) Excavates out as boulders with diameter of approximately 300 mm.
0.50	Slightly moist grey-white streaked orange and red stiff intact sandy **SILT**. Residual. Note: (i) Occasional ferricrete nodules. (ii) Intense sidewall 'smear'. (iii) Tending to sandy silty CLAY.
1.75	As above, but very stiff.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.74010
Y-COORD : S-33.77320

HOLE No: **TP28**

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dotPLOT 7022 PpH67

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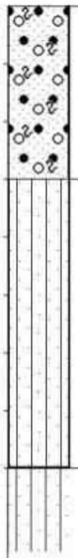
HOLE No: **TP29**
Sheet 1 of 1

PROJECT NUMBER: **4505_C**

Scale
1:10



0.00	Slightly moist dark-brown / black (humic) to grey with depth <u>very loose</u> intact gravelly medium and coarse **SAND**. Transported. Note: (i) Grass roots provide stabilisation. (ii) Humified in places. (iii) Occasional ferricrete nodules; diameter of ferricrete varies from 10 to 15 mm, and up to 25 cm, where more interlocked/indurated/cemented.
0.30	Slightly moist grey with streaks of yellow and red <u>very stiff</u> intact sandy **SILT**. Residual. Note: (i) Tending to silty CLAY.
0.80	As above, but <u>extremely stiff</u>.

NOTES

1) Excavation with TLB particularly time consuming; difficult excavation.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

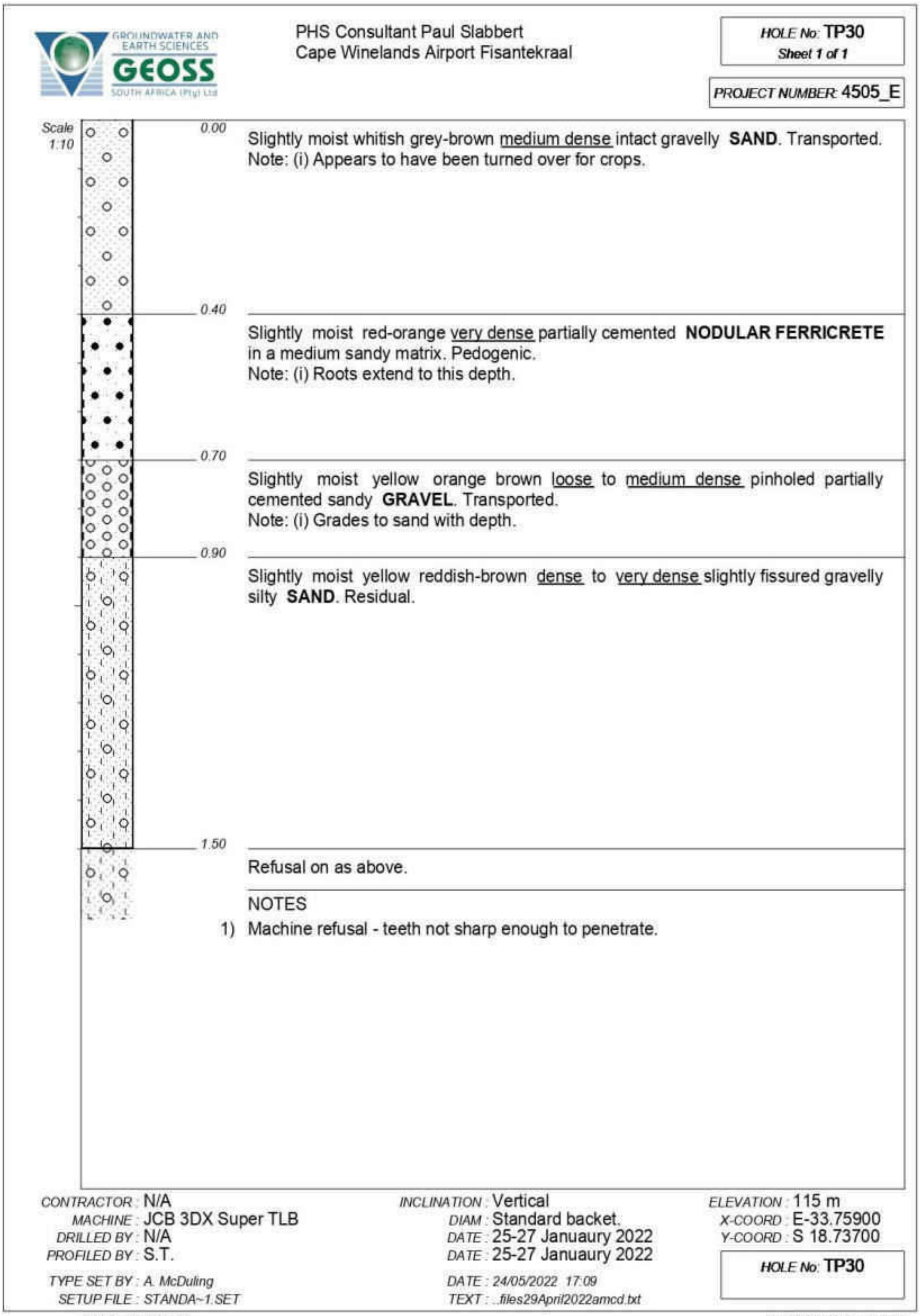
DATE : 21/03/2022 22:24
TEXT : ..tcaptured17March2022.txt

ELEVATION : 126 m
X-COORD : E 18.73880
Y-COORD : S-33.77490

HOLE No: **TP29**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP30**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10

0.00	Slightly moist whitish grey-brown medium dense intact gravelly **SAND**. Transported. Note: (i) Appears to have been turned over for crops.
0.40	Slightly moist red-orange very dense partially cemented **NODULAR FERRICRETE** in a medium sandy matrix. Pedogenic. Note: (i) Roots extend to this depth.
0.70	Slightly moist yellow orange brown loose to medium dense pinholed partially cemented sandy **GRAVEL**. Transported. Note: (i) Grades to sand with depth.
0.90	Slightly moist yellow reddish-brown dense to very dense slightly fissured gravelly silty **SAND**. Residual.
1.50	Refusal on as above.

NOTES

1) Machine refusal - teeth not sharp enough to penetrate.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 115 m
X-COORD : E-33.75900
Y-COORD : S 18.73700

HOLE No: **TP30**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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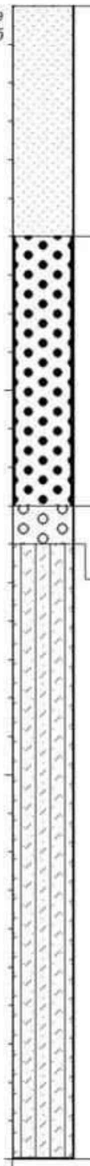
HOLE No: **TP31**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:15



0.00

Slightly moist yellow-brown loose to medium dense intact fine **SAND**. Tranported.
Note: (i) Slight sidewall collapse during excavation.

0.60

Slightly moist red-orange-brown very dense indurated **HARDPAN FERRICRETE**. Pendogenic.
Note: (i) Some difficulty during excavation.

1.30

Slightly moist yellow-brown loose pinholed fine **GRAVEL**. Transported.
Note: (i) Poorly developed.

1.40

Slightly moist white blotched red and ornage with stains of same colour medium dense to dense slightly fissured sandy clayey **SILT**. Residual.
Note: (i) logged from spoil.

3.00

NOTES

1) Similar to residual martial encountered in TP22.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 113 m
X-COORD : E -33.75640
Y-COORD : S 18.73790

HOLE No: **TP31**

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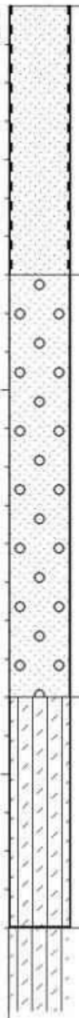
HOLE No: **TP32**
Sheet 1 of 1

PROJECT NUMBER: **4505_E**

Scale
1:15



0.00

Dry to very slightly moist grey dense pinholed and partially cemented fine **SAND** with bioturbations (up to 8 mm in diameter). Transported / topsoil.
Note: (i) Turned over by farmer. (ii) Contains some occasional ferricrete gravels.

0.70

Slightly moist yellow-brown dense to very dense slightly fissured fine **SAND** with occasional gravel. Residual.
Note: (i) Seems like a poorly developed pedogenic horizon is present near surface.

1.80

Slightly moist grey speckled yellow & orange & red firm to stiff fissured clayey **SILT**. Resudual.
Note: (i) Feels soapy. (ii) Intense sidewall smear. (iii) Relict joint structure.

2.40

Refusal in as above.

NOTES

1) Excavation slow.

CONTRACTOR :	N/A	*INCLINATION :*	Vertical	*ELEVATION :*	112 m
MACHINE :	JCB 3DX Super TLB	*DIAM :*	Standard backet.	*X-COORD :*	E -33.75490
DRILLED BY :	N/A	*DATE :*	25-27 Januaury 2022	*Y-COORD :*	S 18.73560
PROFILED BY :	S.T.	*DATE :*	25-27 Januaury 2022		
TYPE SET BY :	*A. McDuling*	*DATE :*	*24/05/2022 17:09*	*HOLE No:*	**TP32**
SETUP FILE :	*STANDA~1.SET*	*TEXT :*	*..files29April2022amcd.txt*		

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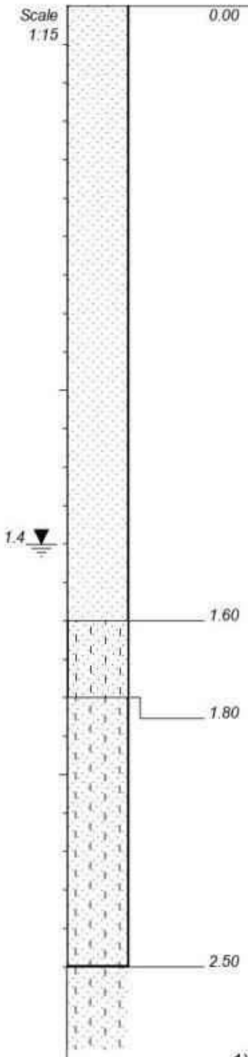
HOLE No: **TP33**
Sheet 1 of 1

PROJECT NUMBER: 4505_E



Slightly moist to wet with depth grey-brown loose to medium dense pinholed fine **SAND**. Transported.
Note: (i) Roots.

Slightly moist to moist grey-brown medium dense intact to slightly fissured silty **SAND**. Residual.
Note: (i) Appears exhibit plasticity.

As above, but predominantly orange blotched red and dense, but variable in consistency.
Notes: (i) Water seepage at 1.4mbgl.

Excavated ended in as above.

NOTES

1) Water table at 1.4 mbgl.

2) Sidewall collapse.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 103 m
X-COORD : E -33.75270
Y-COORD : S 18.73750

HOLE No: **TP33**

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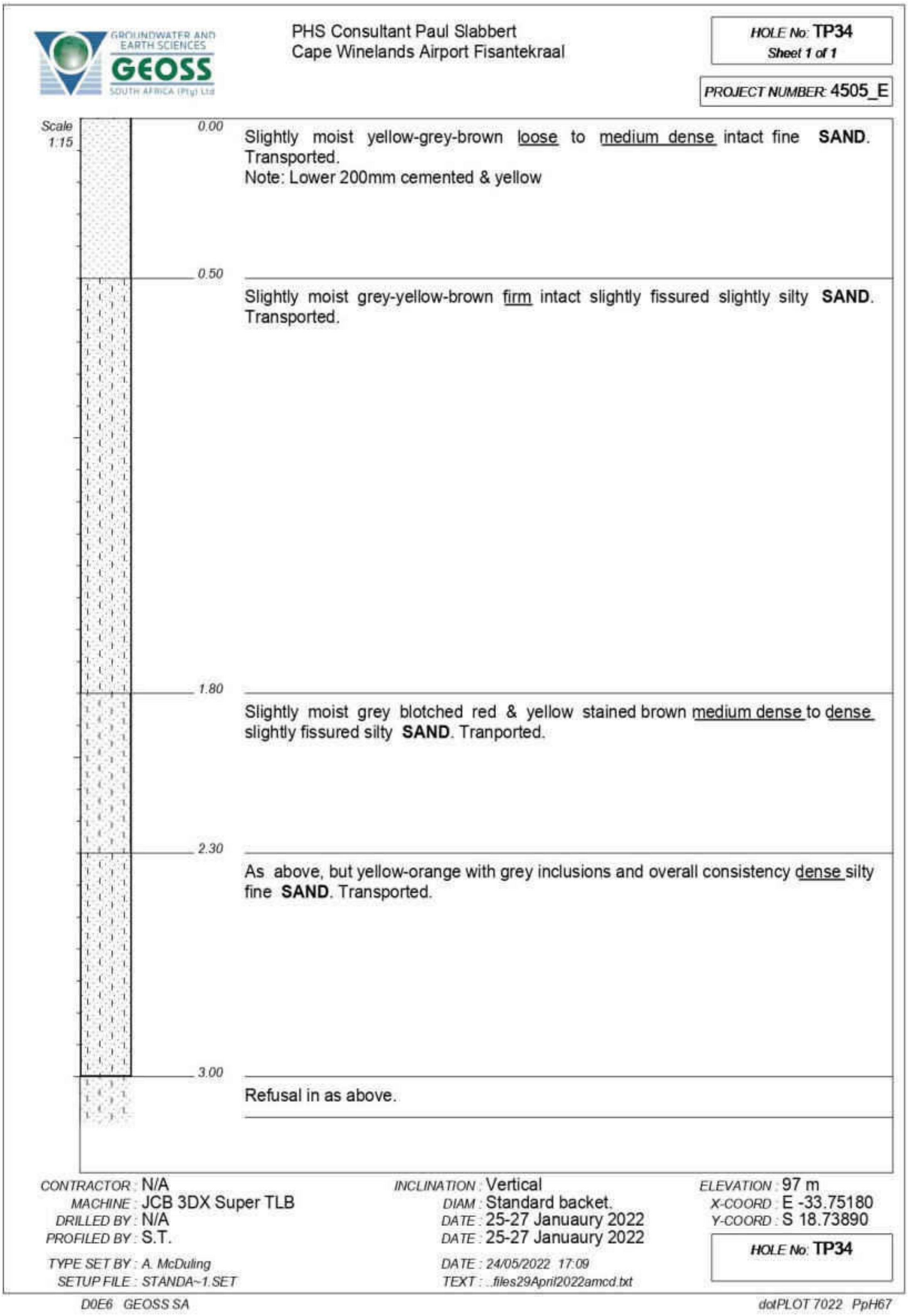
dotPLOT 7022 PpH67



GROUNDWATER AND EARTH SCIENCES
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HOLE No: **TP34**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:15

0.00	Slightly moist yellow-grey-brown loose to medium dense intact fine **SAND**. Transported. Note: Lower 200mm cemented & yellow
0.50	Slightly moist grey-yellow-brown firm intact slightly fissured slightly silty **SAND**. Transported.
1.80	Slightly moist grey blotched red & yellow stained brown medium dense to dense slightly fissured silty **SAND**. Tranported.
2.30	As above, but yellow-orange with grey inclusions and overall consistency dense silty fine **SAND**. Transported.
3.00	Refusal in as above.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 97 m
X-COORD : E -33.75180
Y-COORD : S 18.73890

HOLE No: **TP34**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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HOLE No: **TP35**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10

0.00	Slightly moist yellow-brown medium dense intact fine & coarse **SAND**. Transported.
0.20	Matrix as above, but contains partially cemented abundant fine ferricrete gravel grading to **NODULAR FERRICRETE**. Pedogenic. Note: (i) Ferricrete concentration increases with depth.
0.70	Dry to slightly moist red-orange-brown dense intact fissured slightly silty **SAND**. Residual.
1.60	Refusal on as above, but grey with orange blotching.

NOTES

1) Deeper penetration expected in unrestricted excavation.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

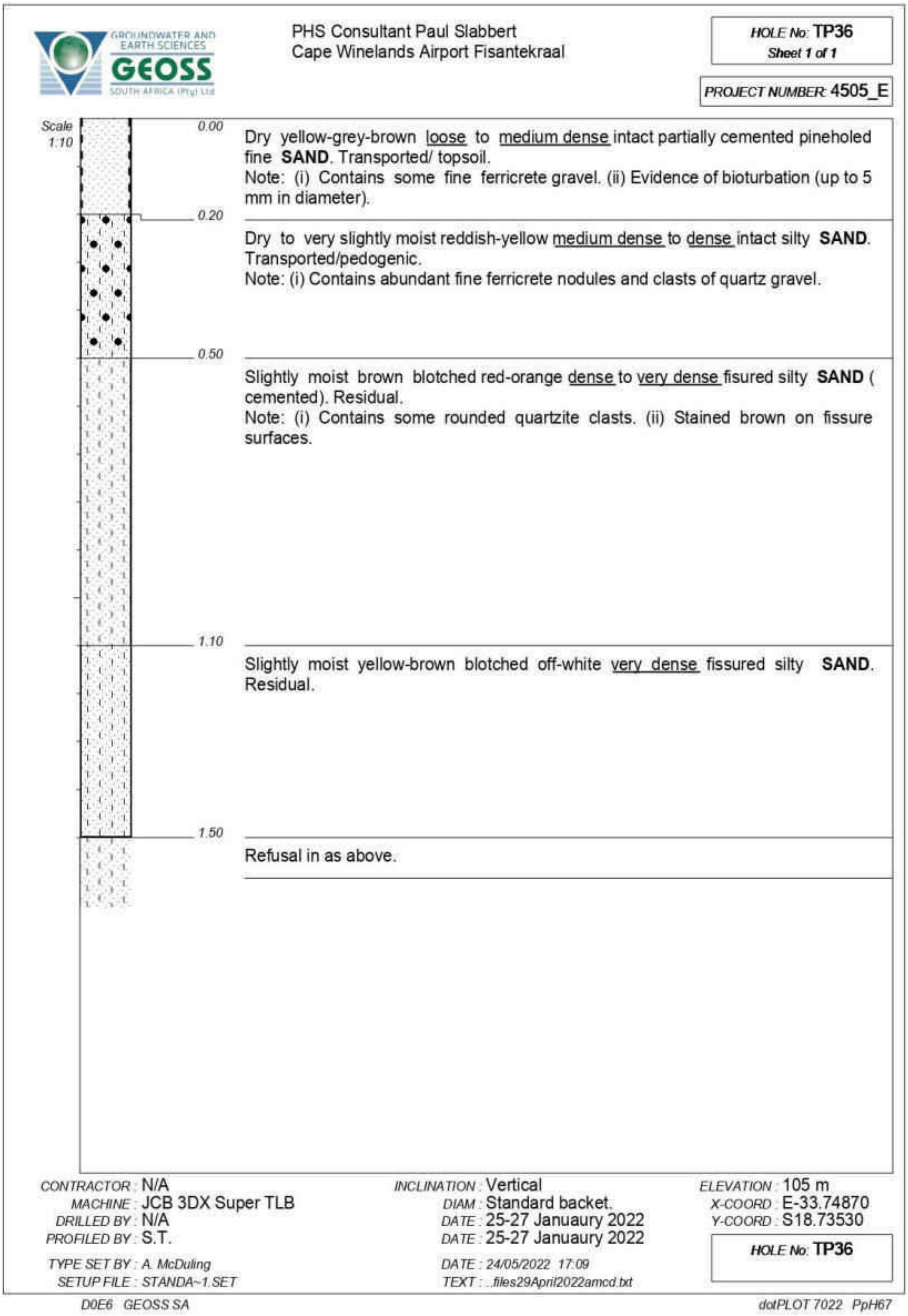
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 94 m
X-COORD : E-33.74930
Y-COORD : S 18.73870

HOLE No: **TP35**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP36**
Sheet 1 of 1

PROJECT NUMBER: **4505_E**

Scale 1:10

0.00	Dry yellow-grey-brown loose to medium dense intact partially cemented pineholed fine **SAND**. Transported/ topsoil. Note: (i) Contains some fine ferricrete gravel. (ii) Evidence of bioturbation (up to 5 mm in diameter).
0.20	Dry to very slightly moist reddish-yellow medium dense to dense intact silty **SAND**. Transported/pedogenic. Note: (i) Contains abundant fine ferricrete nodules and clasts of quartz gravel.
0.50	Slightly moist brown blotched red-orange dense to very dense fisured silty **SAND** (cemented). Residual. Note: (i) Contains some rounded quartzite clasts. (ii) Stained brown on fissure surfaces.
1.10	Slightly moist yellow-brown blotched off-white very dense fissured silty **SAND**. Residual.
1.50	Refusal in as above.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

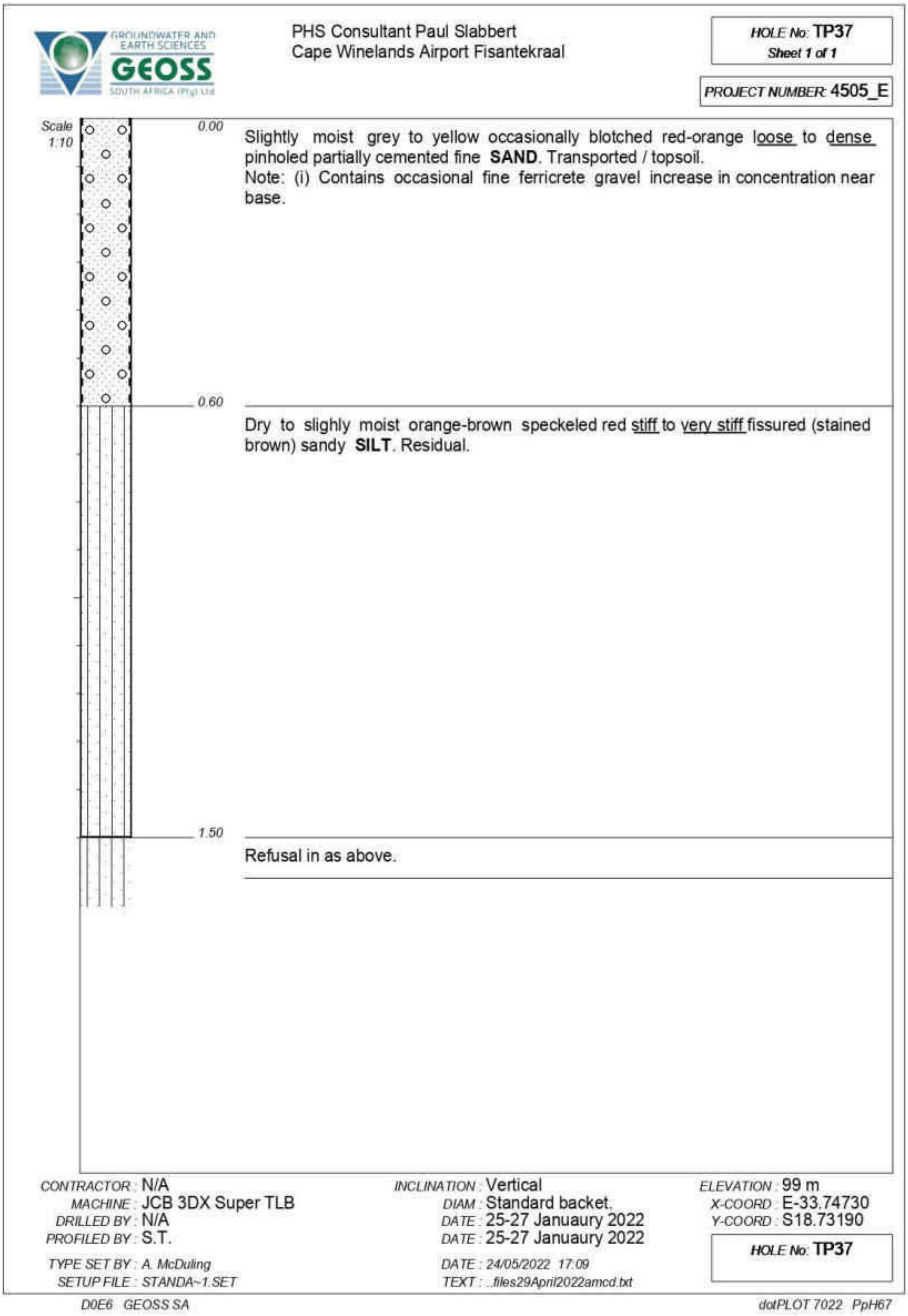
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 105 m
X-COORD : E-33.74870
Y-COORD : S18.73530

HOLE No: **TP36**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP37**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10

Depth	Description
0.00	Slightly moist grey to yellow occasionally blotched red-orange loose to dense pinholed partially cemented fine **SAND**. Transported / topsoil. Note: (i) Contains occasional fine ferricrete gravel increase in concentration near base.
0.60	Dry to slighly moist orange-brown speckeled red stiff to very stiff fissured (stained brown) sandy **SILT**. Residual.
1.50	Refusal in as above.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 99 m
X-COORD : E-33.74730
Y-COORD : S18.73190

HOLE No: **TP37**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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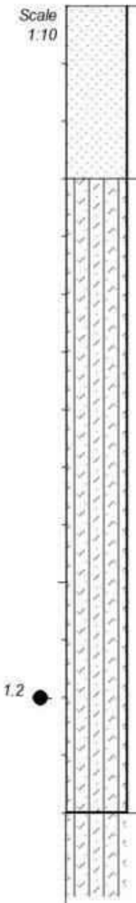
HOLE No: **TP38**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale
1:10



0.00

Dry to slightly moist yellow-brown <u>medium dense</u> to <u>dense</u> pinholed gravelly fine **SAND**. Transported / topsoil.
Note: (i) Pinholes presumably due to bioturbation (up to 8 mm in diameter).

0.30

Dry to slightly moist grey-brown blotched orange <u>firm</u> to <u>stiff</u> slightly shattered to fissured with depth sandy clayey **SILT**. Residual.
Note: (i) Upper 0.2 m of horizon is dark brown and appears to be shattered. (ii) Grades to very thinly folisated very soft rock siltstone in places.

1.40

Refusal in as above.

NOTES

1) Bulk sample 20003 extracted from 1.2 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 100 m
X-COORD : E-33.74480
Y-COORD : S18.73250

HOLE No: **TP38**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

GROUNDWATER AND EARTH SCIENCES
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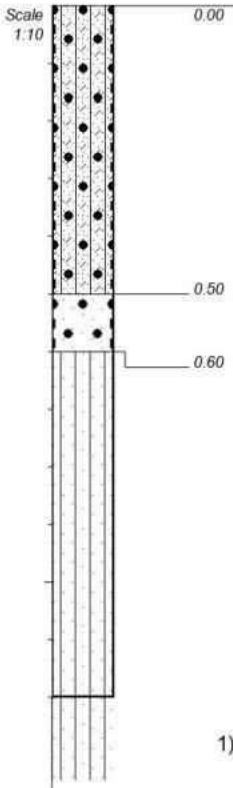
PHS Consultant Paul Slabbert
Cape Winelands Airport Fisantekraal

HOLE No: **TP39**
Sheet 1 of 1

PROJECT NUMBER: 4505_E



Dry to slightly moist grey-brown medium dense intact to pinholed fine **SAND**. Transported / topsoil.
Note: (i) 0.1 m thick yellow-brown horizon as above and partially cemented containing ferricrete gravels.

Slightly moist red-brown-orange very dense partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pedogenic.

Slightly moist yellow-brown blotched red stiff to very stiff slightly sandy **SILT**. Residual.
Note: (i) Inclusions of highly weathered very intensely laminated very soft rock siltstone. (ii) TLB drove the bucket into the ground repeatedly, but still failed to penetrate.

NOTES
1) Slow excavation.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Jauauary 2022
DATE : 25-27 Jauauary 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 97 m
X-COORD : E-33.7417
Y-COORD : S18.73560

HOLE No: **TP39**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

GROUNDWATER AND EARTH SCIENCES
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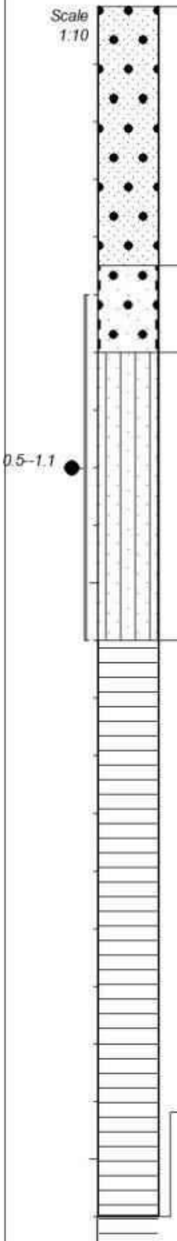
Cape Winelands Airport Fisantekraal

HOLE No: **TP40**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10



0.00 Dry to slightly moist yellow-brown fine **SAND** with ferricrete gravel. Transported.
Note: Ferricrete concentration increases with depth.

0.45 Dry to slightly moist reddish-yellow-brown <u>very dense</u> partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pendogenic.

0.60 Slightly moist reddish-orange <u>firm</u> to <u>stiff</u> fissured sandy **SILT**. Residual.

1.10 Yellow-brown completely weathered very fine grained laminated very thinly foliated <u>very soft rock</u> **SILTSTONE**.
Note: (i) TLB drove the bucket into the ground repeatedly, but still failed to penetrate.

2.10 Refusal on as above.

NOTES

1) Slow excavation.

2) Bulk sample 20001 extracted between 0.5--1.1 mbgl.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 107 m
X-COORD : E-33.74140
Y-COORD : S18.73240

HOLE No: **TP40**

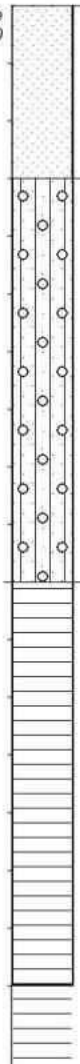
D0E6 GEOSS SA *dotPLOT 7022 PpH67*

PHS Consultant Paul Slabbert
Cape Winelands Airport Fisantekraal

HOLE No: **TP41**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10



0.00

Slightly moist grey-brown loose to medium dense fine **SAND** with occasional fine ferricrete nodules/gravels. Tranported.

0.30

Slightly moist yellow-brown stiff slightly shattered and pinholed fine sandy **SILT** with some gravel. Transported.
Note: Intense sidewall smear.

1.00

As above, but grades to completely weathered thinly foliated very soft rock **SILTSTONE**.
Note: (i) Discontinuities filled by clayey gauge. (ii) Grain size appears to decrease with depth.

NOTES

1) TLB drove the bucket into the ground repeatedly, with little success.

2) Slow excavation.

3) Intense sidewall smear.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

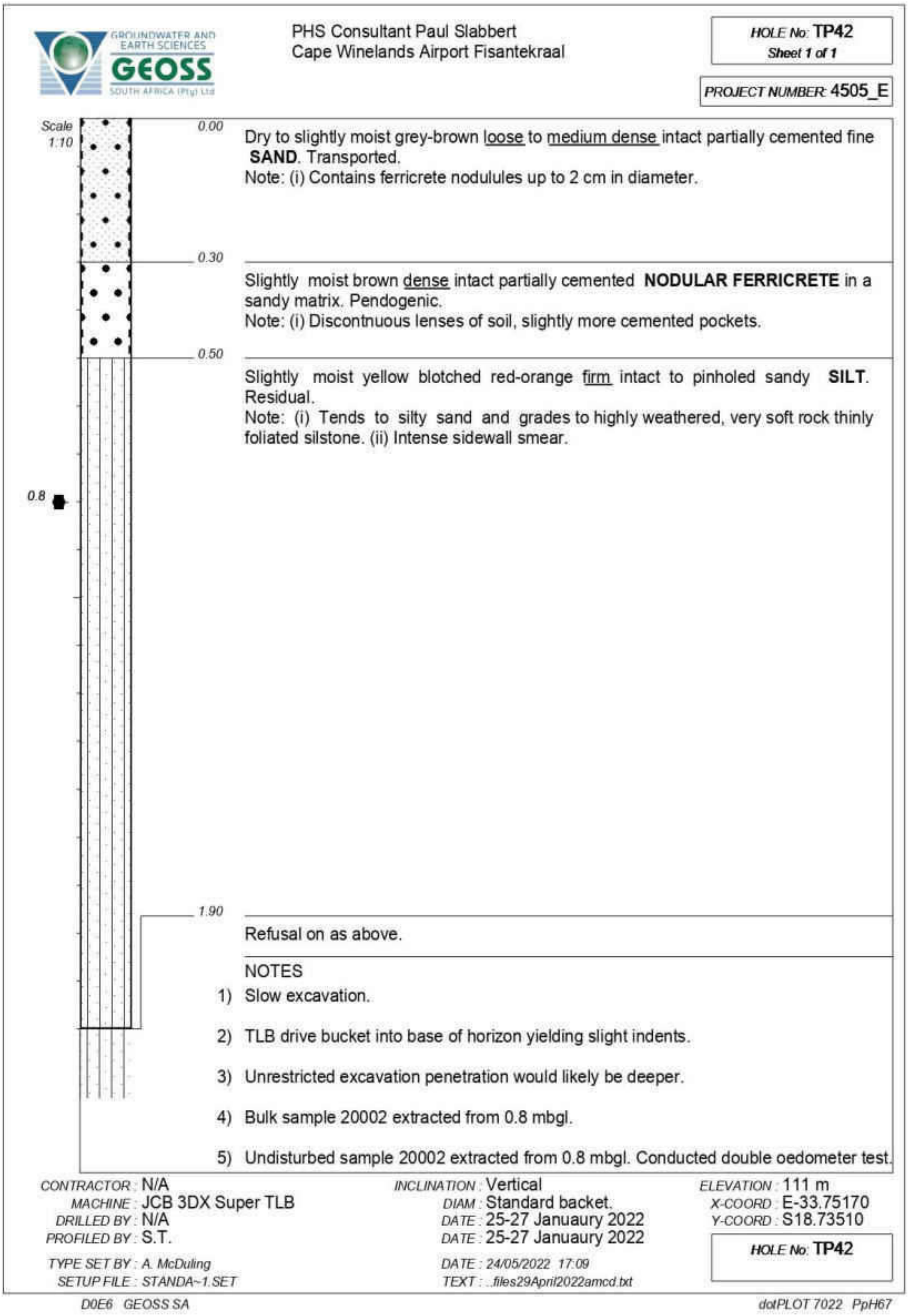
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 89 m
X-COORD : E-33.74540
Y-COORD : S18.73690

HOLE No: **TP41**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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HOLE No: **TP42**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale 1:10

Depth	Description
0.00	Dry to slightly moist grey-brown loose to medium dense intact partially cemented fine **SAND**. Transported. Note: (i) Contains ferricrete nodulules up to 2 cm in diameter.
0.30	Slightly moist brown dense intact partially cemented **NODULAR FERRICRETE** in a sandy matrix. Pendogenic. Note: (i) Discontnuous lenses of soil, slightly more cemented pockets.
0.50	Slightly moist yellow blotched red-orange firm intact to pinholed sandy **SILT**. Residual. Note: (i) Tends to silty sand and grades to highly weathered, very soft rock thinly foliated silstone. (ii) Intense sidewall smear.
1.90	Refusal on as above.

0.8

NOTES

1) Slow excavation.
2) TLB drive bucket into base of horizon yielding slight indents.
3) Unrestricted excavation penetration would likely be deeper.
4) Bulk sample 20002 extracted from 0.8 mbgl.
5) Undisturbed sample 20002 extracted from 0.8 mbgl. Conducted double oedometer test.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 111 m
X-COORD : E-33.75170
Y-COORD : S18.73510

HOLE No: **TP42**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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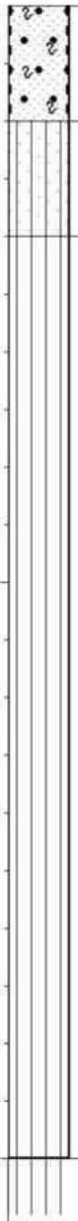
HOLE No: **TP43**
Sheet 1 of 1

PROJECT NUMBER: **4505_E**

Scale
1:10



0.00

Slightly moist grey-brown loose to medium dense intact to partially cemented fine **SAND** with some ferricrete nodules. Transported / topsoil.
Note: (i) Roots.

0.20

Slightly moist yellow-brown stiff fissured and pinholed slightly sandy **SILT**. Residual.
Note: (i) Pinholes likely due to bioturbation (up 8 mm in diameter).

0.40

Slightly moist grey blotched & streaked / stained yellow-orange stiff slightly shattered **SILT**. Residual.
Note: (i) Grades to completely weathered fine grained widely spaced foliations very soft rock siltstone with depth.

2.00

Refusal on as above.

NOTES

1) Slow excavation.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 106 m
X-COORD : E-33.75480
Y-COORD : S18.74090

HOLE No: **TP43**

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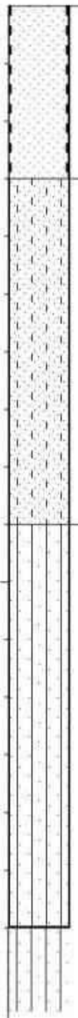
HOLE No: **TP44**
Sheet 1 of 1

PROJECT NUMBER: **4505_E**

Scale 1:10



0.00

Slightly moist grey to yellow-brown loose to medium dense intact partially cemented fine **SAND**. Transported / topsoil.

0.30

Dry to slighly moist yellow blotched red pinholed silty **SAND**. Transported/Pedogenic.
Note: (i) Brown sand inclusions near base.

0.90

Slightly moist white blotched red & orange firm to stiff slightly shattered sandy **SILT**. Residual.
Note: (i) This horizon was easy to excavate (relative to above horizon). (ii) Appeared slickensided in places.

NOTES

1) Slow excavation - Could be ripped by dozer & transported with TLB.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.
TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 104 m
X-COORD : E-33.75960
Y-COORD : S18.74200

HOLE No: **TP44**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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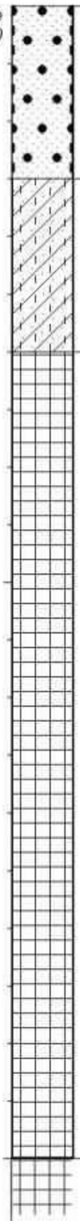
HOLE No: **TP45**
Sheet 1 of 1

PROJECT NUMBER: **4505_E**

Scale
1:10



0.00	Dry to slightly moist grey loose to medium dense intact partially cemented fine **SAND** with some fine ferricrete nodules. Transported/ topsoil. Note: (i) Pockets of soil are partially cemented.
0.30	Slightly moist yellow-brown stiff fissured sandy silty **CLAY**. Residual.
0.60	Slightly moist off white blotched yellow to red with depth very stiff finely laminated in areas **SILT** to soft rock **SILTSTONE**. Residual.
2.00	Refusal on as above.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 116 m
X-COORD : E-33.76110
Y-COORD : S18.73860

HOLE No: **TP45**

D0E6 GEOSS SA

dotPLOT 7022 PpH67

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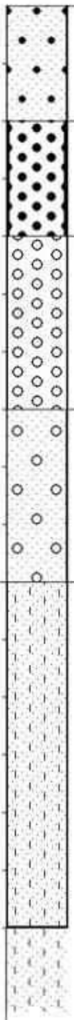
HOLE No: **TP46**
Sheet 1 of 1

PROJECT NUMBER: 4505_E

Scale
1:10



0.00	Slightly moist grey medium dense **SAND** with occasional ferricrete nodules. Transported.
0.20	Slightly moist grey red-brown partially cemented **NODULAR** to **HARDPAN FERRICRETE**. Pedogenic.
0.40	Slightly moist yellow medium dense pineholed fine **GRAVEL**. Transported.
0.70	Yellow-brown medium dense fine **SAND** with fine quartz gravel. Transported.
1.00	Slightly moist yellow-brown to red with depth stiff silty **SAND**. Residual.

CONTRACTOR : N/A
MACHINE : JCB 3DX Super TLB
DRILLED BY : N/A
PROFILED BY : S.T.

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

INCLINATION : Vertical
DIAM : Standard backet.
DATE : 25-27 Januaury 2022
DATE : 25-27 Januaury 2022

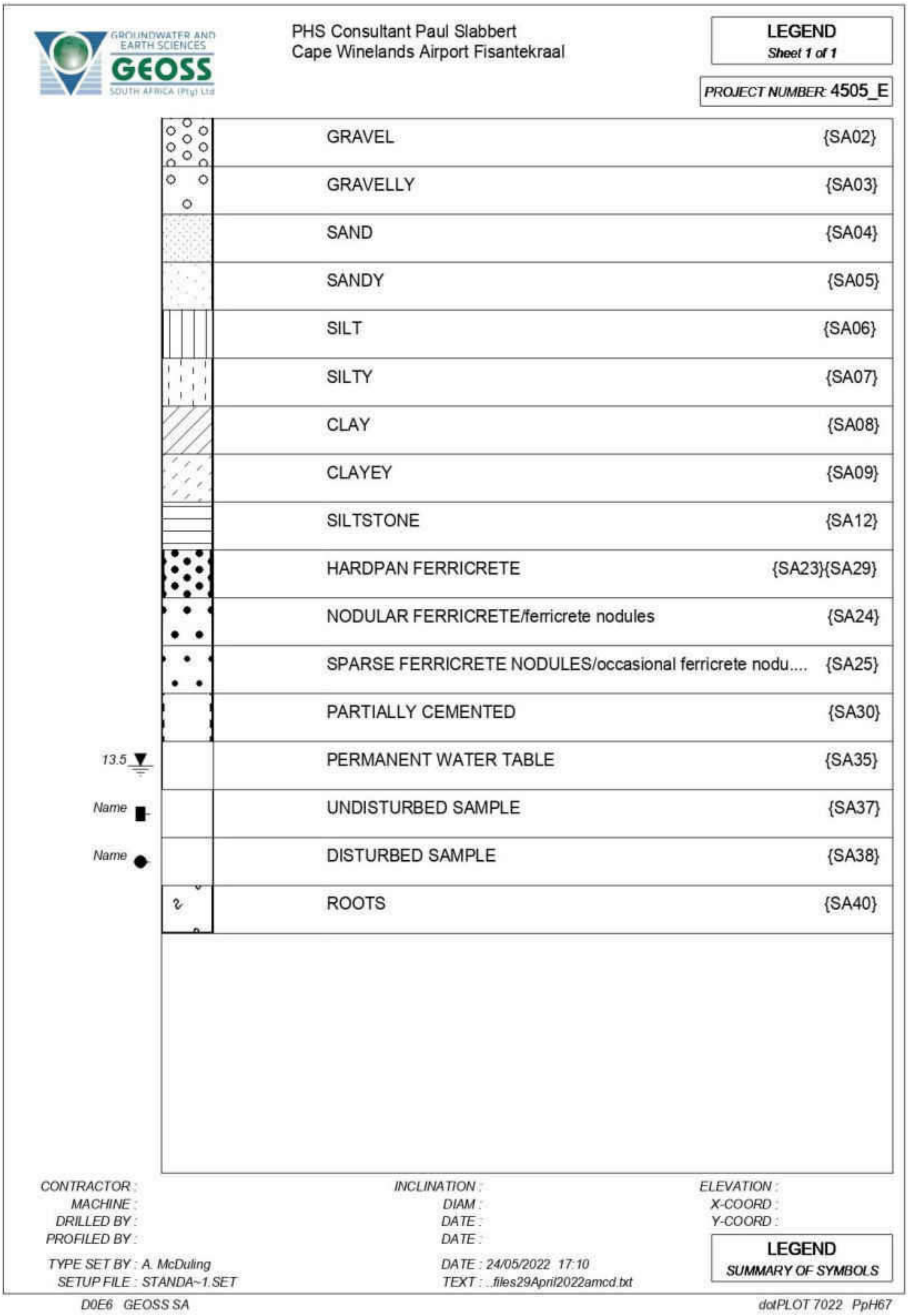
DATE : 24/05/2022 17:09
TEXT : ..files29April2022amcd.txt

ELEVATION : 121 m
X-COORD : E-33.76410
Y-COORD : S18.73940

HOLE No: **TP46**

D0E6 GEOSS SA

dotPLOT 7022 PpH67



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LEGEND
Sheet 1 of 1

PROJECT NUMBER: 4505_E

	○	GRAVEL	{SA02}
	○	GRAVELLY	{SA03}
	░	SAND	{SA04}
	░	SANDY	{SA05}
	▥	SILT	{SA06}
	▥	SILTY	{SA07}
	▨	CLAY	{SA08}
	▨	CLAYEY	{SA09}
	▤	SILTSTONE	{SA12}
	●	HARDPAN FERRICRETE	{SA23}{SA29}
	●	NODULAR FERRICRETE/ferricrete nodules	{SA24}
	●	SPARSE FERRICRETE NODULES/occasional ferricrete nodu....	{SA25}
		PARTIALLY CEMENTED	{SA30}
13.5 ▼		PERMANENT WATER TABLE	{SA35}
Name ■		UNDISTURBED SAMPLE	{SA37}
Name ●		DISTURBED SAMPLE	{SA38}
		ROOTS	{SA40}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : A. McDuling
SETUP FILE : STANDA~1.SET

DATE : 24/05/2022 17:10
TEXT : ..files29April2022amcd.txt

LEGEND
SUMMARY OF SYMBOLS

D0E6 GEOSS SA

dotPLOT 7022 PpH67

11. APPENDIX C: SUPPORTING PHOTOS

Figure 17: Close-up of TP01. Note cohesive nature of the material in the foreground, and the fine gravelly nature of material above refusal surface, i.e. next to hammer.

Figure 18: TP02 - Close-up of sidewall showing hardpan ferricrete refusal surface, note thin humified horizon on surface.

Figure 19: TP02 - Close-up of ferricrete nodules encountered near base of trial pit.

Figure 20: TP03 - Close up of sidewall; note nodular ferricrete grading to very dense hardpan ferricrete refusal surface.

Figure 21: TP04 – Nodular to hardpan ferricrete.

Figure 22: TP04: Close-up of trial pit sidewall. Note cemented nature of nodular ferricrete above hammer, and texture of sidewall 'smear' beneath hammer; sand- to clay- dominated with depth.

Figure 23: TP04 - Close-up of lower sandy clayey silt near base of trial pit.

Figure 24: TP04 – Close-up of sandy clayey silt spoil.

Figure 25: TP05 – Close-up of trial pit sidewall. Note pinch out of nodular ferricrete horizon, and pinholed nature of gravel horizon near base of hammer. Sidewall smear near base indicating high fines content.

Figure 26: TP05 – ferricrete nodules scattered on surface.

Figure 27: TP06 – Close-up of spoil excavated from lower-most sandy clayey silt horizon.

Figure 28: TP07 – Close-up of spoil excavated from residual horizon.

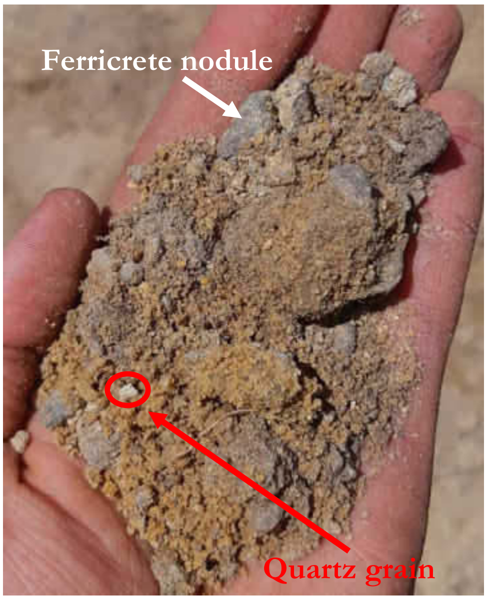

Figure 29: TP07 – Close-up of spoil from residual horizon; note angular nature of grains. Rounded grains are ferricrete.

Figure 30: TP08 – Close-up of upper transported sand horizon.

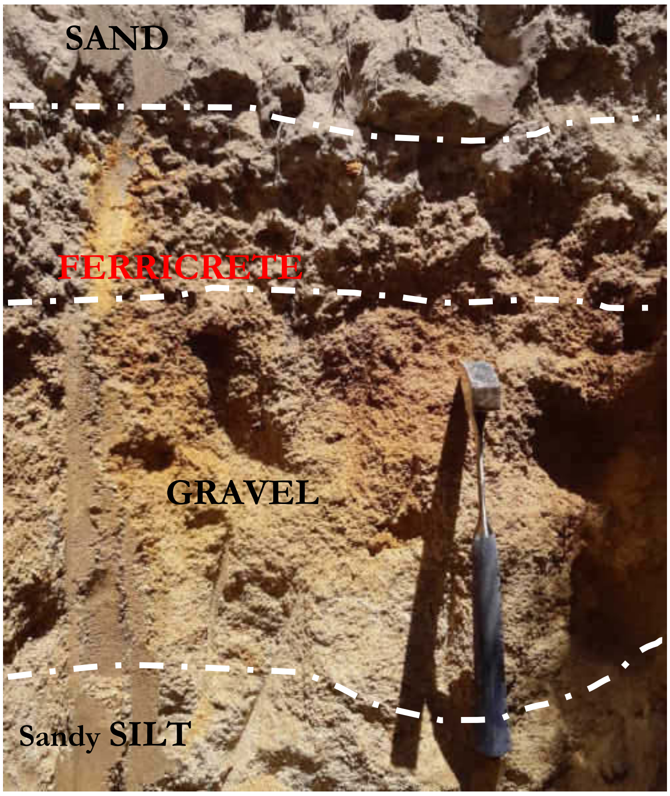

Figure 31: TP08 – Close-up of partially cemented pinholed sandy fine gravel horizon beneath nodular ferricrete. Note there is large variation in thickness of the ferricrete horizon (between 0.3 and 0.8 m thick).

Figure 32: TP10 – Close up of bottom of trial pit; note sidewall smear near base of trial pit.

Figure 33: TP10 – Close up of bottom of ferricrete nodules strewn across surface surrounding trial pit; exposed soil profile pictured on LHS of photograph.

Figure 34: TP11 – Close-up of spoil pile of ferricrete nodules excavated from trial pit.

.

Figure 35: TP11 – Close-up of ferricrete nodule; note angular nature of grains stuck to nodule.

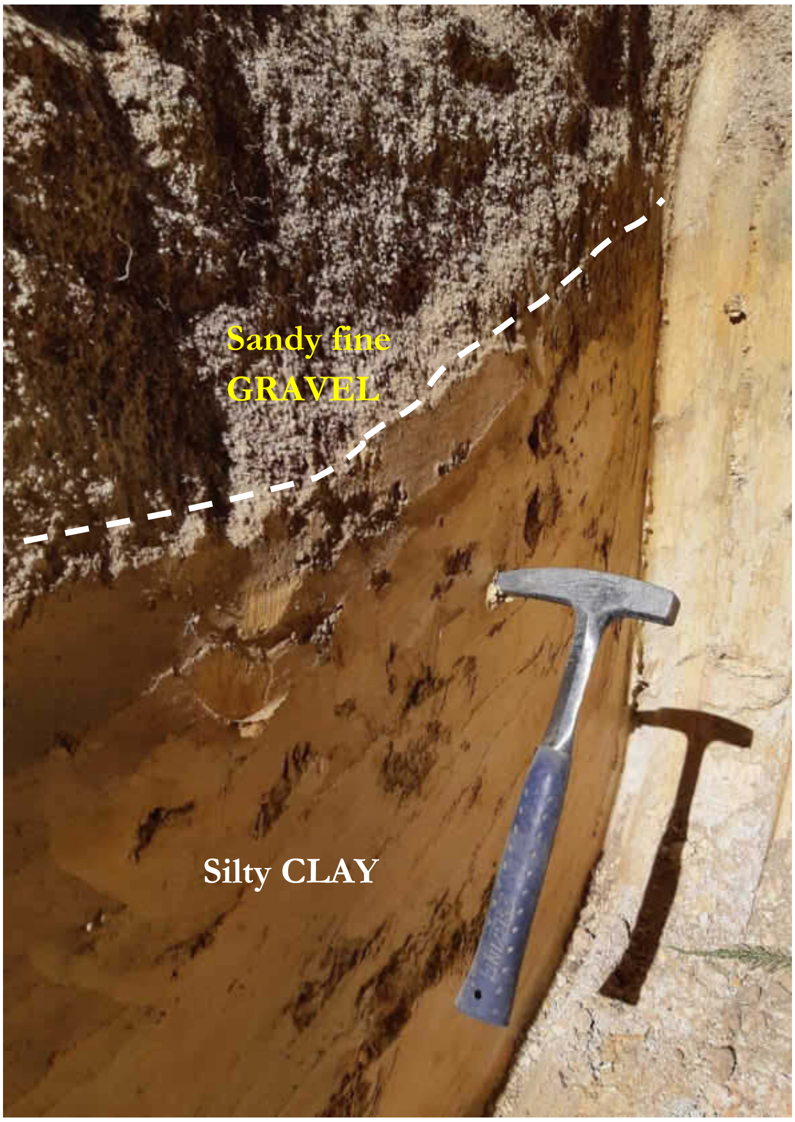

Figure 36: TP13 – Close-up of sidewall smear in silty clay residual horizon.

Figure 37: TP14 – Close-up of ferricrete boulders excavated from nodular ferricrete horizon.

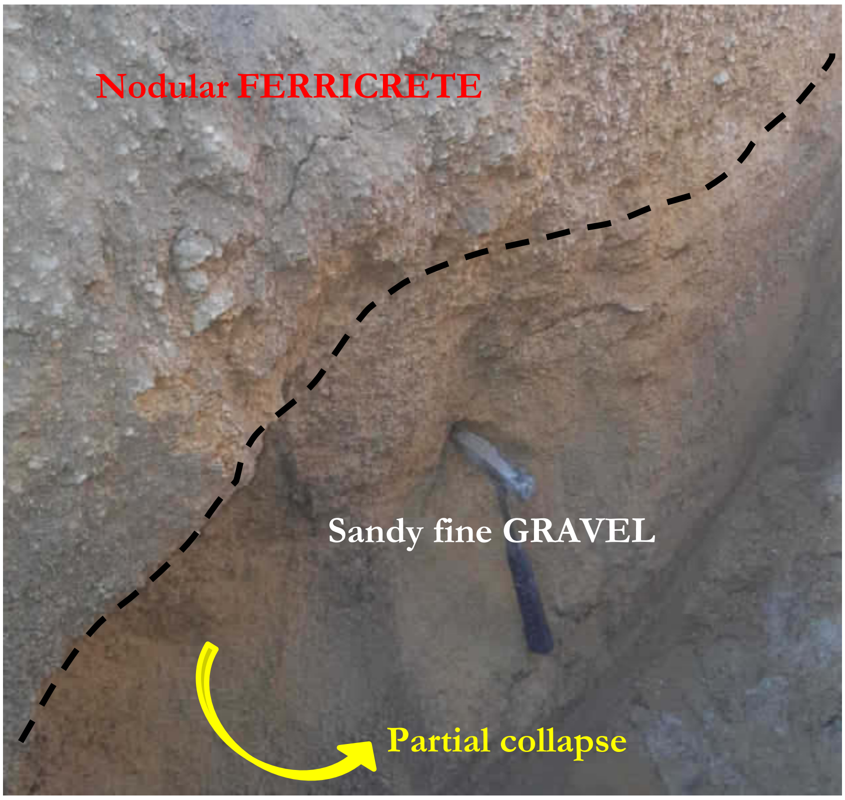

Figure 38: TP14 – Partial collapse of trial pit sidewall within the pinholed sandy fine gravel horizon; prior to water level rise.

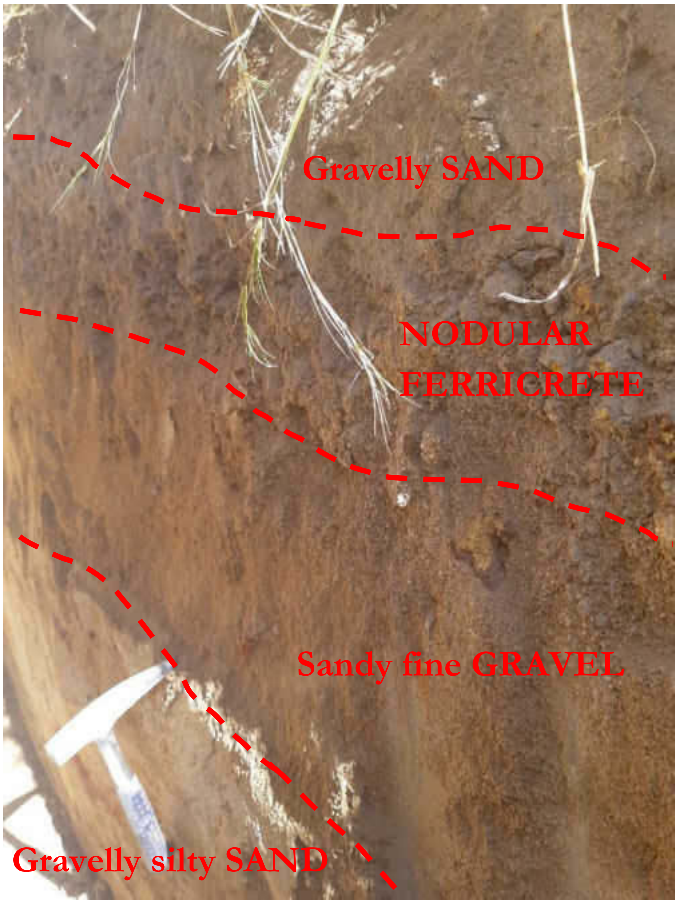

Figure 39: TP15 – Close-up of trial pit sidewall showing various horizons encountered.

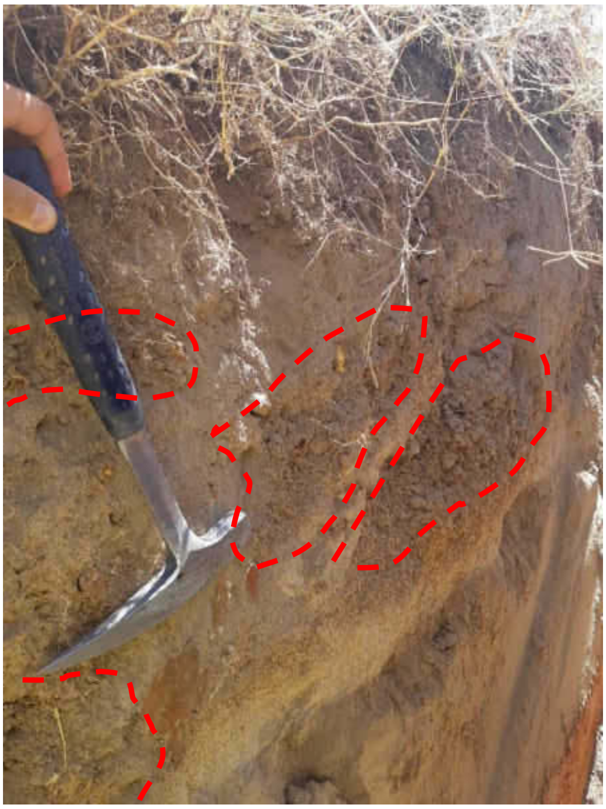

Figure 40: TP16 – Close-up of trial pit sidewall showing pockets of ferricrete nodules (annotated in red).

Figure 41: TP16 – Close-up of trial pit sidewall showing variation in 'smear' texture; material becomes less sandy toward base. Upon close inspection sandy grains are angular suggesting in-situ weathering.

Figure 42: TP18 – Close-up of trial pit upper surface of red-orange-brown nodular ferricrete horizon prior to excavation through to silty clay residual horizon.

Figure 43: TP19 – Close-up of trial pit floor; note metallic coating on base of trial pit.

Figure 44: TP21 – GEOSS team conducting DCP test beneath nodular ferricrete horizon. White clay-silt Corrobrick material pictured in the background.

Figure 45: TP22 – Close-up of transported gravelly sand horizon.

Figure 46: TP22 – Close-up of nodular ferricrete spoil pile; note this material excavated out in boulder-form occasionally. Excavation slow and time consuming.

Figure 47: TP22 – Close-up of spoil of silty clay material of the residual horizon; note blocky form of material in foreground - evidence of relict foliations.

Figure 48: TP27 – Close-up of soil profile; note the highly pinholed nature of fine gravel horizon near base of trial pit.

Figure 49: TP28 – Ferricrete boulders (approx. 300 mm in diameter) excavated from pedogenic hardpan ferricrete horizon.

Figure 50: TP29 – Close-up of trial pit sidewall; note occasional indurated ferricrete boulders in upper-most horizon. Intense sidewall 'smear' in residual clayey sandy silt horizon.

Figure 51: TP29 – Close-up of spoil of residual sandy silt horizon.

Figure 52: TP32 – Close-up of pin holed nature of transported material; likely due to bioturbation.

Figure 53: TP32 – Close-up of orange blotched red residual horizon.

Figure 54: TP43 – Close-up of voided/bioturbated residual material.

Figure 55: TP44 – Close-up of slightly smoothed/slickensided surface of residual material encountered in trial pit.

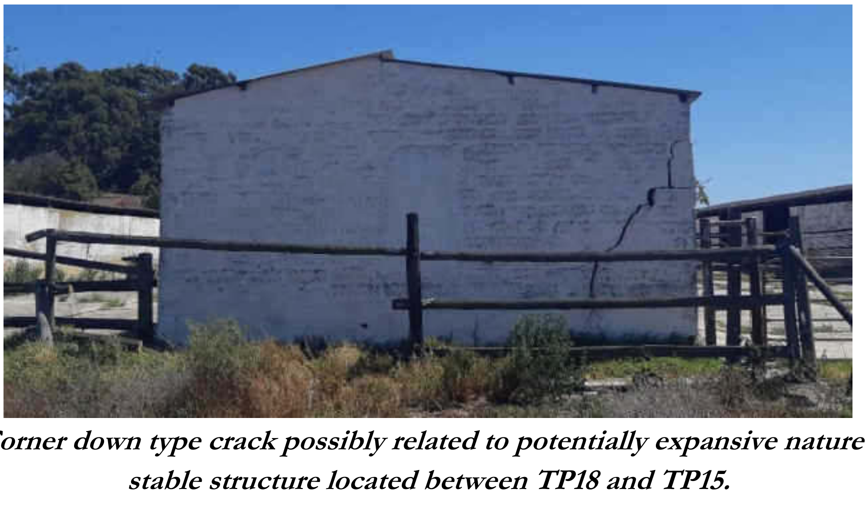

Figure 56: Corner down type crack possibly related to potentially expansive nature of subsoils; stable structure located between TP18 and TP15.

Figure 57: Vertical crack possibly related to potentially expansive nature of subsoils; storage structure located between TP18 and TP15.

Figure 58: Ferricrete outcrop exposed in northern portion of the site near TP36.

Figure 59: Fill dumped in drainage in northern portion of the site intended for future development.

Figure 60: View of JCB 3DX Super Tractor Loader Backhoe excavating a trial pit near the central portion of the site.

Figure 61: Close-up of TLB bucket tines used for conducting reconnaissance investigation.

12. APPENDIX D: DCP TESTING LOGS

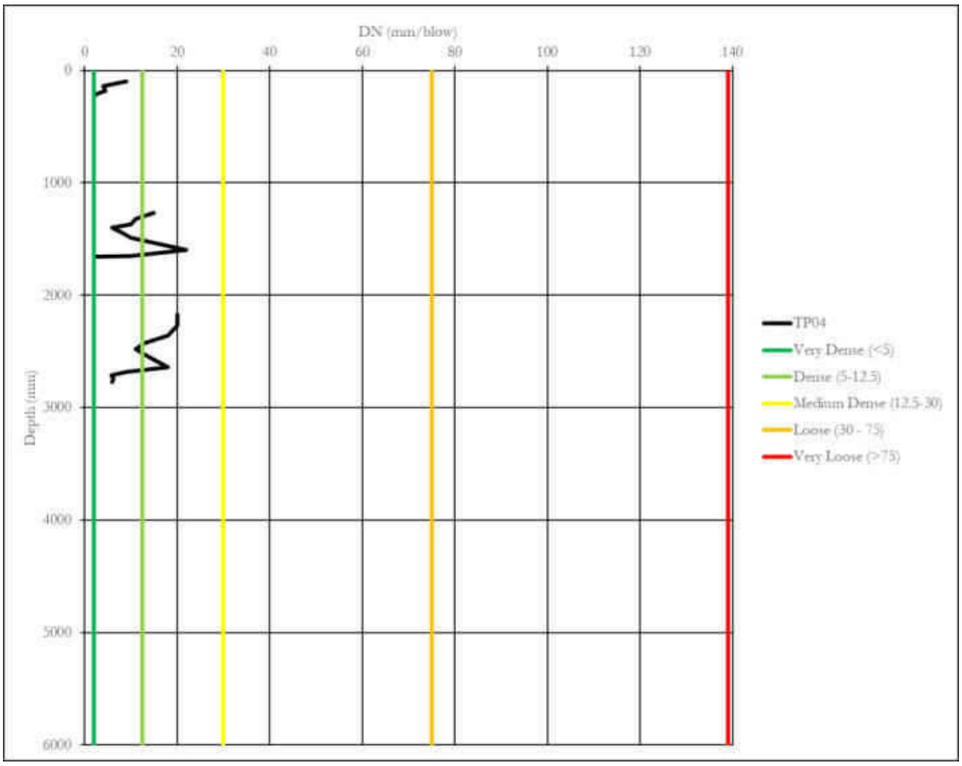

Figure 62: DCP04 Log.

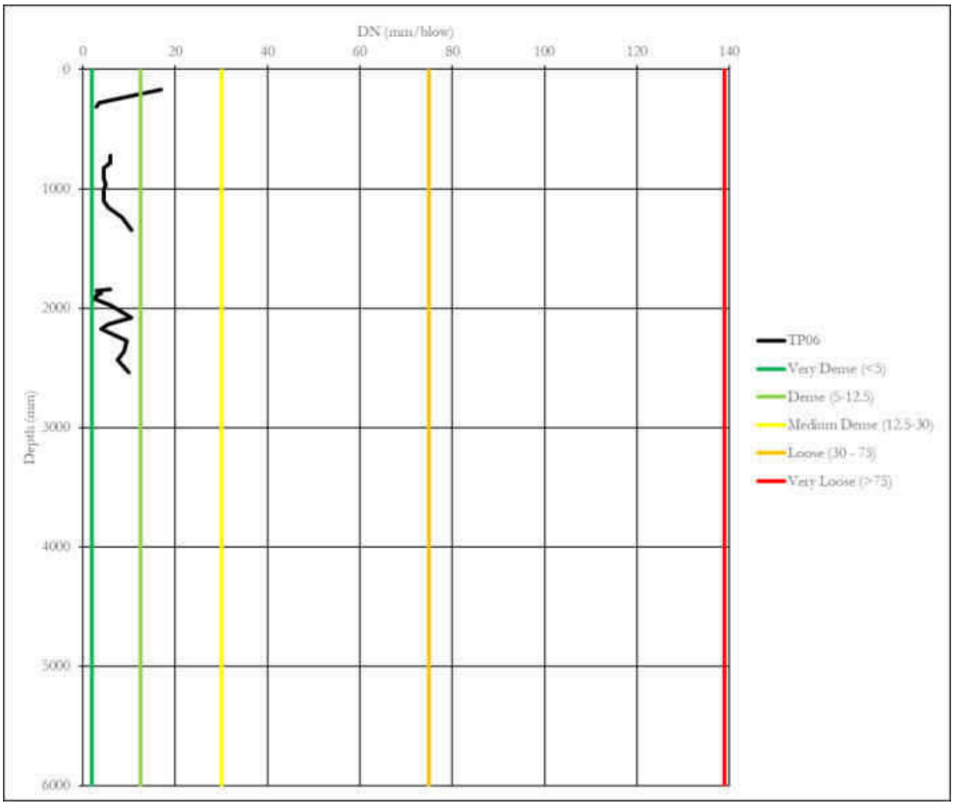

Figure 63: DCP06 Log.

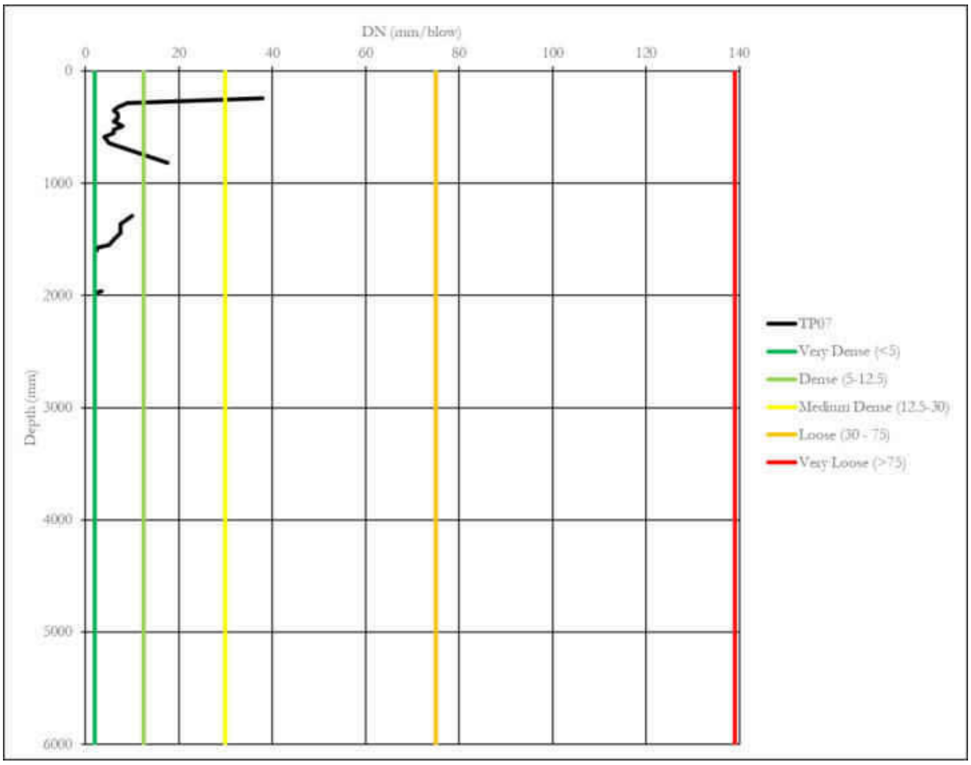

Figure 64: DCP07 Log.

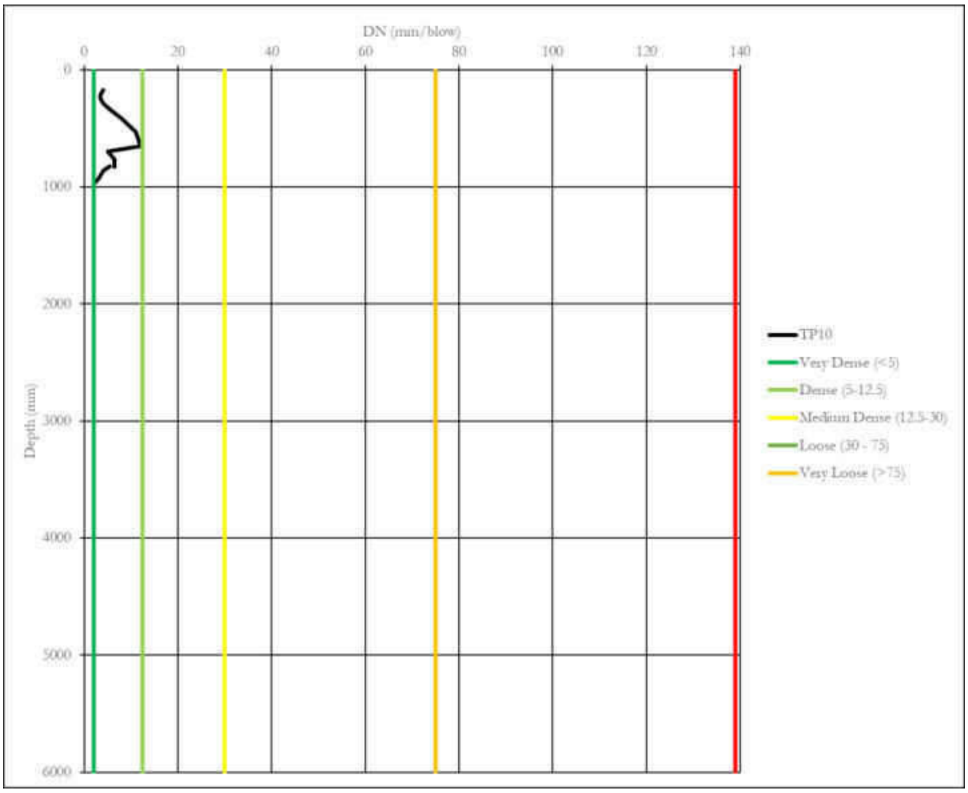

Figure 65: DCP10 Log.

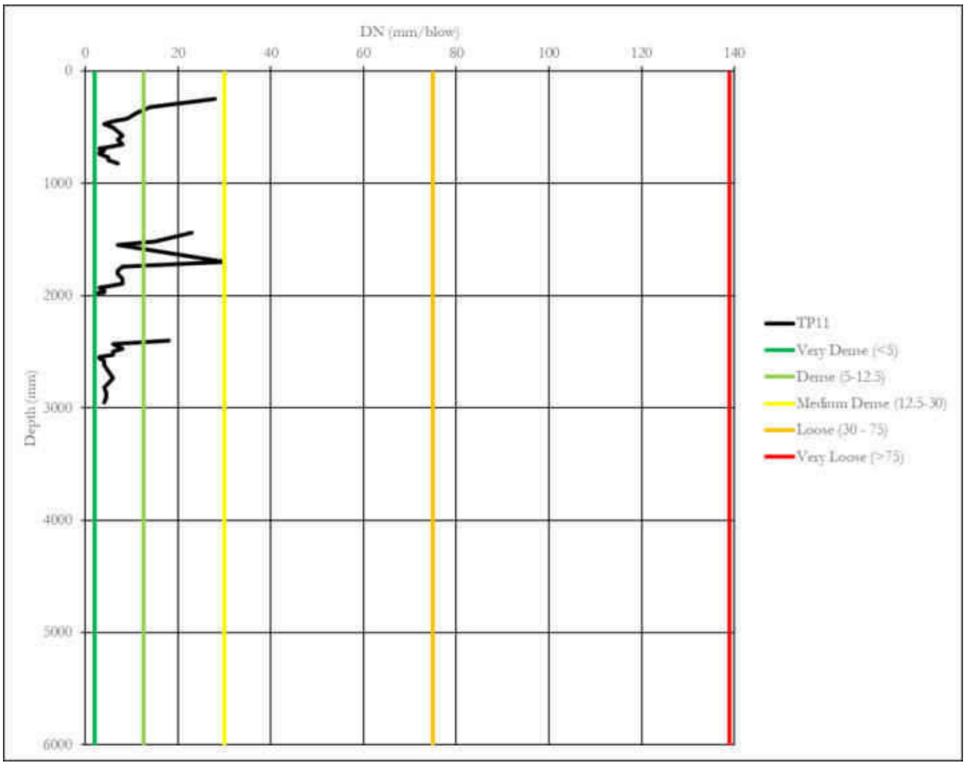

Figure 66: DCP11 Log.

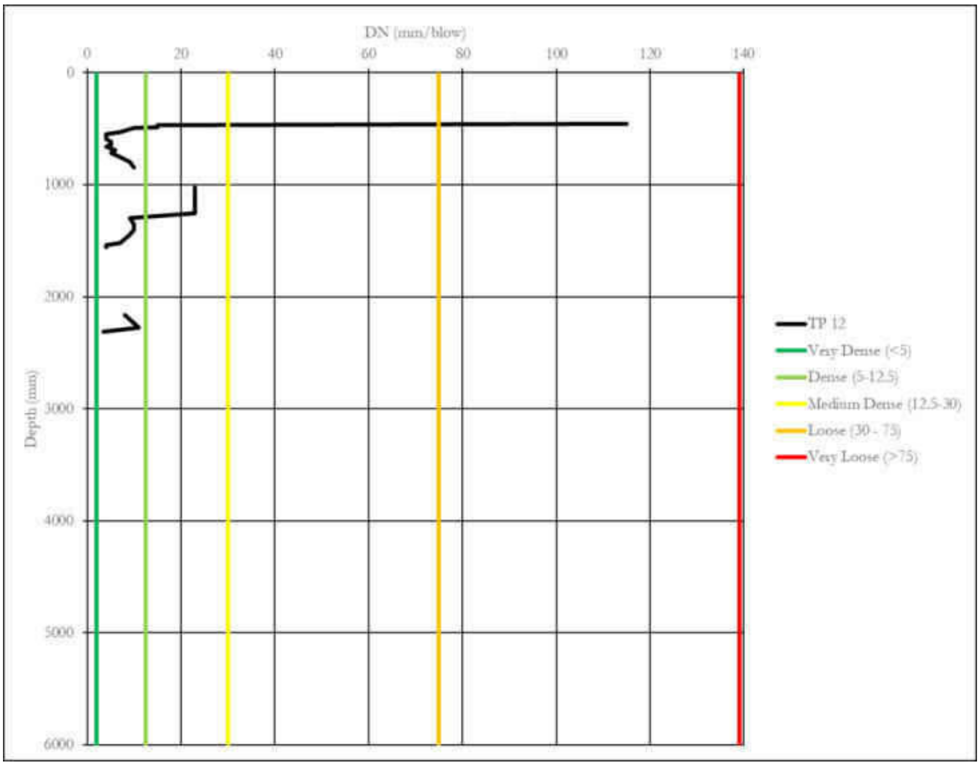

Figure 67: DCP12 Log.

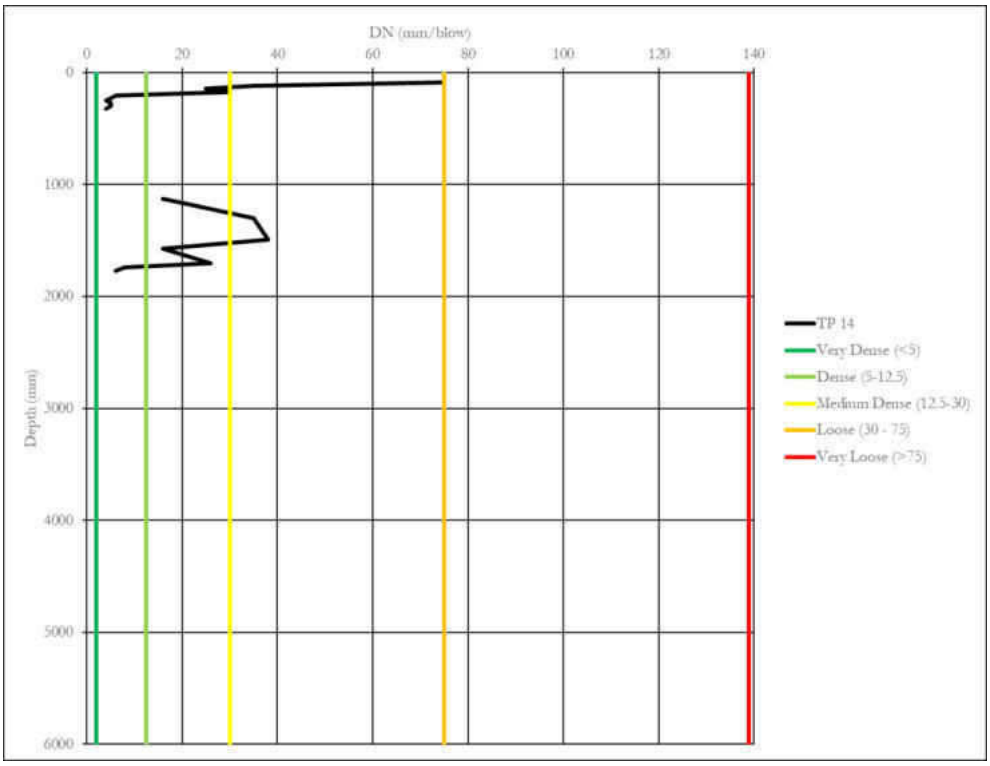

Figure 68: DCP14 Log.

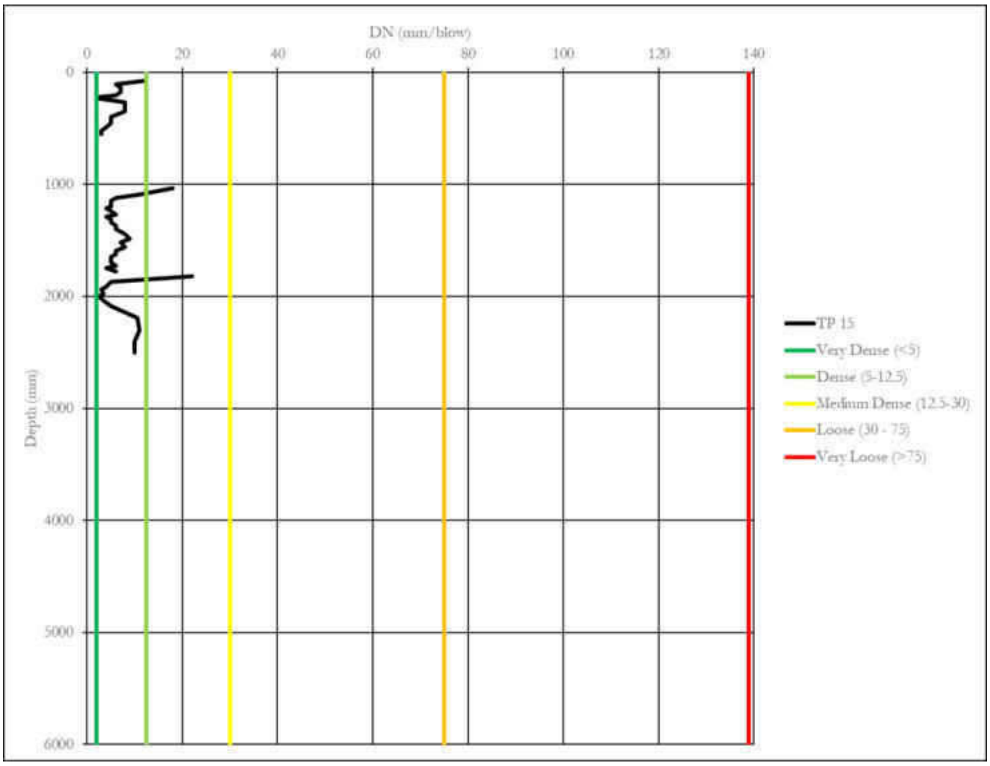

Figure 69: DCP15 Log.

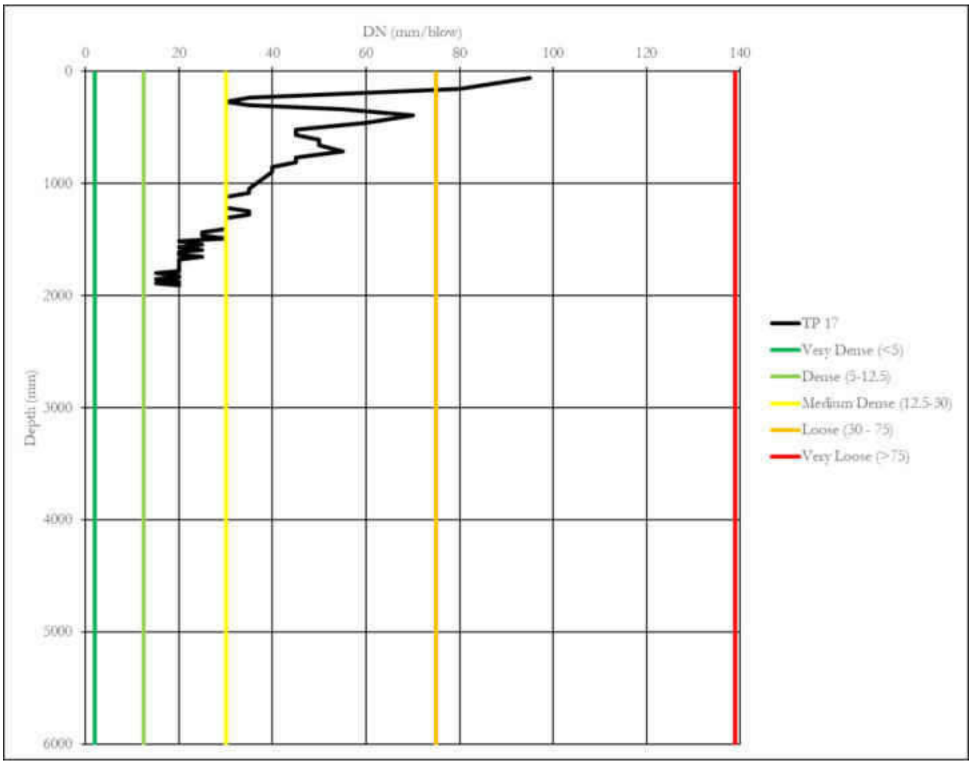

Figure 70: DCP17 Log.

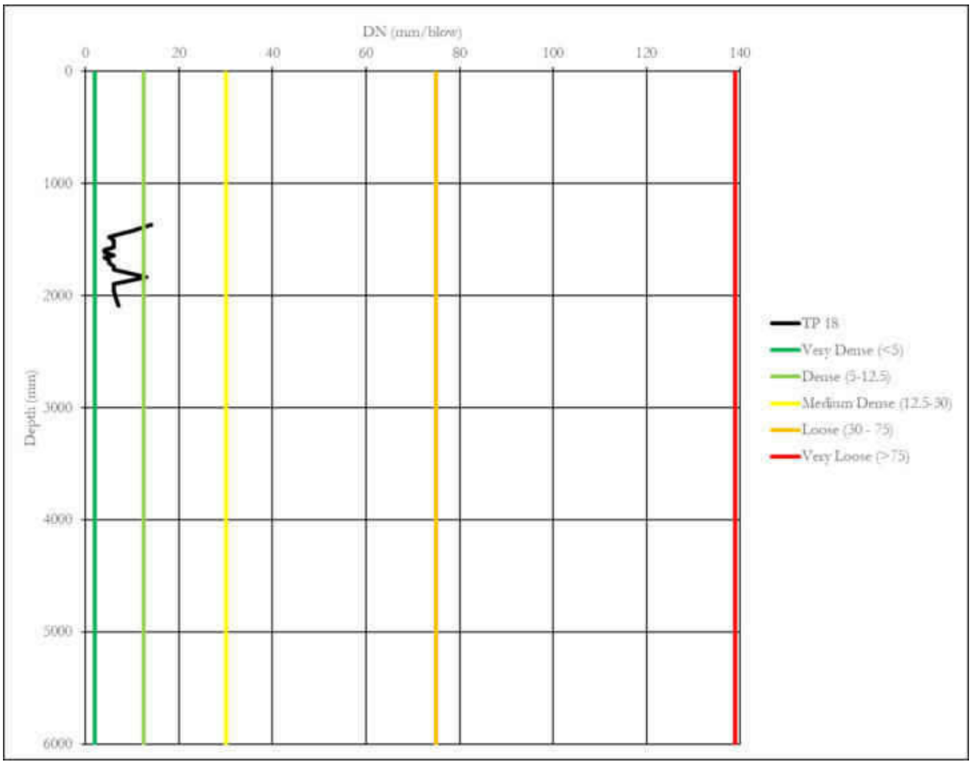

Figure 71: DCP18 Log.

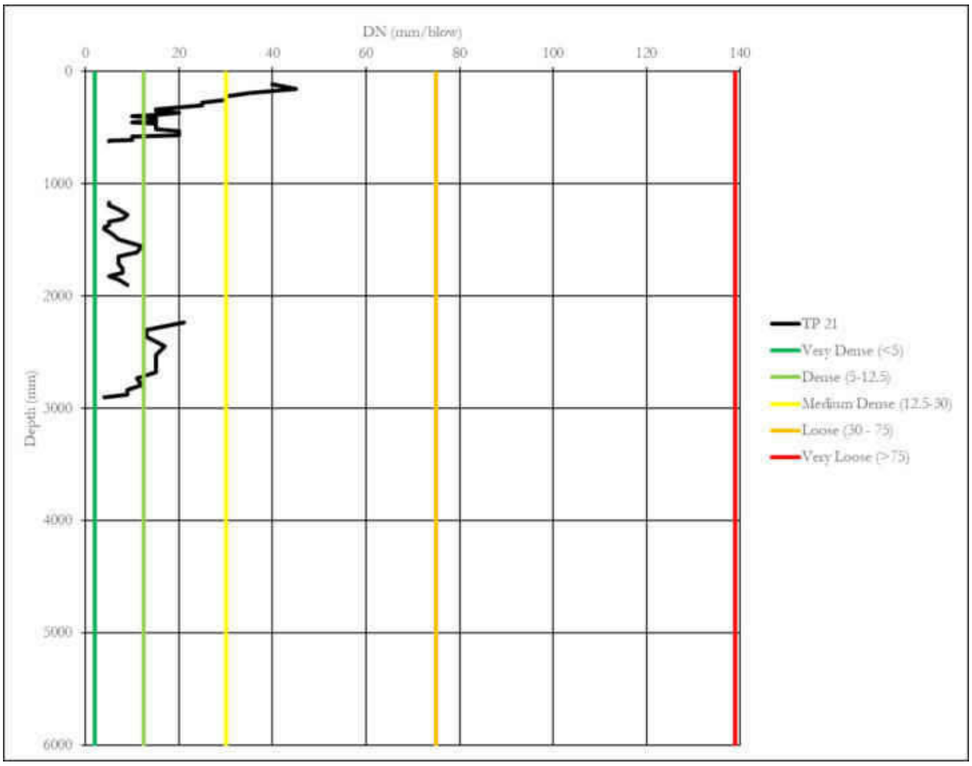

Figure 72: DCP21 Log.

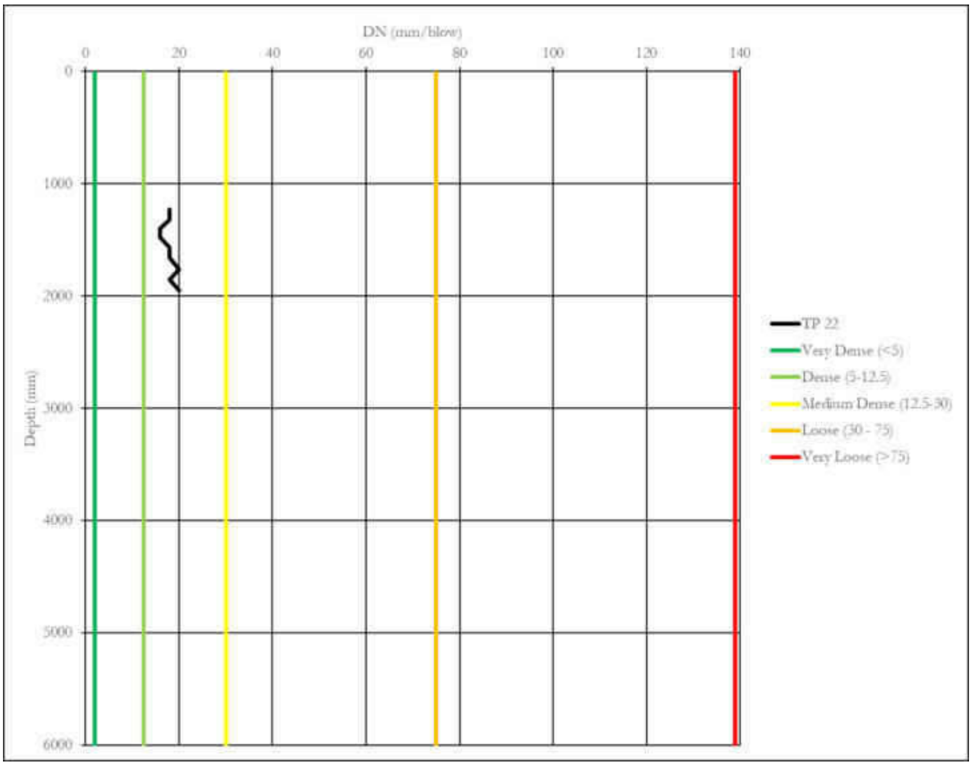

Figure 73: DCP22 Log.

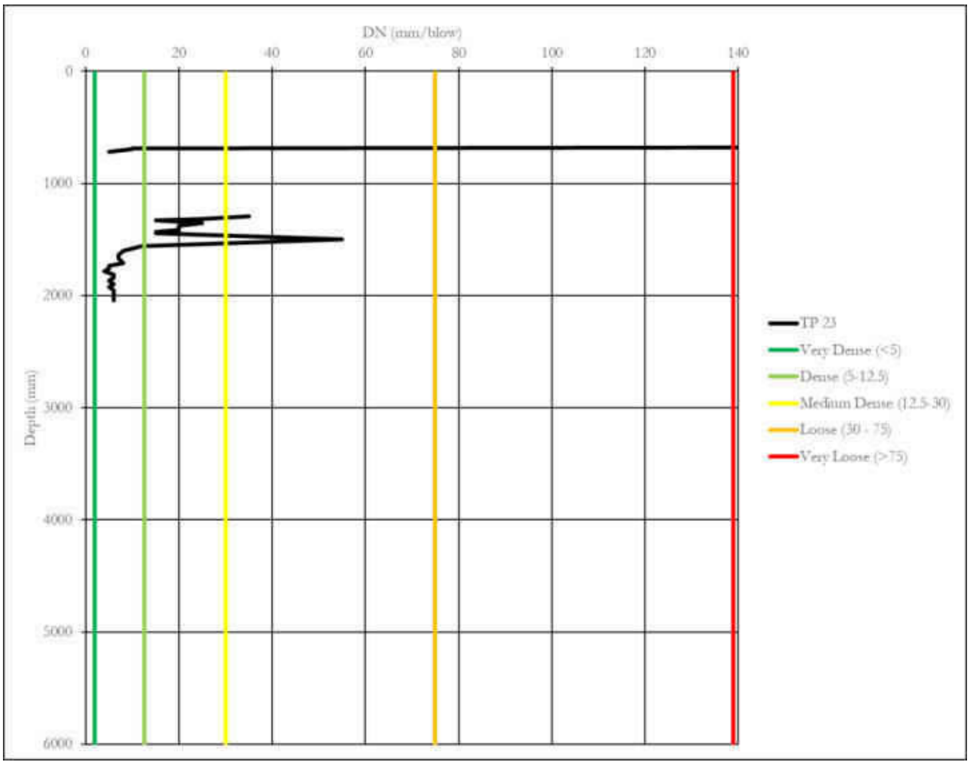

Figure 74: DCP23 Log.

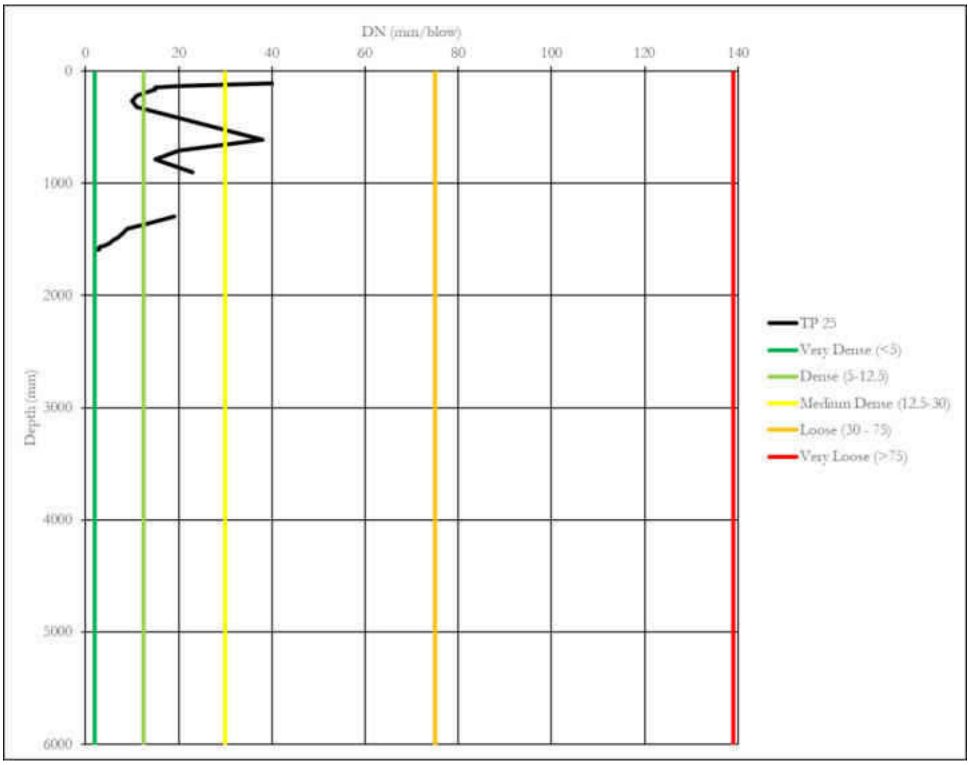

Figure 75: DCP25 Log.

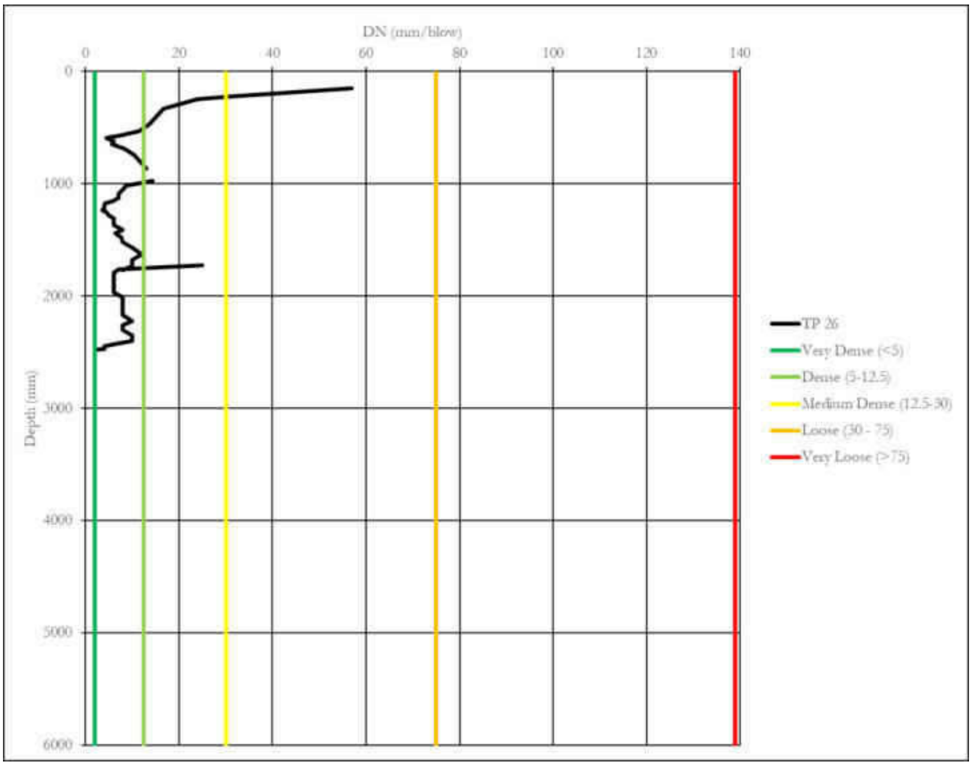

Figure 76: DCP26 Log.

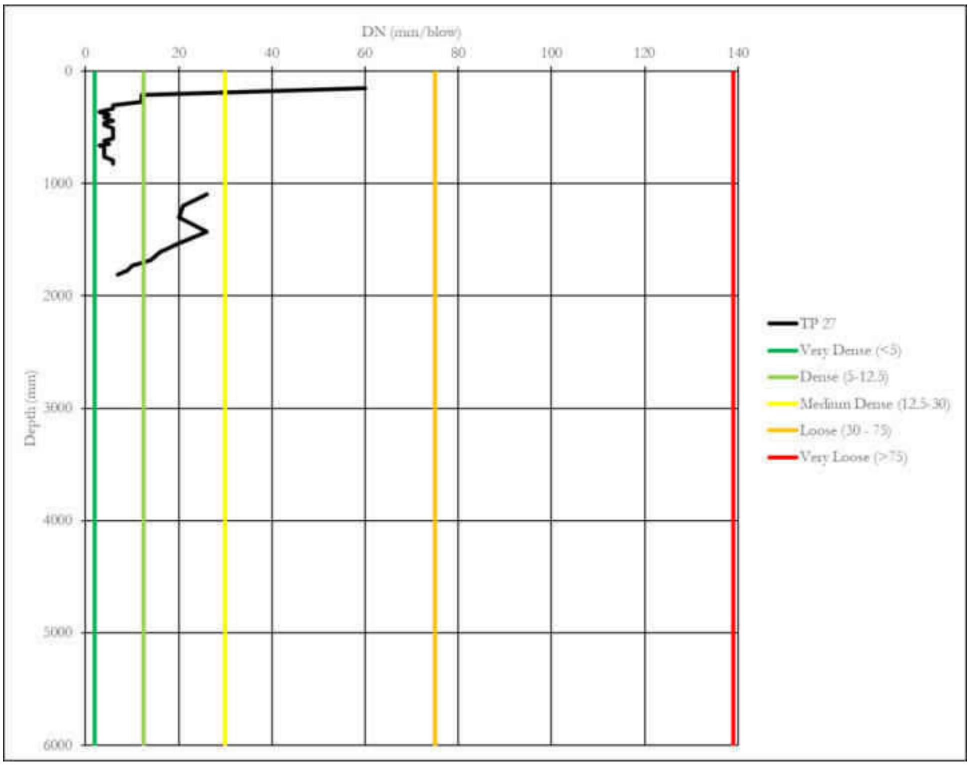

Figure 77: DCP27 Log.

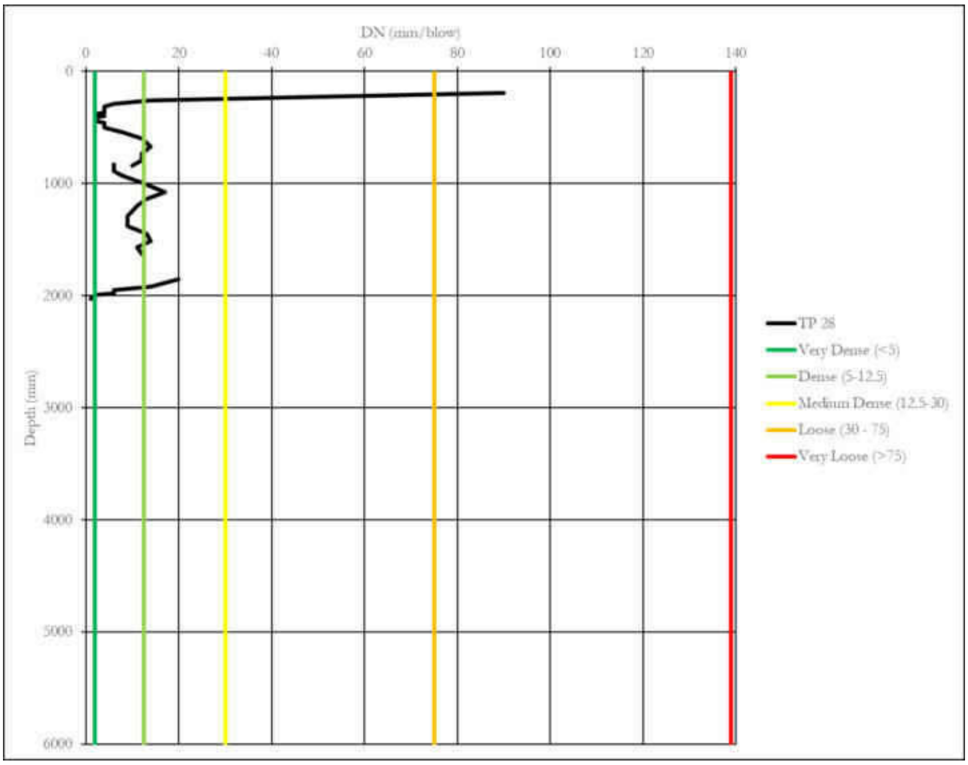

Figure 78: DCP28 Log.

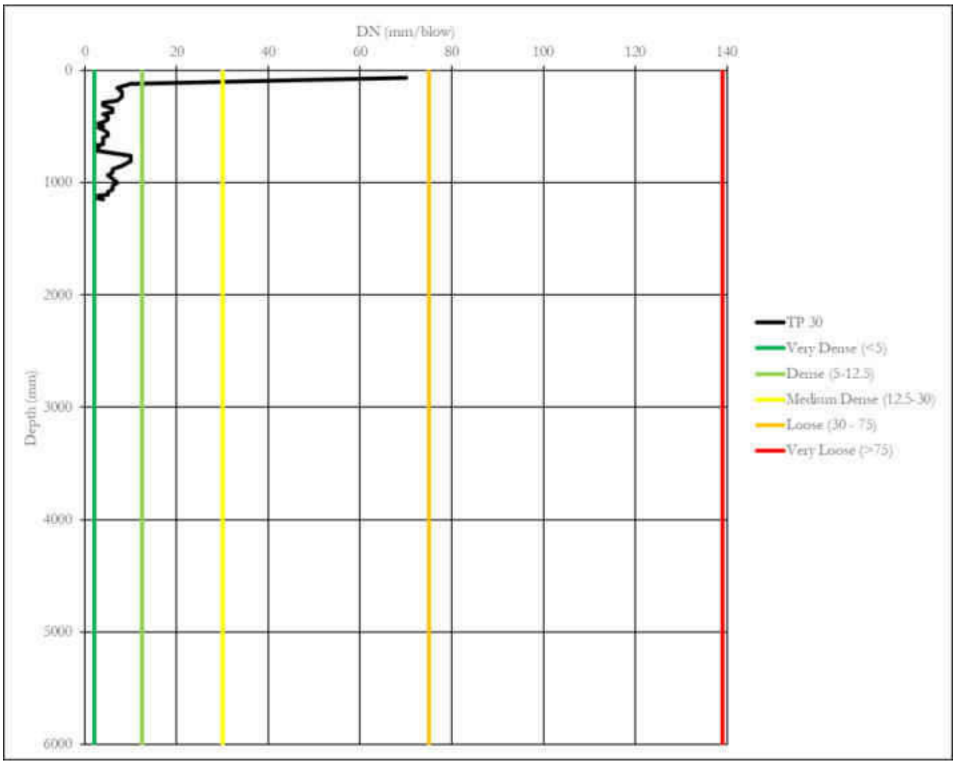

Figure 79: DCP30 Log.

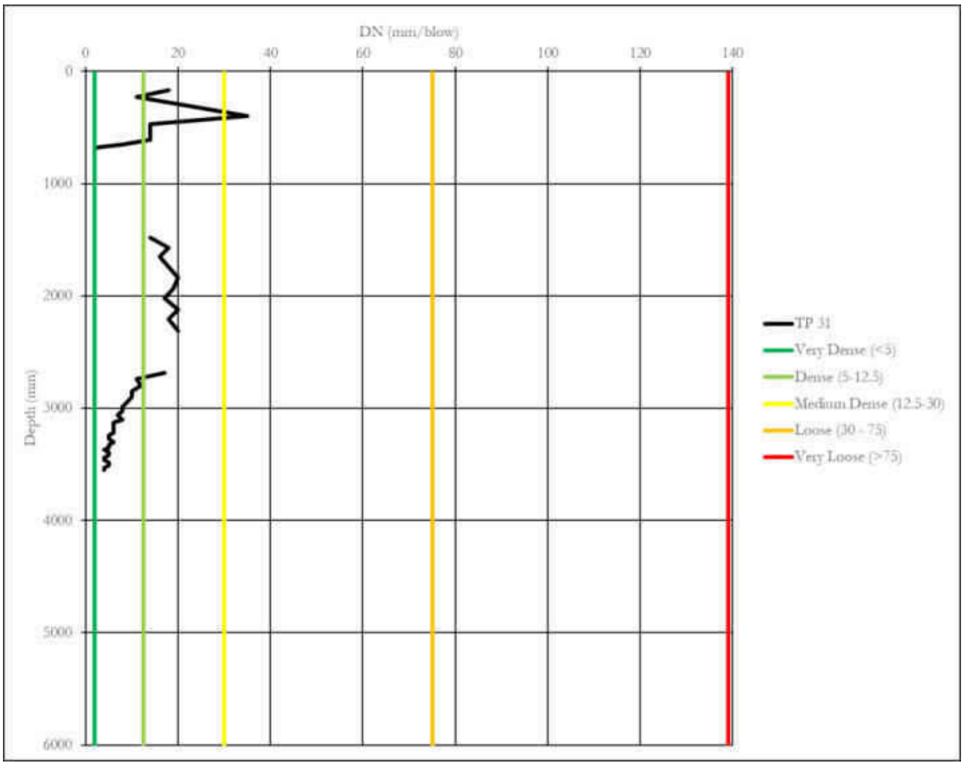

Figure 80: DCP31 Log.

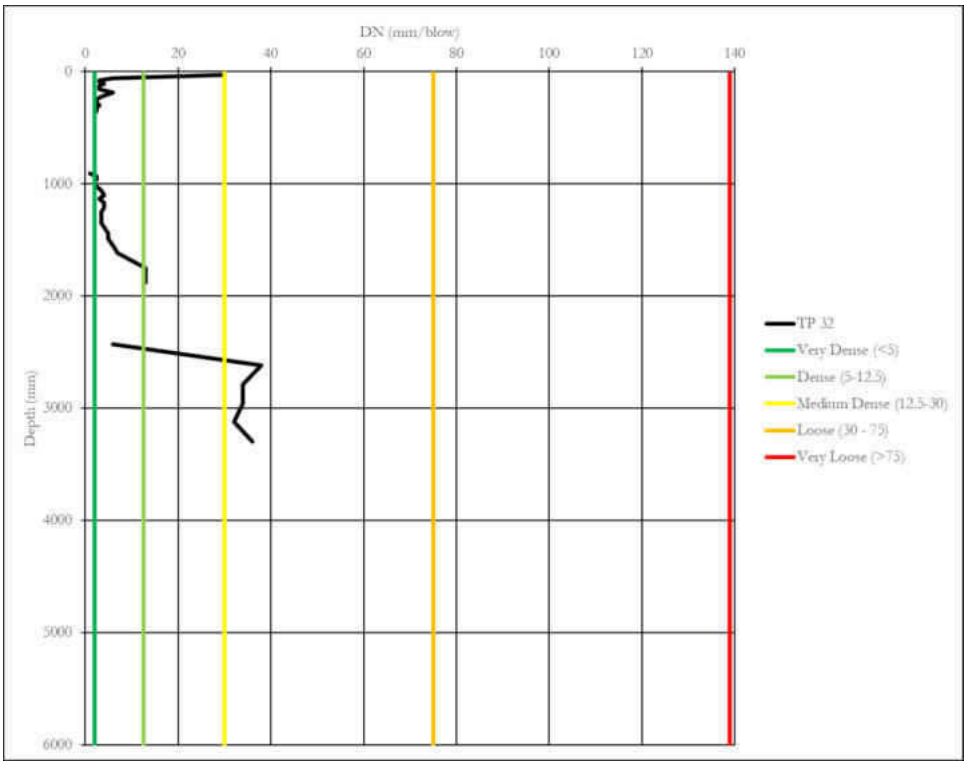

Figure 81: DCP32 Log.

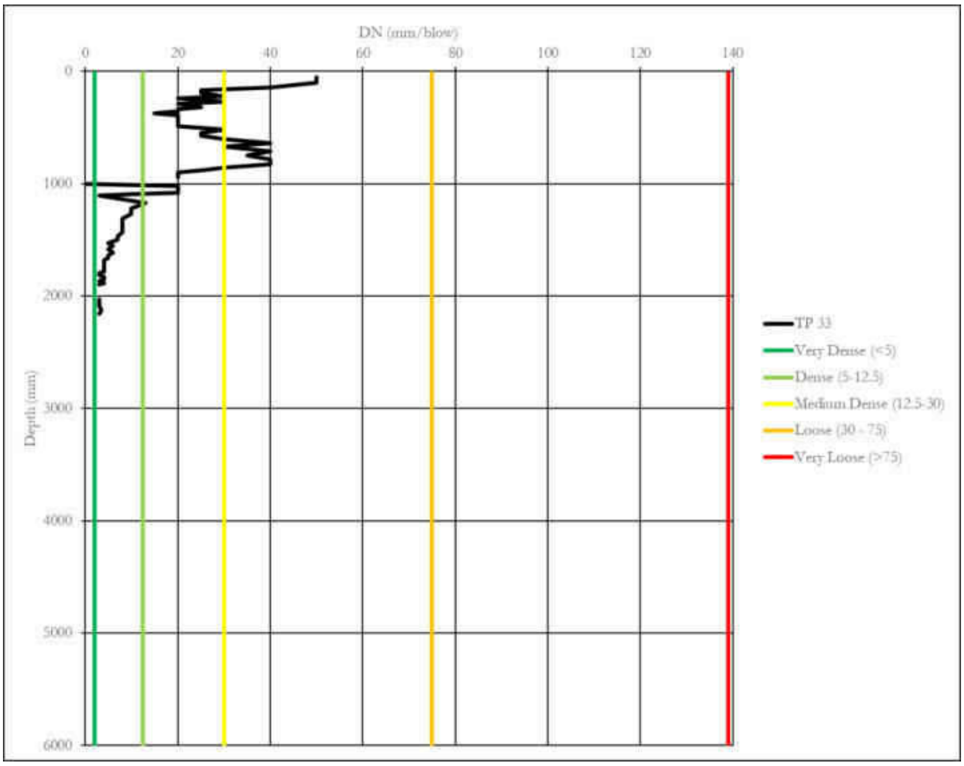

Figure 82: DCP33 Log.

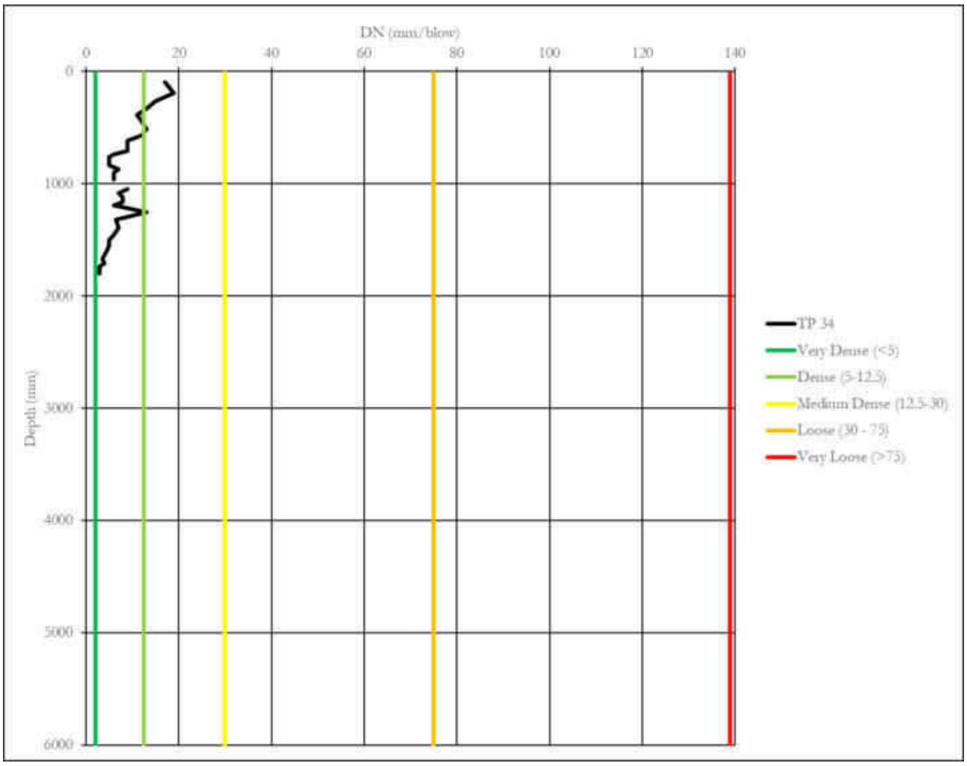

Figure 83: DCP34 Log.

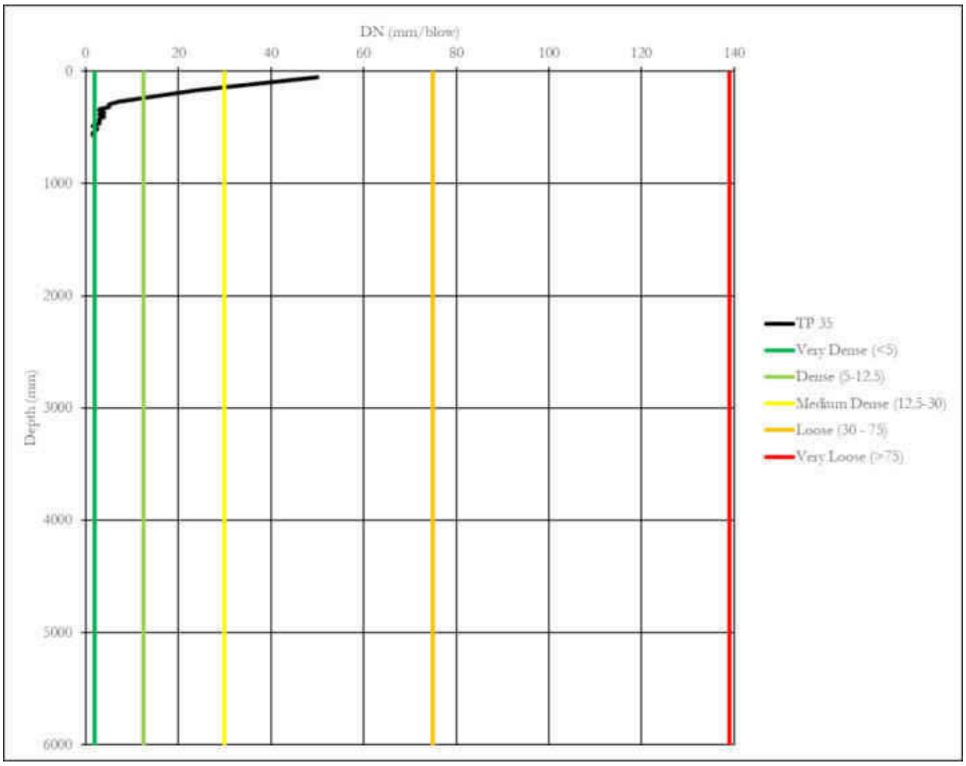

Figure 84: DCP35 Log.

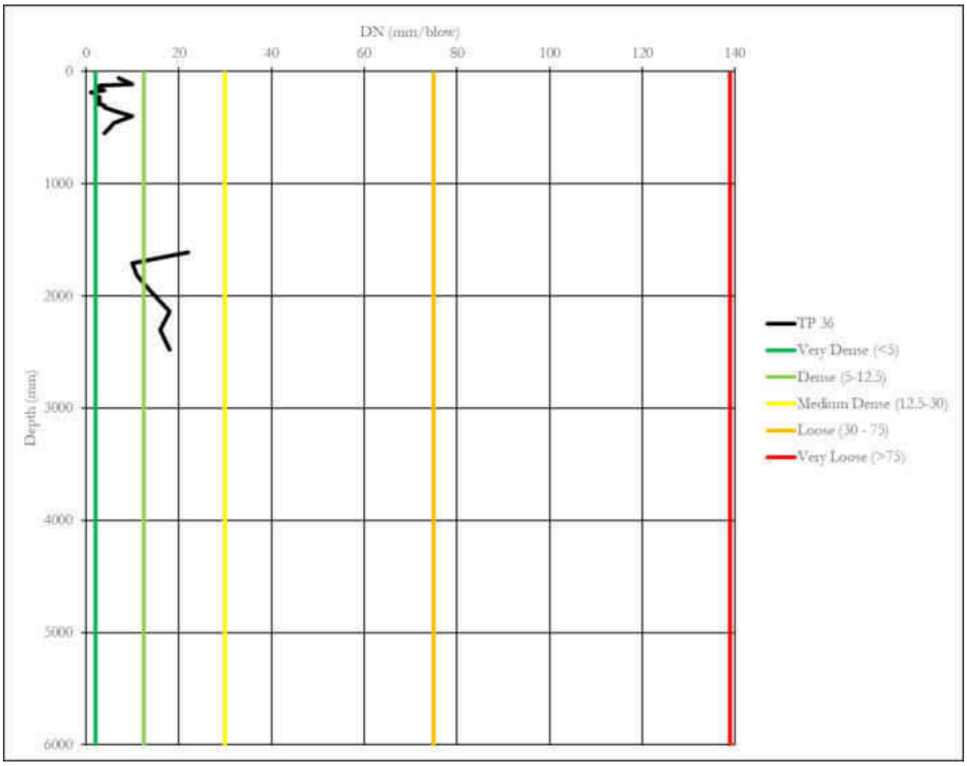

Figure 85: DCP36 Log.

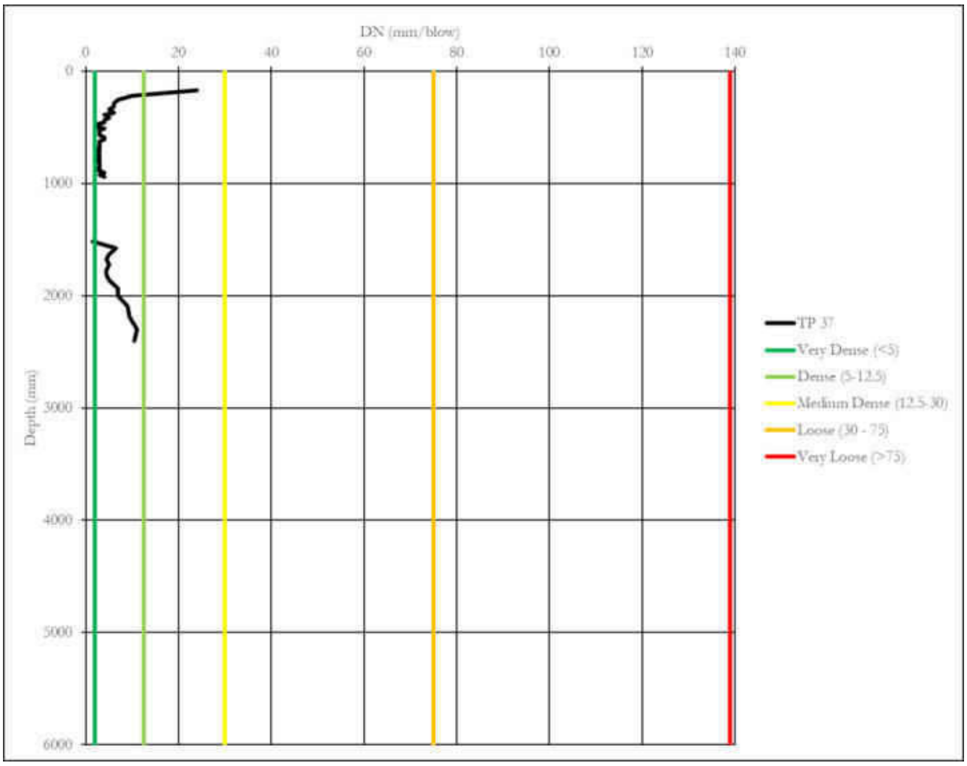

Figure 86: DCP37 Log.

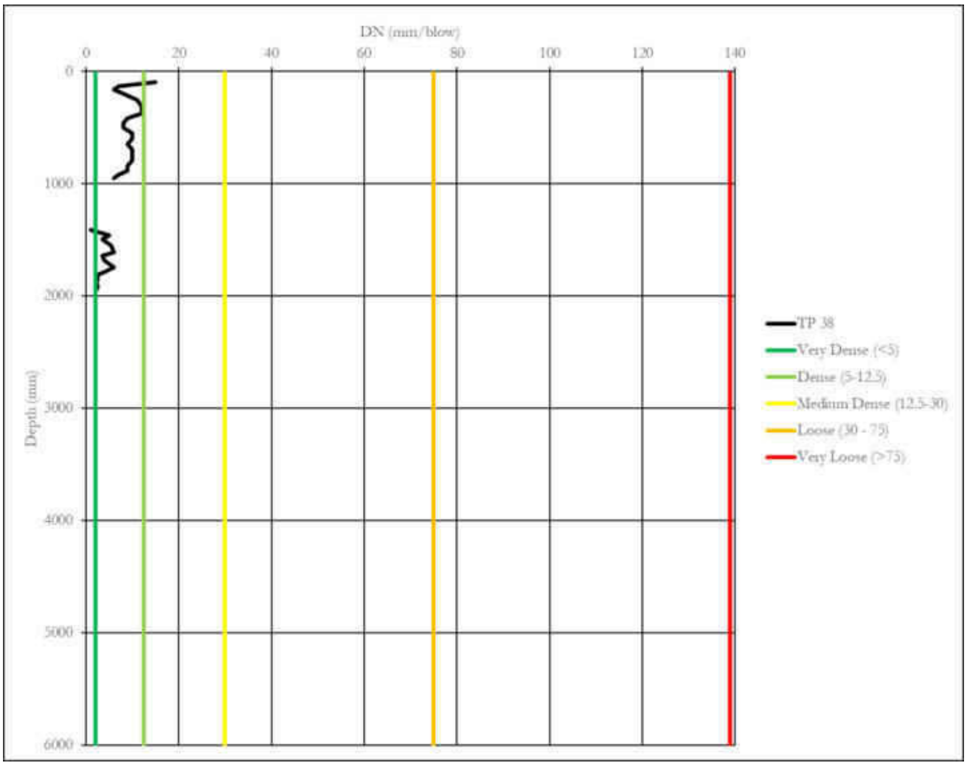

Figure 87: DCP38 Log.

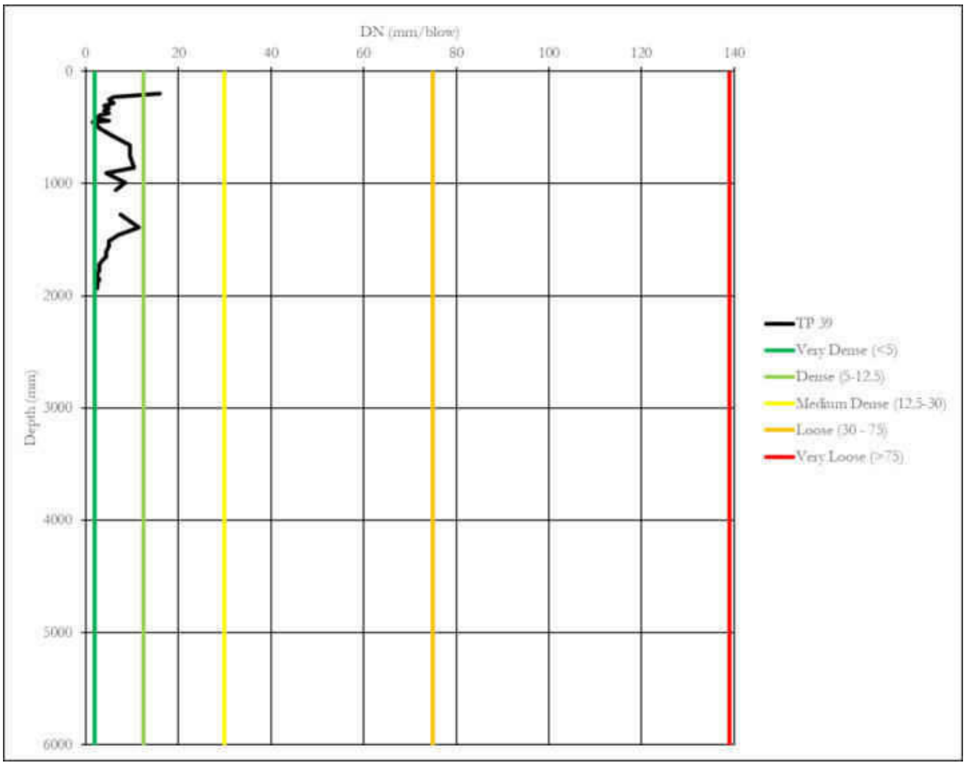

Figure 88: DCP39 Log.

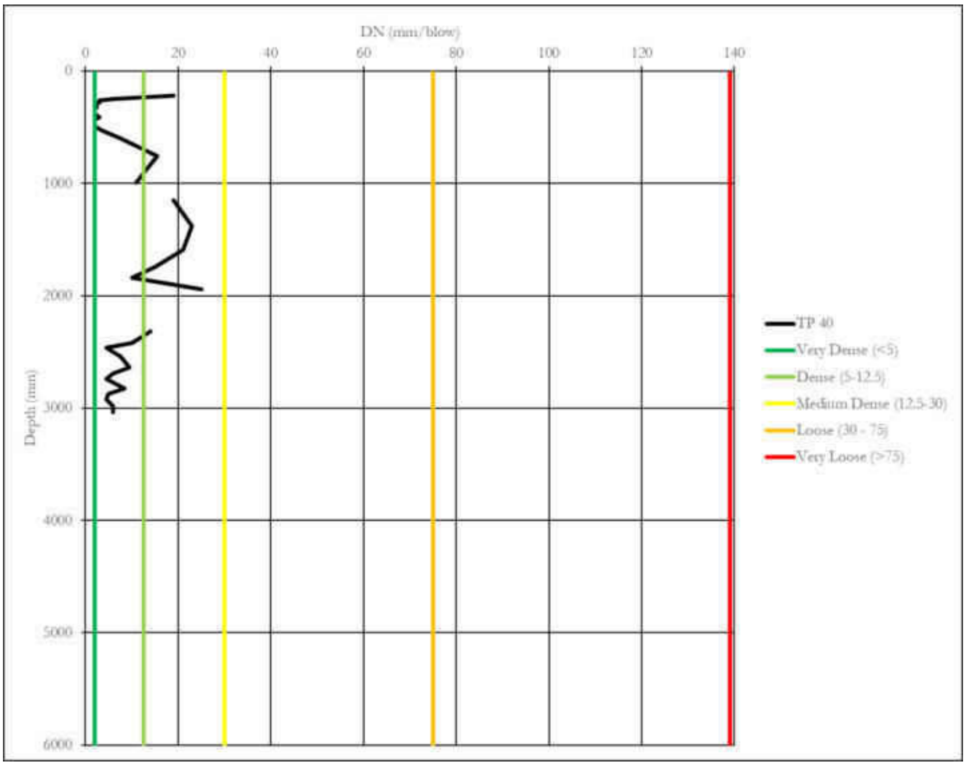

Figure 89: DCP40 Log.

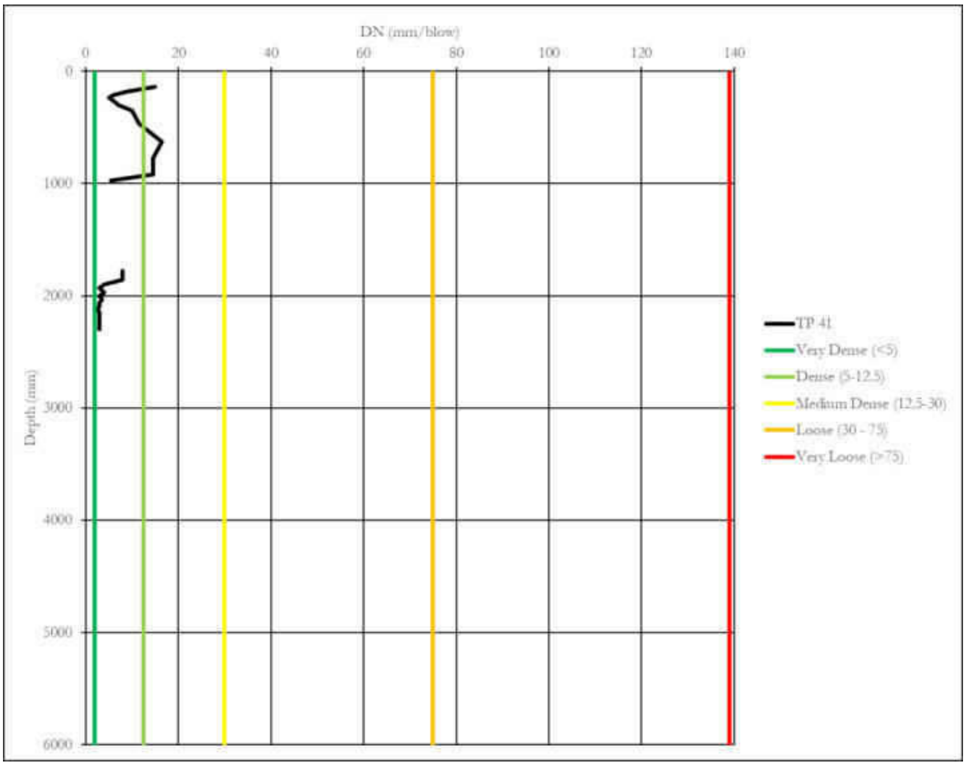

Figure 90: DCP41 Log.

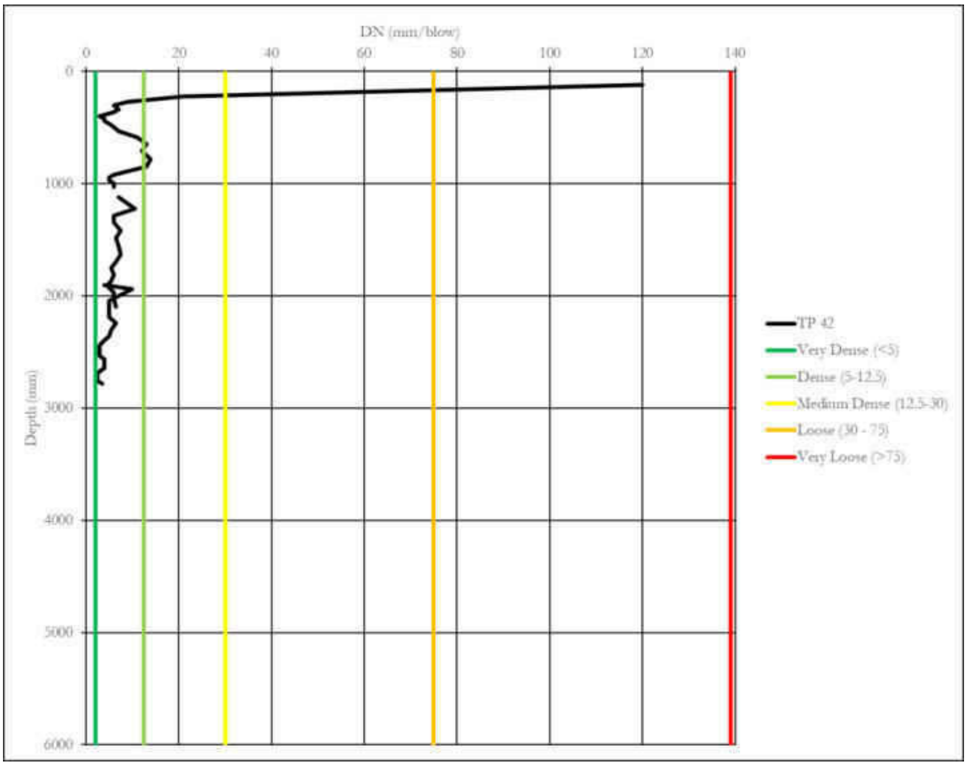

Figure 91: DCP42 Log.

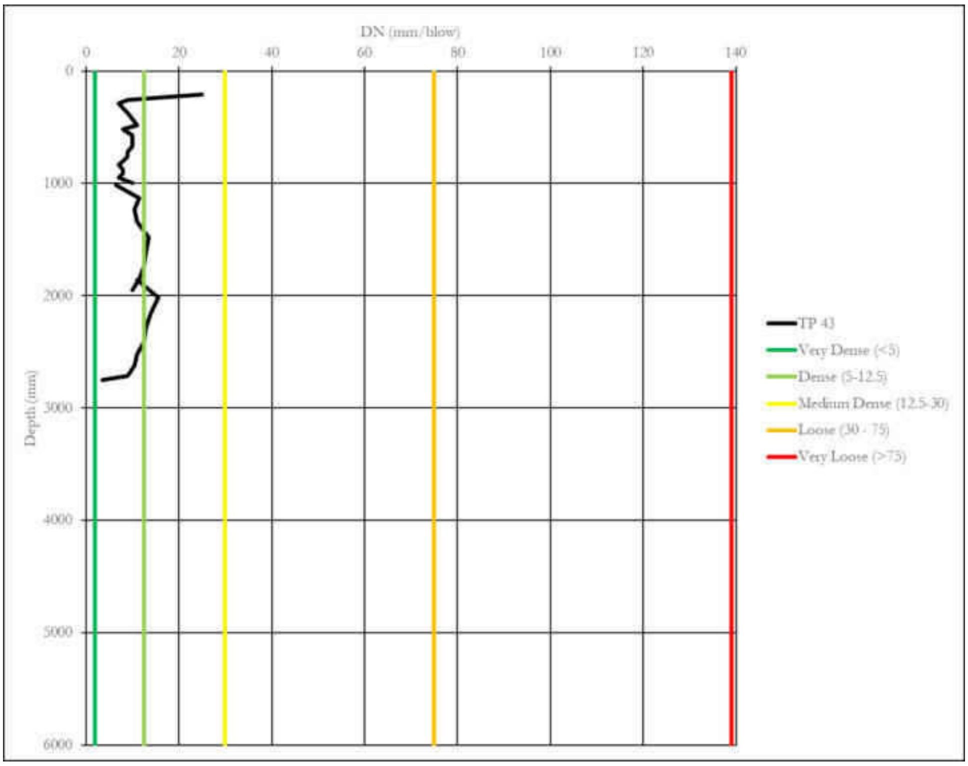

Figure 92: DCP43 Log.

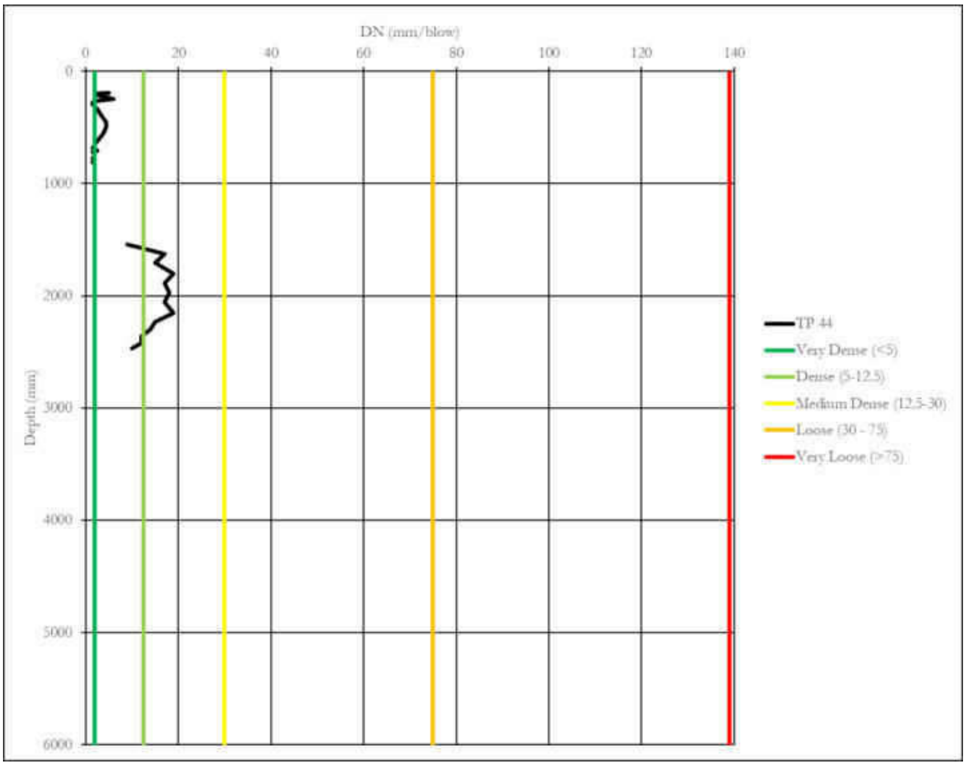

Figure 93: DCP44 Log.

13. APPENDIX E: LABORATORY ANALYSIS RESULTS

05 March 2019 Rev02 TR - SW0039

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Web: www.steynwilson.co.za

Client:	**GEOSS South Africa**
Project:	Fisantekraal Airport
Attention:	Mr Shane Teek
Your Ref. No:	4505
Date Reported	16/02/22

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL19674

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested		***Site Sampling and Materials Information***	
4 x	*MOD / CBR / FOUNDATION INDICATOR*	*Sampling Method*	*Specimens delivered to Steyn Wilson Laboratory.*
		Environmental Condition	*Sunny & Hot*

● **FINAL REPORT**

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr. R.Wilson
Technical Signatory

Remarks:

1. Information contained herein is confidential to STEYN-WILSON PTY LTD and the addressee
2. Opinions & Interpretations are not included in our schedule of Accreditation.
3. The samples where subjected and analysed according to ASTM.
4. The results reported relate only to the sample tested, Further use of the attached information is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.
5. This document is the correct record of all measurements made, and may not be reproduced other than with full written approval from a director of STEYN-WILSON LABORATORIES (PTY) LTD.
6. Measuring equipment is traceable to national standards (Where applicable).
7. Should there be any deviation from the prescribed test method comments will be made thereof, pertaining to the test on the relevant materials report.

DIRECTORS:	Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)
FINANCIAL MANAGER:	Mr. D. Erasmus (SAICA Reg No: 200522562)
LABORATORY MANAGER:	Mr. K. Booysen

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Customer : **GEOSS South Africa**
9 Quantum Street, Techno Park, Unit 12 Technostell Building
Stellenbosch
7600
Attention : Mr Shane Teek

Project : Fisantekraal Airport
Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

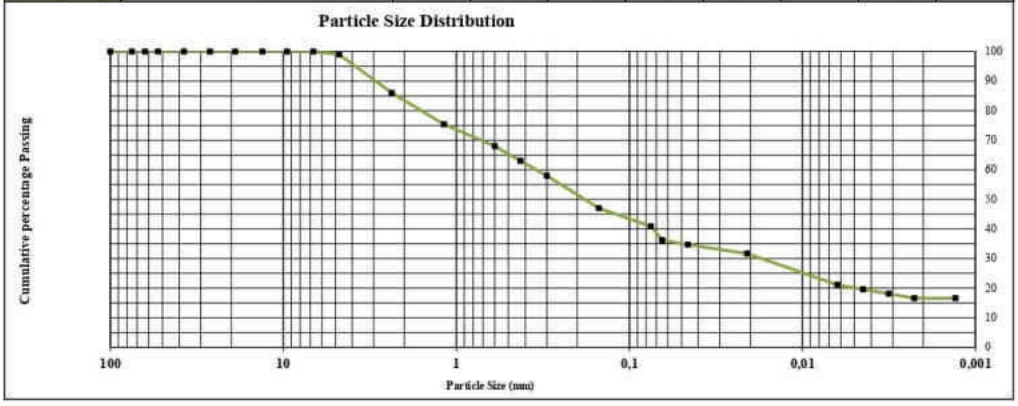
Material Description:	Light Reddish White Clayey SAND	Sample Number:	18589		
Position:	TP 4	Liquid Limit	**33**	Linear Shrinkage	**8,1**
Depth:	1.7m	Plasticity Index	**15**	Insitu M/C%	**1,5**

pH (TMH1 A20)*		Conductivity s.m-¹ (TMH1 A21T)*		SG (TMH1 A12T)*	2,660

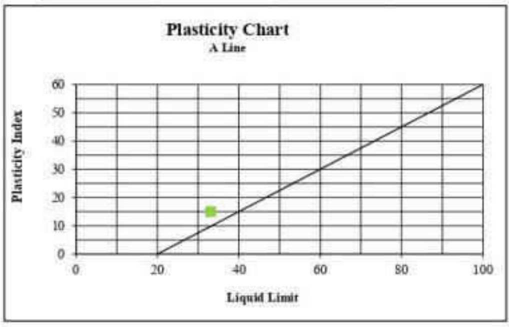
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,065	0,046	0,021	0,006	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	99	86	75,4	68	63	58	47	40,9	36,19	34,68	31,67	21,11	19,6	18,1	16,59	16,59

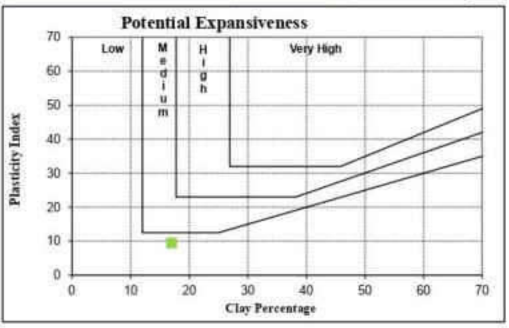
% Passing

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	10,2	COMP MC	% SWELL	100%	98%	97%	95%	93%	90%
MDD(KG/M³)	2102	10,6	1,19	4	3	2	2	1	1

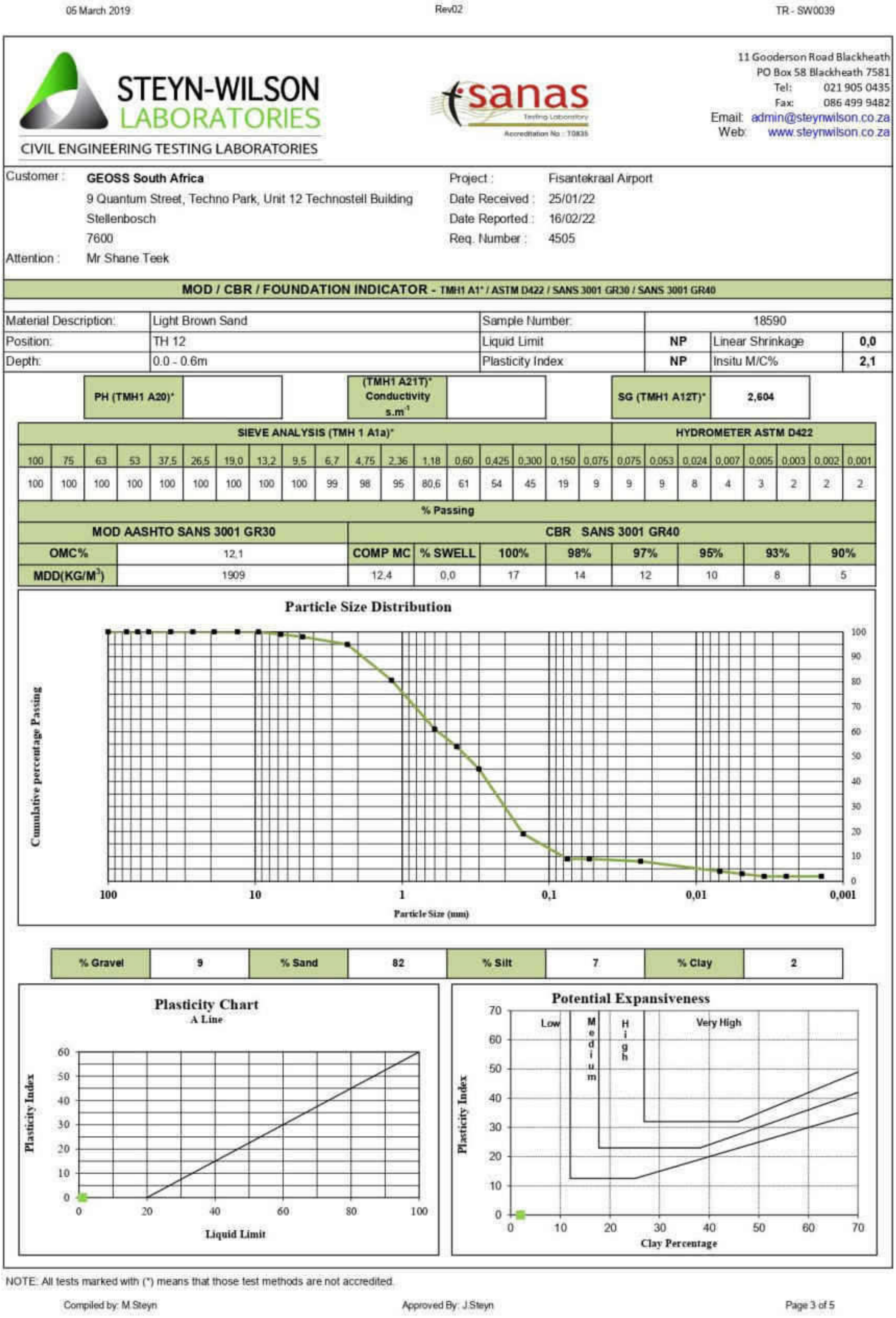


% Gravel	17	% Sand	47	% Silt	19	% Clay	17





NOTE: All tests marked with (*) means that those test methods are not accredited.



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7600
Attention : Mr Shane Teek

Project : Fisantekraal Airport
Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	18590		
Position:	TH 12	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.0 - 0.6m	Plasticity Index	**NP**	Insitu M/C%	**2,1**

PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,604**

SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,075	0,053	0,024	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	99	98	95	80,6	61	54	45	19	9	9	9	8	4	3	2	2	2
% Passing																									

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	12,1	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	1909	12,4	0,0	17	14	12	10	8	5

Particle Size Distribution

% Gravel	9	**% Sand**	82	**% Silt**	7	**% Clay**	2

Plasticity Chart

Potential Expansiveness

NOTE: All tests marked with (*) means that those test methods are not accredited.

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Customer :	**GEOSS South Africa**	Project :	Fisantekraal Airport
	9 Quantum Street, Techno Park, Unit 12 Technostell Building	Date Received :	25/01/22
	Stellenbosch	Date Reported :	16/02/22
	7600	Req. Number :	4505
Attention :	Mr Shane Teek		

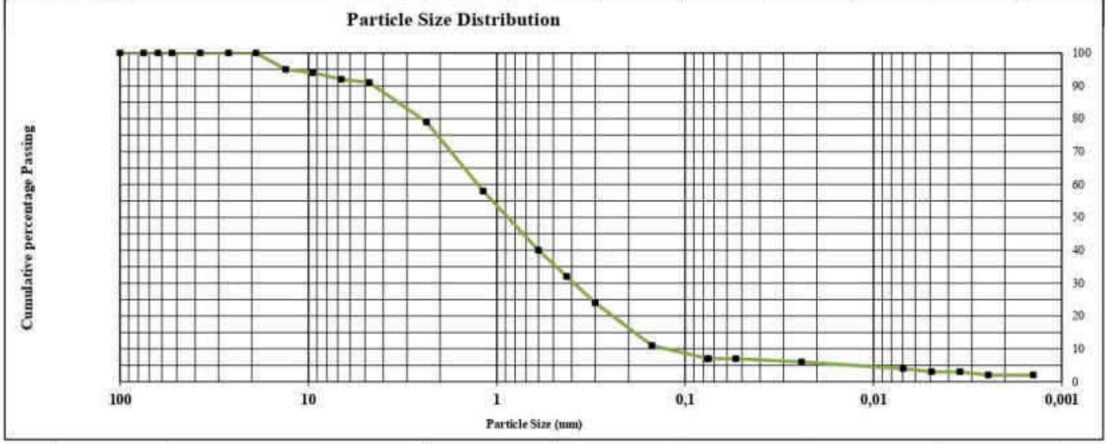
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Coarse Sand	Sample Number:	18591			
Position:	TP 12	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.75 - 1.2m	Plasticity Index	**NP**	Insitu M/C%	**1,2**

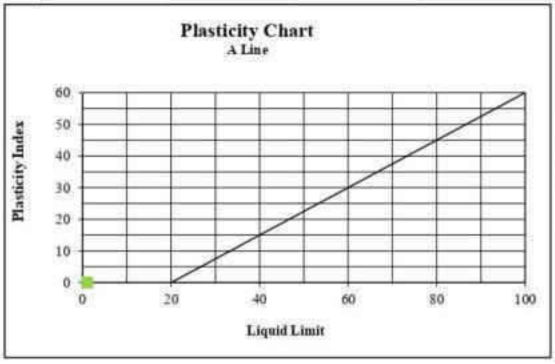
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,577**

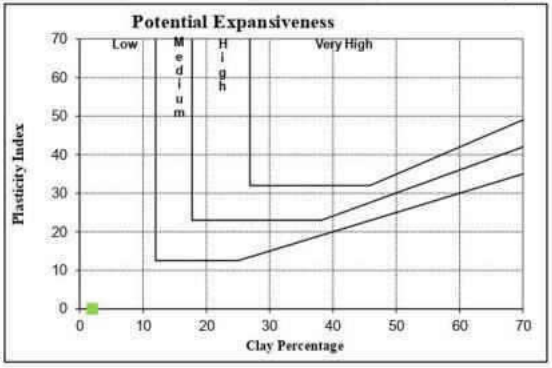
SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,076	0,054	0,024	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	95	94	92	91	79	58	40	32	24	11	7	7	7	6	4	3	3	2	2
% Passing																									

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	9,2	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	2030	9,6	0,0	16	13	12	9	7	5



% Gravel	**27**	**% Sand**	**66**	**% Silt**	**5**	**% Clay**	**2**





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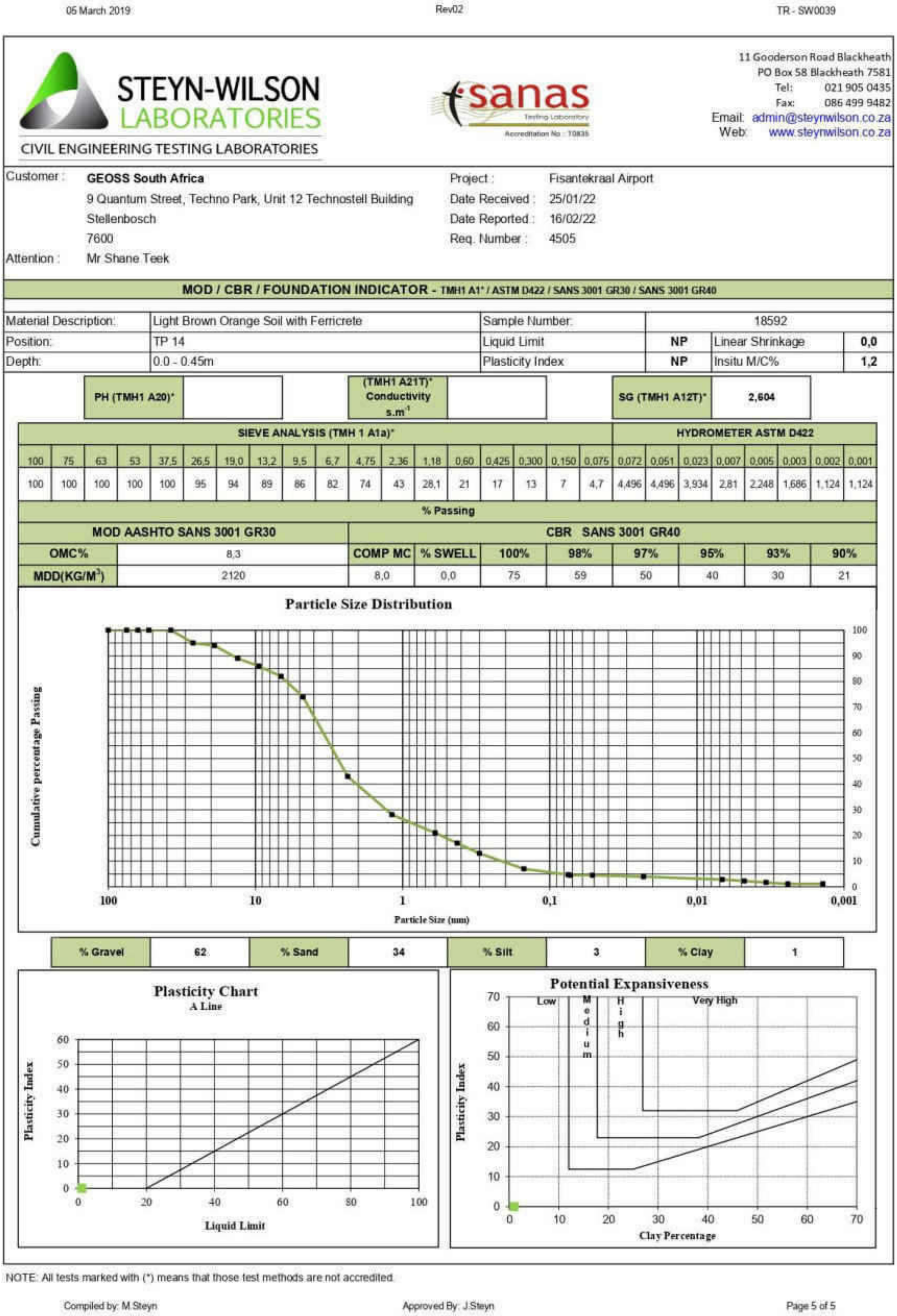

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		Date Received :	25/01/22
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Attention :	Mr Shane Teek		

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Orange Soil with Ferricrete	Sample Number:	18592		
Position:	TP 14	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.0 - 0.45m	Plasticity Index	**NP**	Insitu M/C%	**1,2**

PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m⁻¹**		**SG (TMH1 A12T)***	**2,604**

SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	95	94	89	86	82	74	43	28,1	21	17	13	7	4,7	4,496	4,496	3,934	2,81	2,248	1,686	1,124	1,124

% Passing

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	8,3	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M³)	2120	8,0	0,0	75	59	50	40	30	21

Particle Size Distribution

% Gravel	62	**% Sand**	34	**% Silt**	3	**% Clay**	1

Plasticity Chart

Potential Expansiveness

NOTE: All tests marked with (*) means that those test methods are not accredited.

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Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Whiteish Silty Clay Soil	Sample Number:	18593		
Position:	TP 14	Liquid Limit	**32,2**	Linear Shrinkage	**7,9**
Depth:	1.5-2.0m	Plasticity Index	**15,7**	Insitu M/C%	**4,2**

pH (TMH1 A20)*		**Conductivity s.m-¹ (TMH1 A21T)***		**SG (TMH1 A12T)***	**2,632**

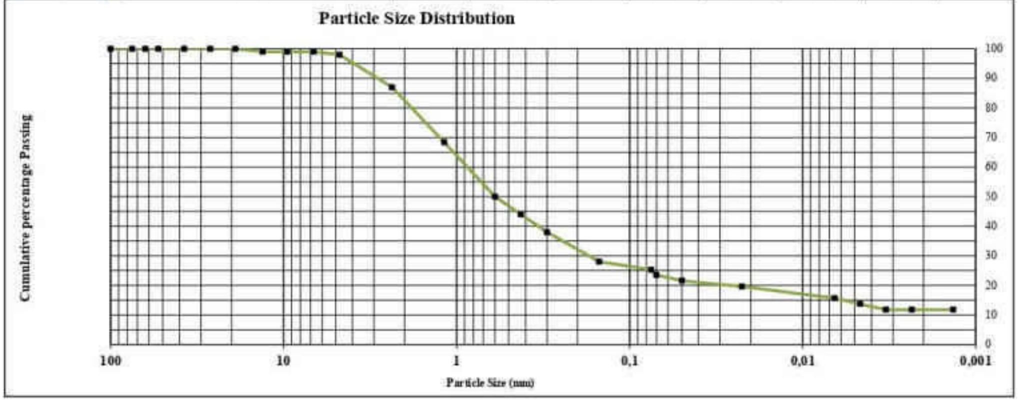
SIEVE ANALYSIS (TMH 1 A1a)* / **HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,070	0,050	0,022	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	99	99	99	98	87	68,4	50	44	38	28	25,3	23,52	21,56	19,6	15,68	13,72	11,76	11,76	11,76

% Passing

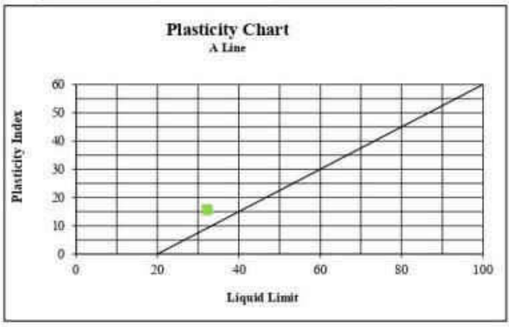
MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	12,2	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M³)	2025	11,8	1,14	19	14	11	8	5	3

Particle Size Distribution

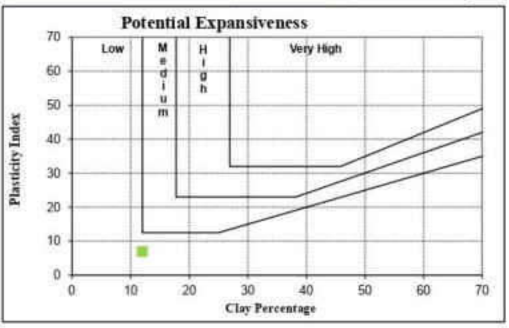


% Gravel	**19**	**% Sand**	**58**	**% Silt**	**11**	**% Clay**	**12**

Plasticity Chart



Potential Expansiveness



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	7600	Req. Number :	4505
Attention :	Mr Shane Teek		

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

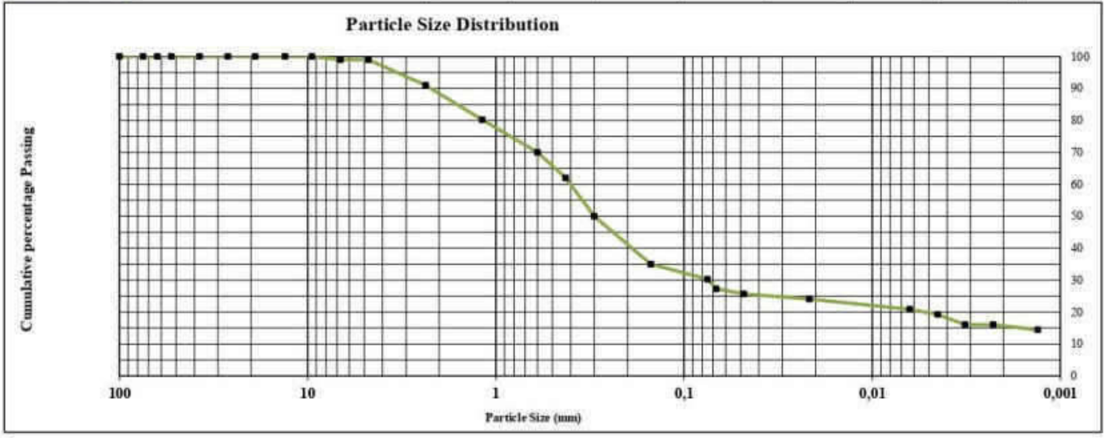
Material Description:	Light Brown Whiteish Silty Soil with Sandstone	Sample Number:	18594		
Position:	TP 15	Liquid Limit	**27**	Linear Shrinkage	**6**
Depth:	0.9-1.7m	Plasticity Index	**9,8**	Insitu M/C%	**7,3**

PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,660**

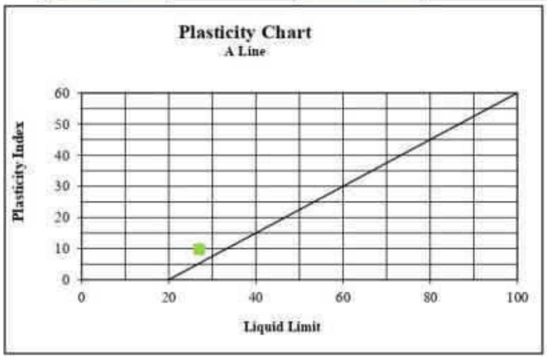
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,067	0,048	0,022	0,006	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	99	99	91	80,2	70	62	50	35	30,3	27,27	25,66	24,06	20,85	19,25	16,04	16,04	14,44

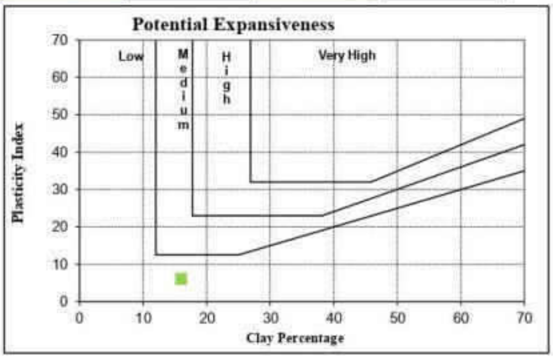
% Passing

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	12,5	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	2022	12,1	0,87	17	11	8	5	3	2



% Gravel	12	% Sand	61	% Silt	11	% Clay	16





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Customer :	**GEOSS South Africa**	Project :	Fisantekraal Airport
	9 Quantum Street, Techno Park, Unit 12 Technostell Building	Date Received :	25/01/22
	Stellenbosch	Date Reported :	16/02/22
	7600	Req. Number :	4505
Attention :	Mr Shane Teek		

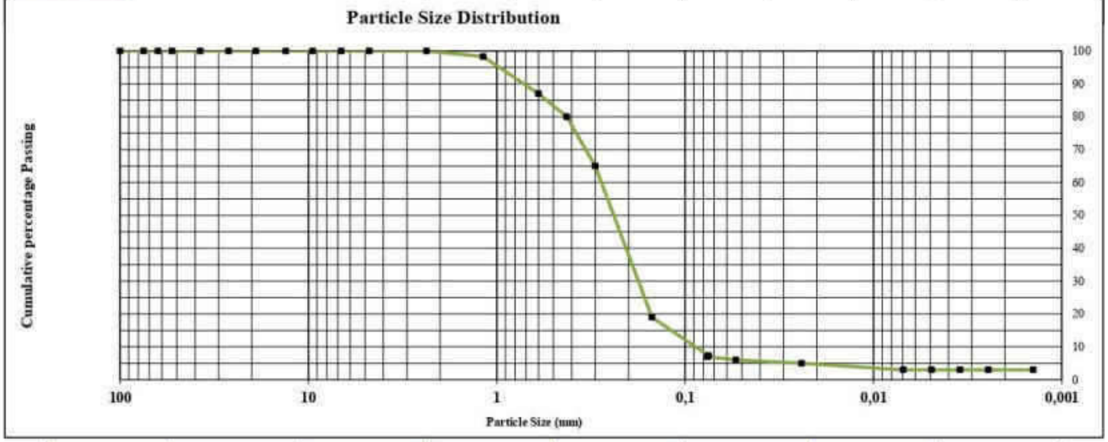
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	18595		
Position:	TP 17	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.0-1.9m	Plasticity Index	**NP**	Insitu M/C%	**4,5**

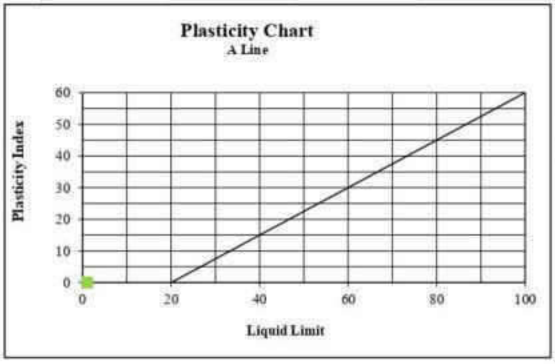
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,577**

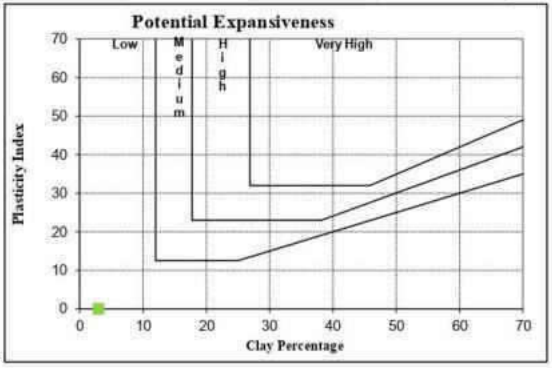
SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,076	0,054	0,024	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	98,3	87	80	65	19	7,3	7	6	5	3	3	3	3	3
% Passing																									

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	12,3	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	1808	12,4	0,0	14	10	9	7	6	4



% Gravel	1	**% Sand**	93	**% Silt**	3	**% Clay**	3





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9 Quantum Street, Techno Park, Unit 12 Technostell Building
Stellenbosch
7600
Attention : Mr Shane Teek

Project : Fisantekraal Airport
Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

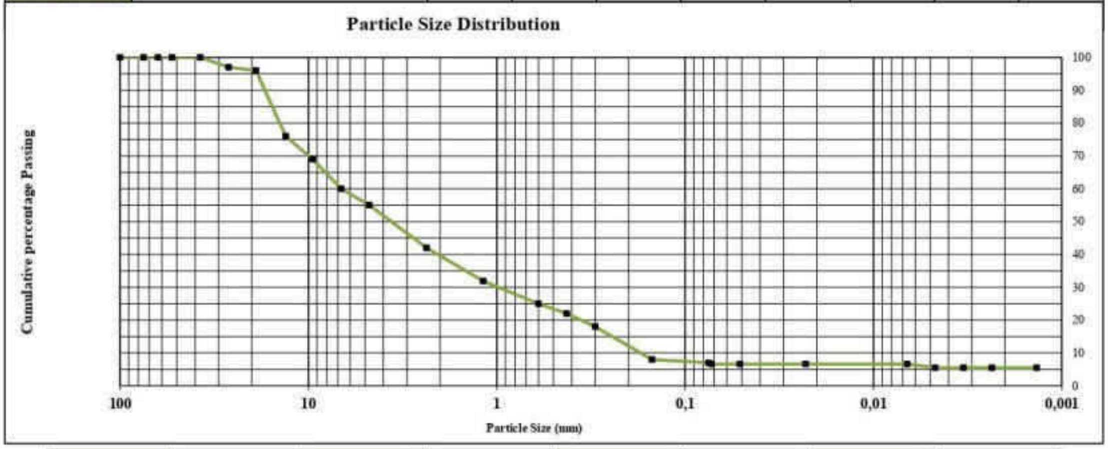
Material Description:	Dark Bown Sandy GRAVEL	Sample Number:	18596		
Position:	TP 18	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.2-0.6m	Plasticity Index	**NP**	Insitu M/C%	**4,5**

PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,632**

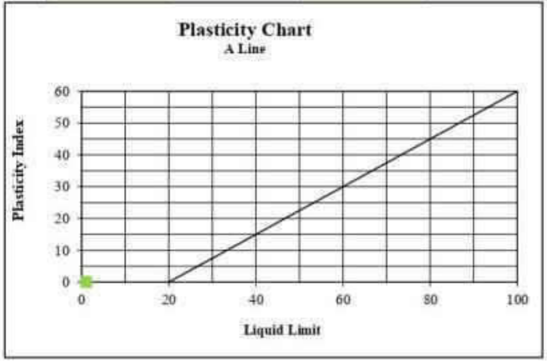
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	97	96	76	69	60	55	42	31,9	25	22	18	8	7	6,6	6,6	6,6	6,6	5,5	5,5	5,5	5,5

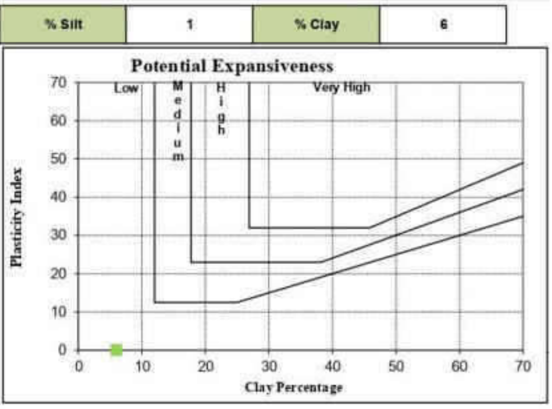
% Passing

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	7,3	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	2240	7,0	0,0	50	39	33	26	20	13



% Gravel	61	% Sand	32	% Silt	1	% Clay	6





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	Stellenbosch	Date Reported :	16/02/22
	7600	Req. Number :	4505
Attention :	Mr S Teek		

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

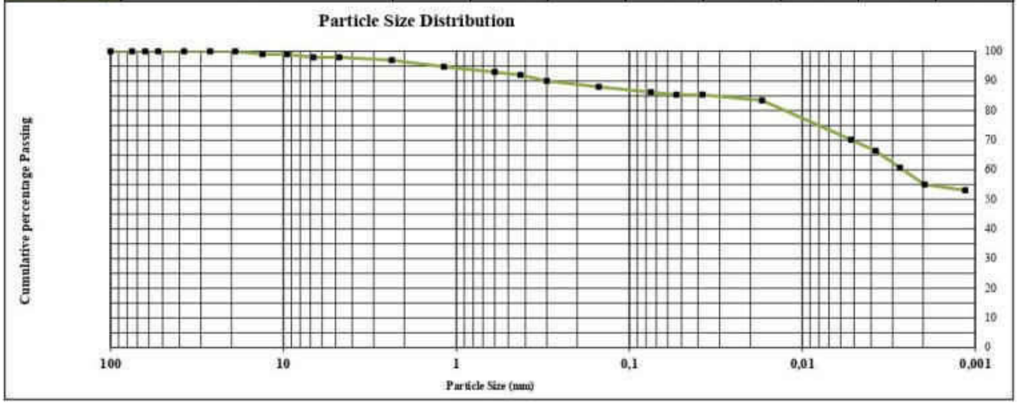
Material Description:	Reddish Brown CLAY	Sample Number:	18597		
Position:	TP 18	Liquid Limit	**77,9**	Linear Shrinkage	**18,9**
Depth:	0.6-1.0m	Plasticity Index	**41,8**	Insitu M/C%	**15,8**

pH (TMH1 A20)*		**Conductivity s.m-¹ (TMH1 A21T)***		**SG (TMH1 A12T)***	**2,747**

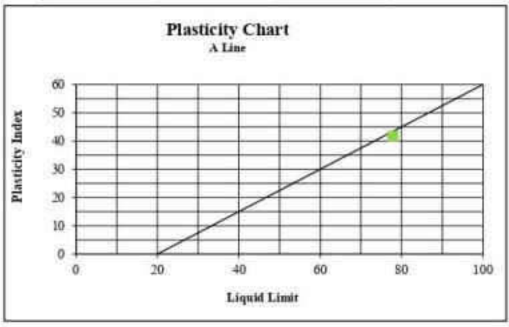
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,053	0,038	0,017	0,005	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	99	99	98	98	97	94,8	93	92	90	88	86,2	85,32	85,32	83,42	70,15	66,36	60,67	54,98	53,09

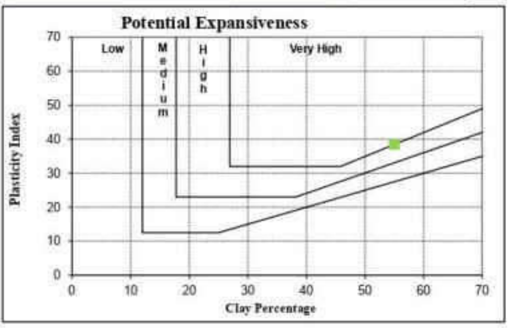
% Passing

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	14,3	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M³)	1788	14,0	1,87	1	1	1	1	1	1



% Gravel	4	**% Sand**	11	**% Silt**	30	**% Clay**	55





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Attention : Mr S Teek

Project : Fisantekraal Airport
Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

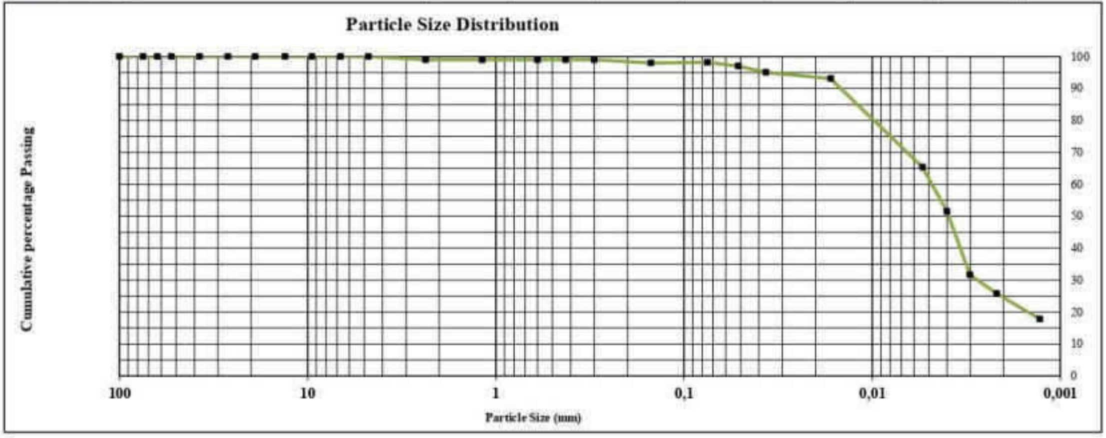
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	White Clayey SILT	Sample Number:	18598		
Position:	TP 22	Liquid Limit	**48**	Linear Shrinkage	**6,2**
Depth:	0.5-2.0m	Plasticity Index	**16,8**	Insitu M/C%	**15,6**

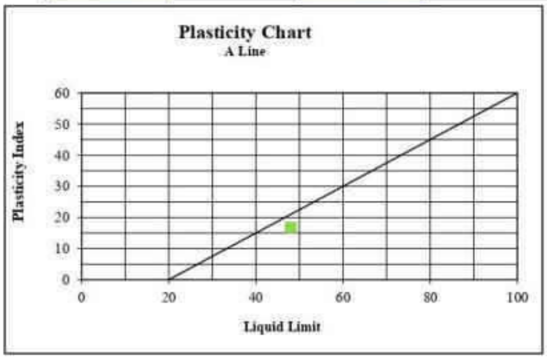
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,747**

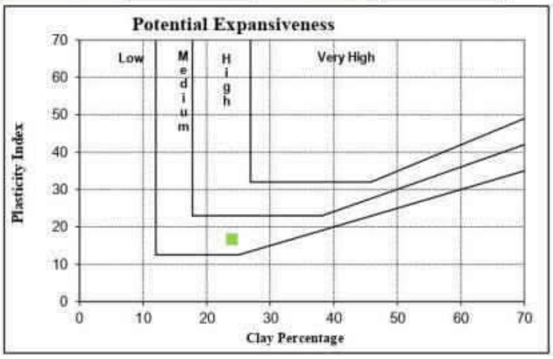
SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,052	0,037	0,017	0,005	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	99	99	99	99	99	98	98,2	97,02	95,04	93,06	65,34	51,48	31,68	25,74	17,82
% Passing																									

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	13,4	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	1745	13,1	0,94	1	1	1	1	1	1



% Gravel	1	**% Sand**	1	**% Silt**	74	**% Clay**	24





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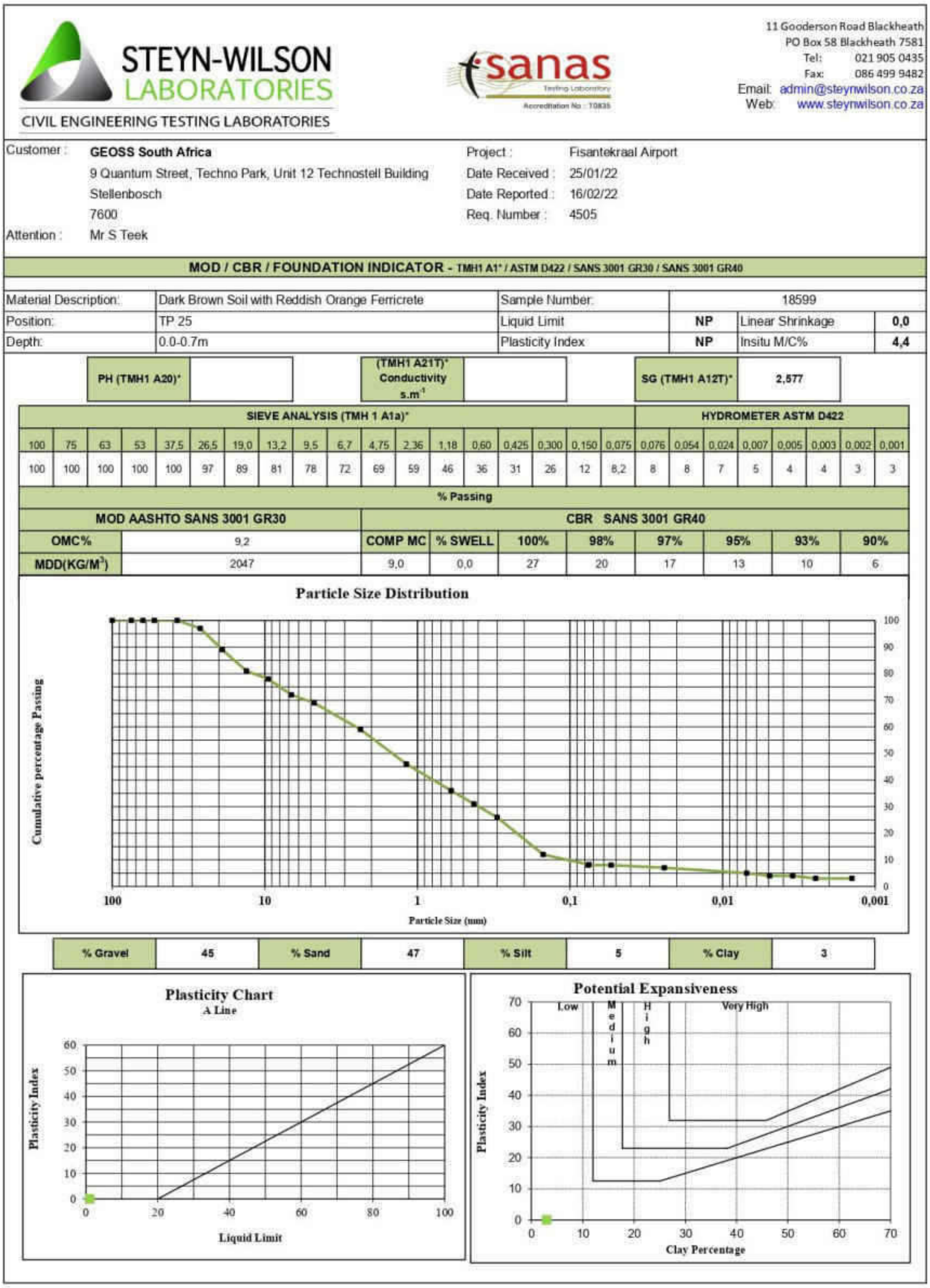

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	9 Quantum Street, Techno Park, Unit 12 Technostell Building	Date Received :	25/01/22
	Stellenbosch	Date Reported :	16/02/22
	7600	Req. Number :	4505
Attention :	Mr S Teek		

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Dark Brown Soil with Reddish Orange Ferricrete	Sample Number:	18599		
Position:	TP 25	Liquid Limit	**NP**	Linear Shrinkage	**0,0**
Depth:	0.0-0.7m	Plasticity Index	**NP**	Insitu M/C%	**4,4**

PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,577**

SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,076	0,054	0,024	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	97	89	81	78	72	69	59	46	36	31	26	12	8,2	8	8	7	5	4	4	3	3
% Passing																									

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	9,2	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	2047	9,0	0,0	27	20	17	13	10	6

Particle Size Distribution

% Gravel	45	**% Sand**	47	**% Silt**	5	**% Clay**	3

Plasticity Chart

Potential Expansiveness

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Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

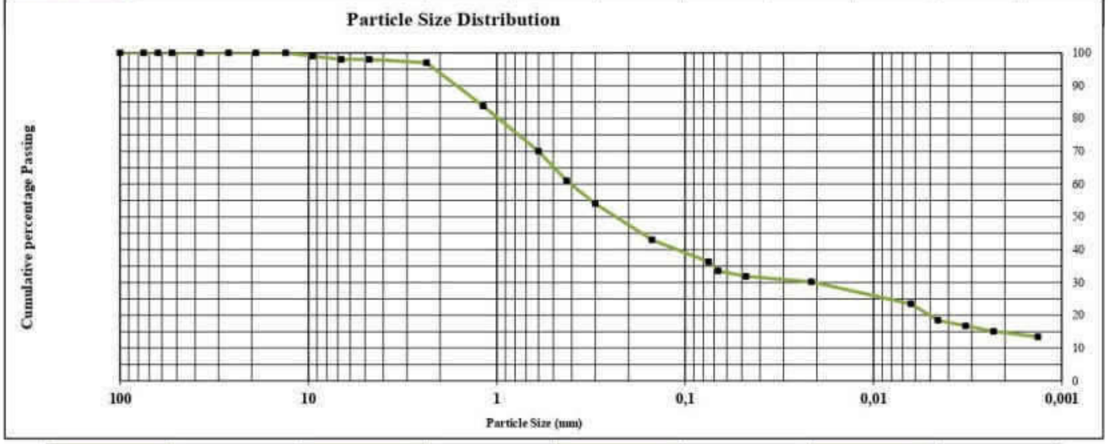
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Whiteish Silty Sand	Sample Number:	18600		
Position:	TP 25	Liquid Limit	**24**	Linear Shrinkage	**4,5**
Depth:	0.9-1.4m	Plasticity Index	**8,6**	Insitu M/C%	**4,4**

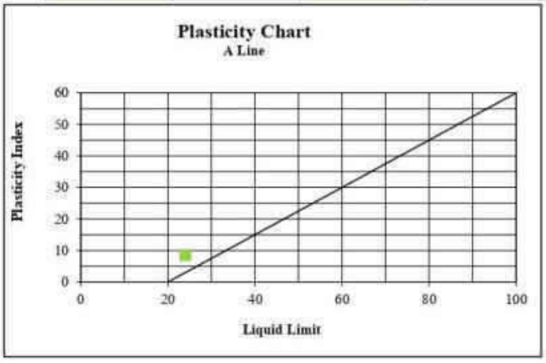
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,632**

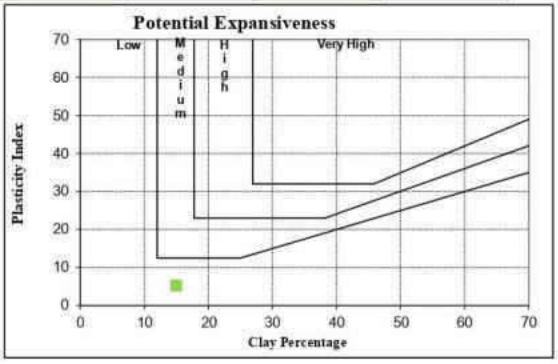
SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,067	0,048	0,021	0,006	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	99	98	98	97	83,8	70	61	54	43	36,3	33,52	31,84	30,17	23,46	18,44	16,76	15,08	13,41
% Passing																									

MOD AASHTO SANS 3001 GR30		**CBR SANS 3001 GR40**							
OMC%	8,2	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M^3)	2143	7,8	0,58	14	12	11	9	7	5



% Gravel	7	**% Sand**	60	**% Silt**	18	**% Clay**	15





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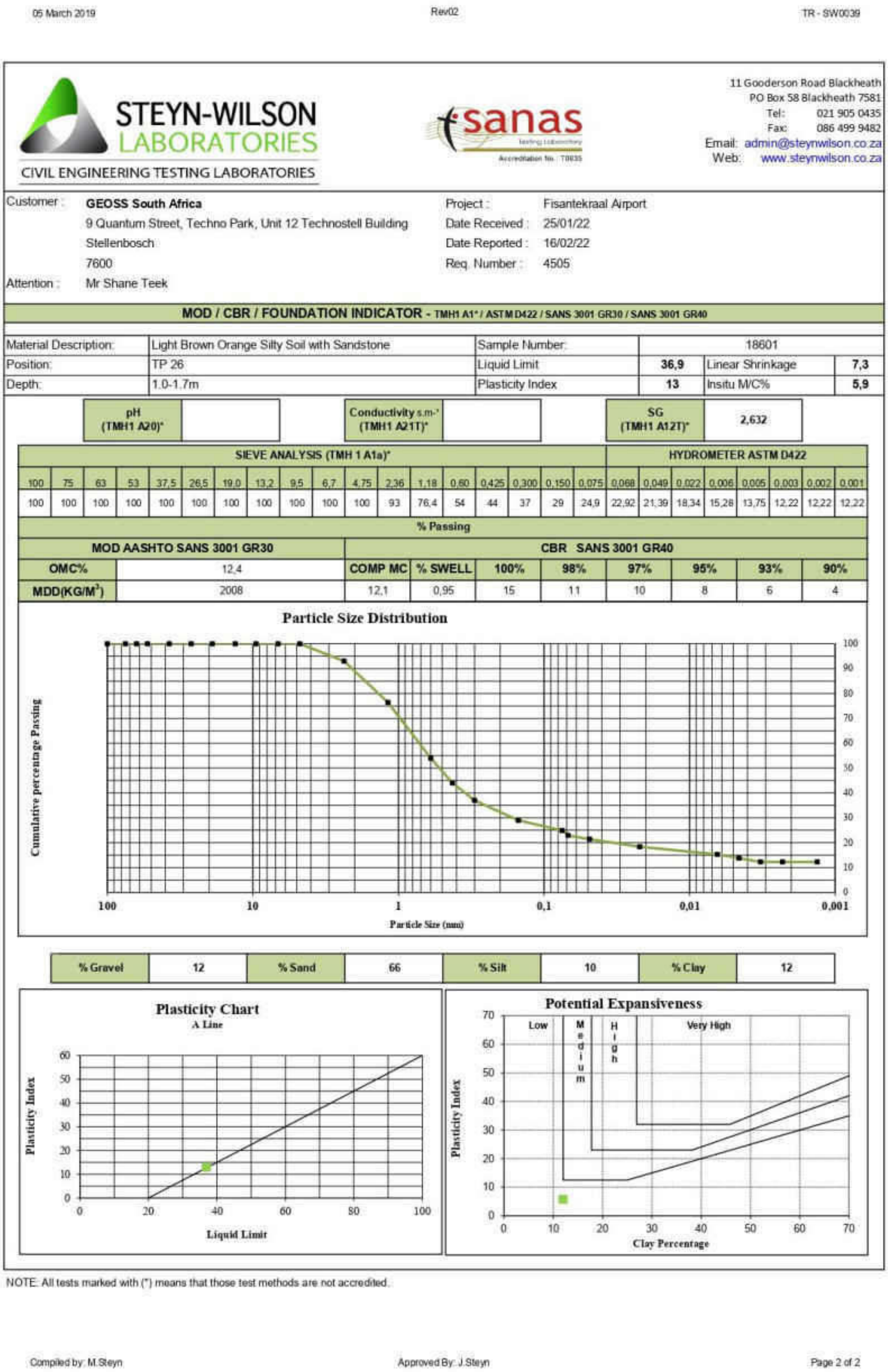

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Date Received : 25/01/22
Date Reported : 16/02/22
Req. Number : 4505

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Orange Silty Soil with Sandstone	Sample Number:	18601		
Position:	TP 26	Liquid Limit	**36,9**	Linear Shrinkage	**7,3**
Depth:	1.0-1.7m	Plasticity Index	**13**	Insitu M/C%	**5,9**

pH (TMH1 A20)*		**Conductivity s.m-¹ (TMH1 A21T)***		**SG (TMH1 A12T)***	**2,632**

SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,068	0,049	0,022	0,006	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	93	76,4	54	44	37	29	24,9	22,92	21,39	18,34	15,28	13,75	12,22	12,22	12,22

% Passing

MOD AASHTO SANS 3001 GR30		CBR SANS 3001 GR40							
OMC%	12,4	**COMP MC**	**% SWELL**	**100%**	**98%**	**97%**	**95%**	**93%**	**90%**
MDD(KG/M³)	2008	12,1	0,95	15	11	10	8	6	4

Particle Size Distribution

% Gravel	12	**% Sand**	66	**% Silt**	10	**% Clay**	12

Plasticity Chart
A Line

Potential Expansiveness

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Client:	**GEOSS South Africa**
Project:	4505
Attention:	Mr S Teek
Your Ref. No:	4505
Date Reported	11/05/22

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL21614

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested	***Site Sampling and Materials Information***	
3 x FOUNDATION INDICATOR	*Sampling Method*	*Specimens delivered to Steyn Wilson Laboratory.*
	Environmental Condition	*Sunny*
	Deviation from the prescribed test method	
	Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

● **FINAL REPORT**

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr J.Steyn
Technical Signatory

Remarks:

1. Information contained herein is confidential to STEYN-WILSON PTY LTD and the addressee
2. Opinions & Interpretations are not included in our schedule of Accreditation.
3. The samples where subjected and analysed according to ASTM.
4. The results reported relate only to the sample tested, Further use of the attached information is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.
5. This document is the correct record of all measurements made, and may not be reproduced other than with full written approval from a director of STEYN-WILSON LABORATORIES (PTY) LTD.
6. Measuring equipment is traceable to national standards (Where applicable).
7. Should there be any deviation from the prescribed test method comments will be made thereof, pertaining to the test on the relevant materials report.
8. Uncertainty of measurement is calculated and corresponds to a coverage probability of approximately 95%. Available on request.
9. The decision rule states that the measurement of uncertainty can be applied by the customer to the test results, on request. It is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.

DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

Compiled By: M Steyn Approved By: J.Steyn / R. Wilson Page 1 of 4

STEYN-WILSON
LABORATORIES
CIVIL ENGINEERING TESTING LABORATORIES

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Fax: 086 499 9482
Email: info@steynwilson.co.za
Web: www.steynwilson.co.za

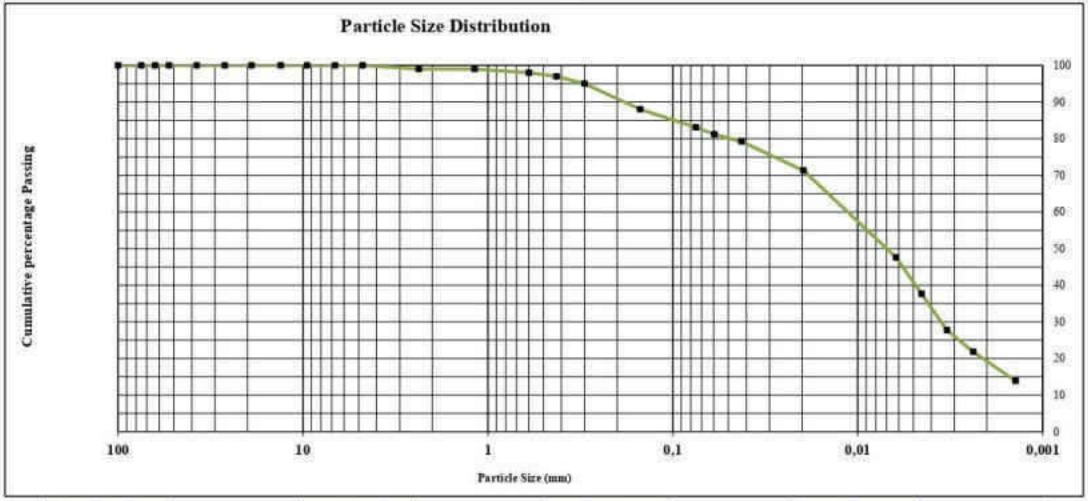
Customer :	**GEOSS South Africa**	Project :	4505
	9 Quantum Street, Techno Park, Unit 12 Technostell Building	Date Received :	19/04/22
	Stellenbosch	Date Reported :	11/05/22
	7600	Req. Number :	4505
Attention :	Mr S Teek	Date Sampled:	19/04/22

FOUNDATION INDICATOR ASTM D422

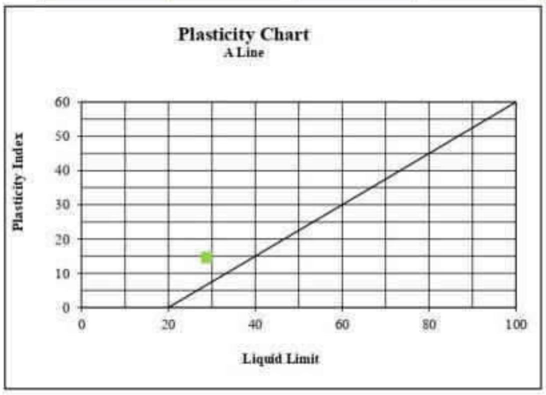
Material Description:	Light Orange Clay	Sample Number:		20001		
Position:	TP 40	Liquid Limit	Casagranda SANS 3001 GR12	**28,8**	Linear Shrinkage	**7,8**
Depth:	0.5 - 1.1m	Plasticity Index		**14,6**	Insitu M/C%	**15,7**

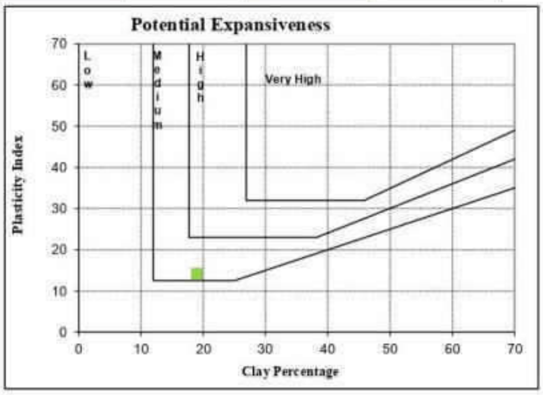
PH (TMH1 A20)		**(TMH1 A21T) Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,660**

SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,060	0,042	0,020	0,006	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	99	99	98	97	95	88	83,1	81,18	79,2	71,28	47,52	37,62	27,72	21,78	13,86
% Passing																									



% Gravel	1	% Sand	18	% Silt	62	% Clay	19





NOTE: All tests marked with (*) means that those test methods are not accredited.

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Customer : **GEOSS South Africa**
9 Quantum Street, Techno Park, Unit 12 Technostell Building
Stellenbosch
7600
Attention : Mr S Teek

Project : 4505
Date Received : 19/04/22
Date Reported : 11/05/22
Req. Number : 4505

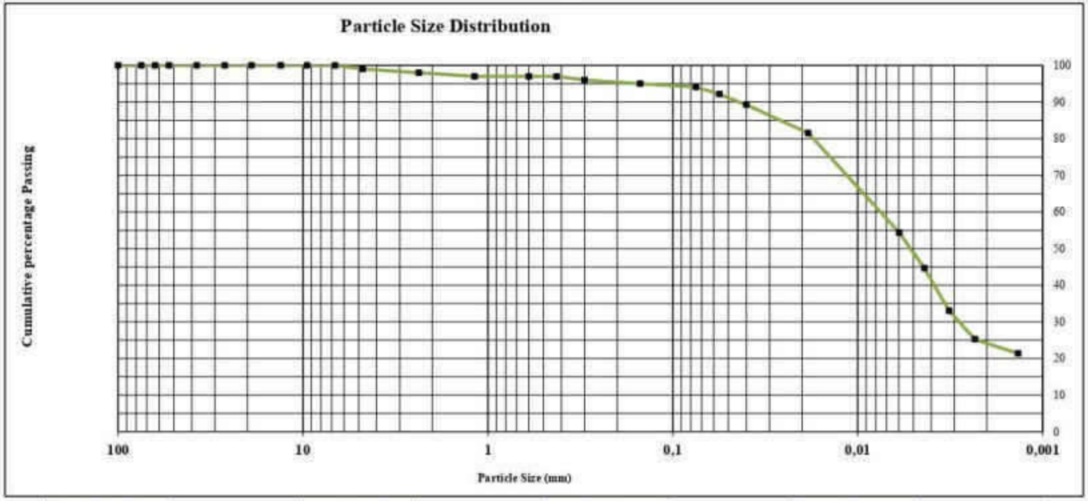
FOUNDATION INDICATOR ASTM D422

Material Description:	Light Orange Clay	Sample Number:	20002		
Position:	TP 42	Liquid Limit Casagranda SANS 3001 GR12	**34,6**	Linear Shrinkage	**7,6**
Depth:	0.8m	Plasticity Index	**15,6**	Insitu M/C%	**11,4**

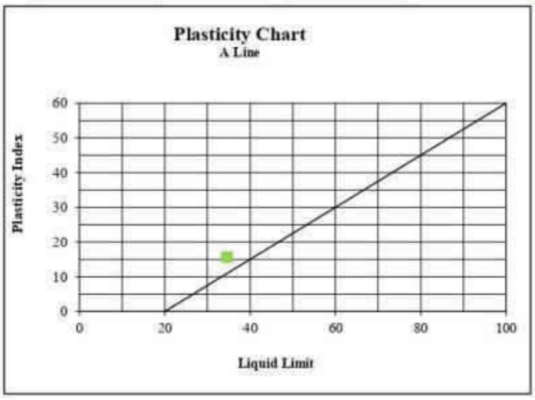
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity $s.m^{-1}$**		**SG (TMH1 A12T)***	**2,688**

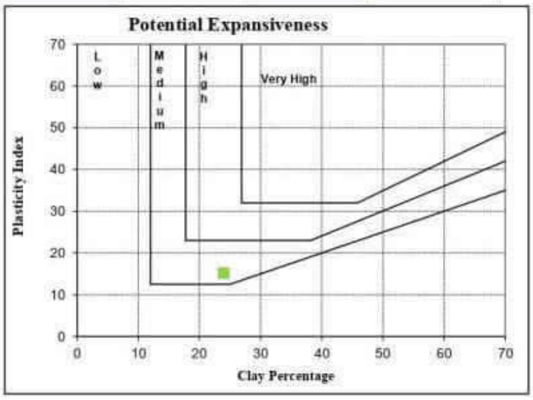
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,056	0,040	0,018	0,006	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	99	98	97	97	97	96	95	94,1	92,15	89,24	81,48	54,32	44,62	32,98	25,22	21,34

% Passing



% Gravel	2	**% Sand**	5	**% Silt**	69	**% Clay**	24





NOTE: All tests marked with (*) means that those test methods are not accredited.

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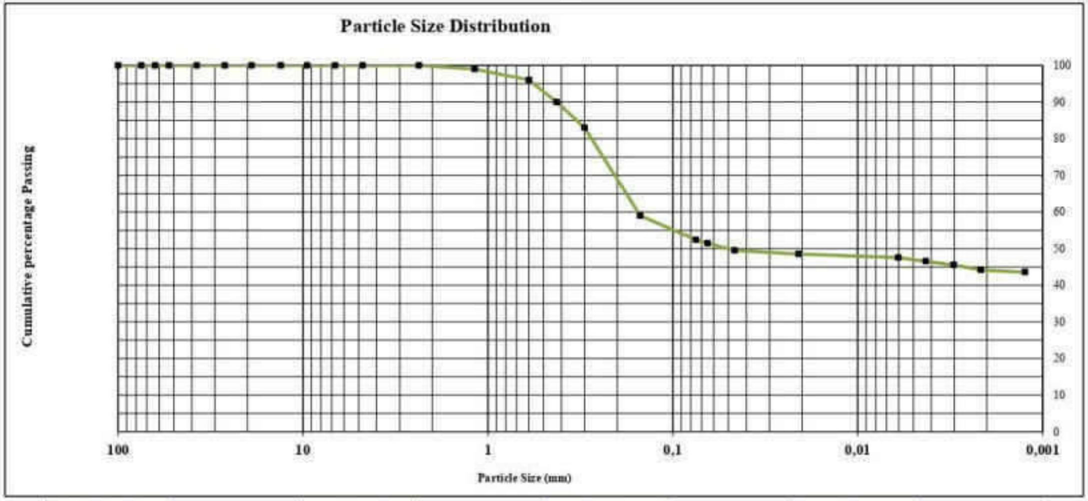
Customer :	**GEOSS South Africa**	Project :	4505
	9 Quantum Street, Techno Park, Unit 12 Technostell Building	Date Received :	19/04/22
	Stellenbosch	Date Reported :	11/05/22
	7600	Req. Number :	4505
Attention :	Mr S Teek		

FOUNDATION INDICATOR ASTM D422

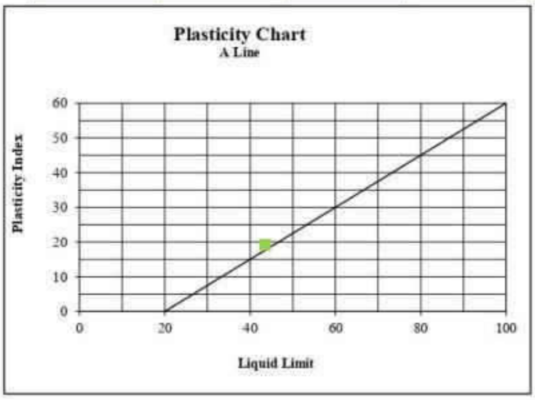
Material Description:	Light Brown Silty Clay	Sample Number:	20003		
Position:	TP 34	Liquid Limit Casagranda SANS 3001 GR12	**43,5**	Linear Shrinkage	**9,2**
Depth:	1.2m	Plasticity Index	**19,2**	Insitu M/C%	**13,5**

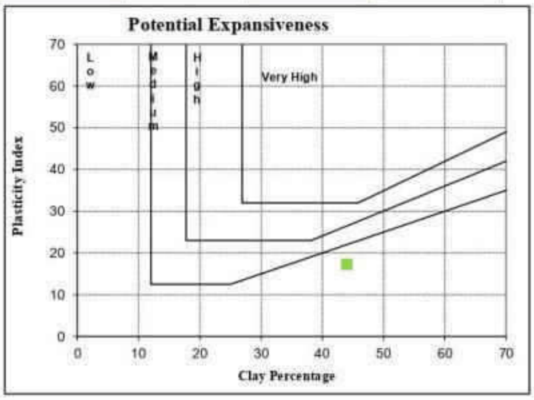
PH (TMH1 A20)*		**(TMH1 A21T)* Conductivity s.m^{-1}**		**SG (TMH1 A12T)***	**2,747**

SIEVE ANALYSIS (TMH 1 A1a)*																		**HYDROMETER ASTM D422**							
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,065	0,046	0,021	0,006	0,004	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	99	96	90	83	59	52,4	51,5	49,5	48,5	47,5	46,5	45,5	44,2	43,6
% Passing																									



% Gravel		**% Sand**	**49**	**% Silt**	**7**	**% Clay**	**44**





NOTE: All tests marked with (*) means that those test methods are not accredited.

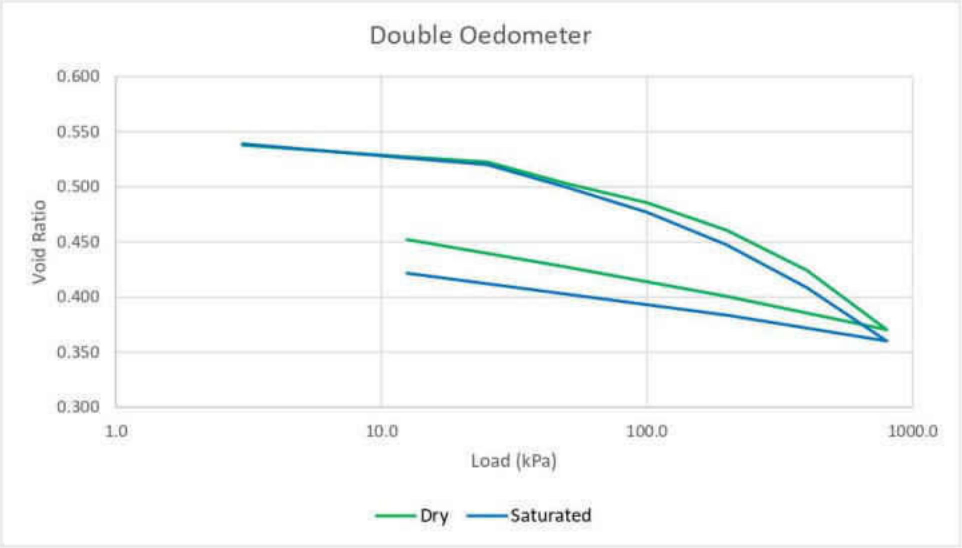
Double Oedometer Test

Dry Sample Detail		Initial	Final
Height	(mm)	20.3	19.2
Diameter	(mm)	63.5	63.5
Weight	(g)	125.7	130.5
Moisture	(%)	13.5	13.9
Dry Density	(Mg/m^3)	1.72	1.89
Bulk Density	(Mg/m^3)	1.96	2.15
Void Ratio		0.538	0.452
Particle Density	(Mg/m^3)	2.65	
Disturbed/Undisturbed		Undisturbed	
Remoulded Density	(Mg/m^3)	-	

Saturated Sample Detail		Initial	Final
Height	(mm)	20.3	18.8
Diameter	(mm)	63.5	63.5
Weight	(g)	125.6	120.2
Moisture	(%)	13.5	28.1
Dry Density	(Mg/m^3)	1.72	1.58
Bulk Density	(Mg/m^3)	1.95	2.02
Void Ratio		0.539	0.421
Particle Density	(Mg/m^3)	2.65	
Disturbed/Undisturbed		Undisturbed	
Remoulded Density	(Mg/m^3)	-	

Dry Sample		
Load (kPa)	Height (mm)	Void Ratio
3.0	20.300	0.538
12.5	20.160	0.527
25.0	20.100	0.523
50.0	19.840	0.503
100.0	19.610	0.486
200.0	19.280	0.461
400.0	18.800	0.424
800.0	18.090	0.370
200.0	18.490	0.401
50.0	18.840	0.427
12.5	19.170	0.452

Saturated Sample		
Load (kPa)	Height (mm)	Void Ratio
3.0	20.300	0.539
12.5	20.130	0.526
25.0	20.050	0.520
50.0	19.780	0.500
100.0	19.480	0.477
200.0	19.090	0.447
400.0	18.580	0.409
800.0	17.940	0.360
200.0	18.250	0.384
50.0	18.500	0.403
12.5	18.750	0.421



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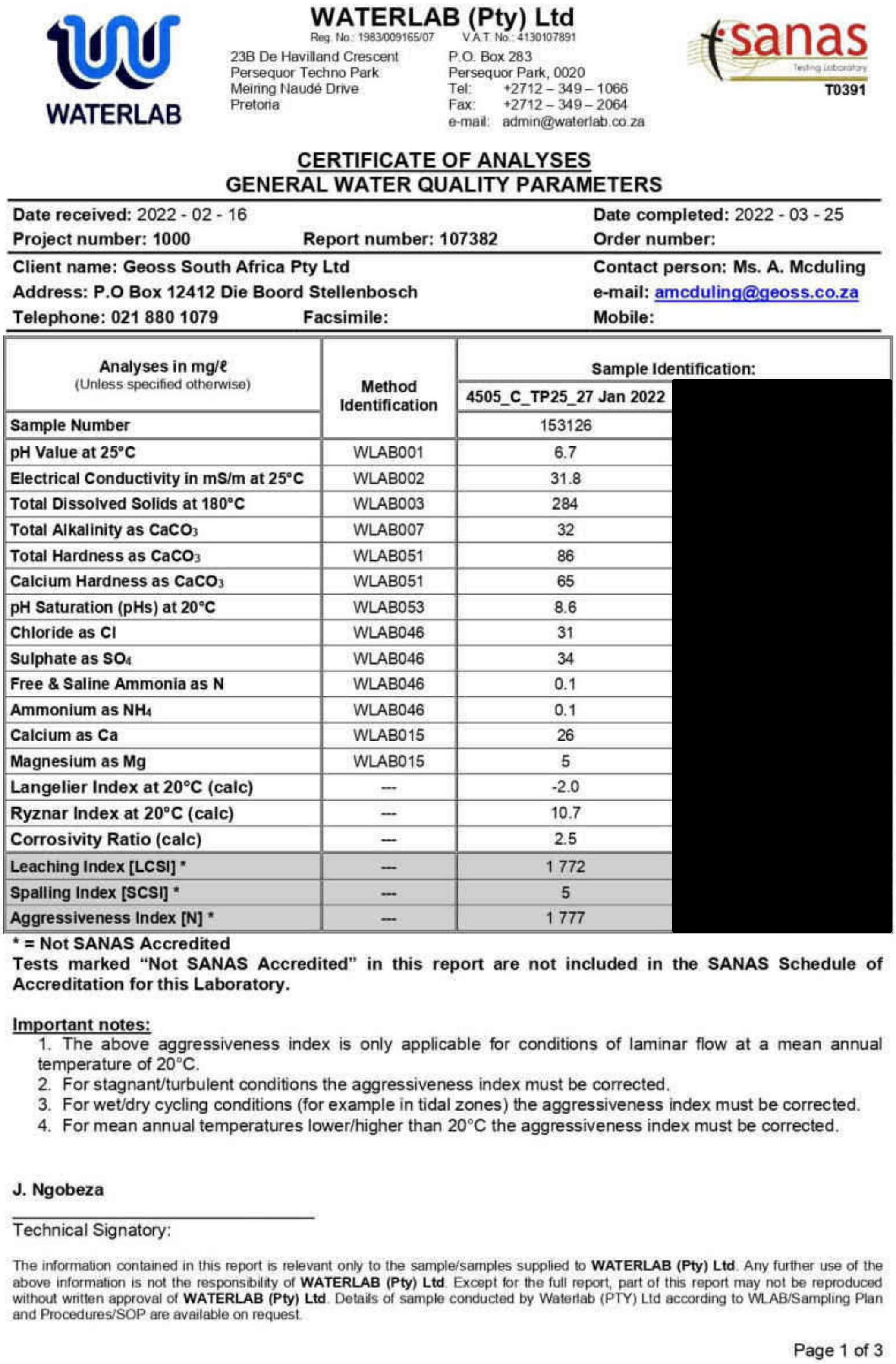
Project	Fisantekraal		
Sample	TP42_0.8m		
Client	Geoss	Test Method	BS1377 - 5: 1990
Jobfile	SWG0036	Test Date	16/05/2022

01/02/2021 Rev2 TR/GEO-SW0011 Compiled: M. Steyn Approved: R. Wilson



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CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2022 - 02 - 16
Date completed: 2022 - 03 - 25
Project number: 1000
Report number: 107382
Order number:

Client name: Geoss South Africa Pty Ltd
Contact person: Ms. A. Mcduling
Address: P.O Box 12412 Die Boord Stellenbosch
e-mail: amcduling@geoss.co.za
Telephone: 021 880 1079
Facsimile:
Mobile:

Analyses in mg/ℓ (Unless specified otherwise)	**Method Identification**	**Sample Identification:**	
		4505_C_TP25_27 Jan 2022	[redacted]
Sample Number		153126	[redacted]
pH Value at 25°C	WLAB001	6.7	[redacted]
Electrical Conductivity in mS/m at 25°C	WLAB002	31.8	[redacted]
Total Dissolved Solids at 180°C	WLAB003	284	[redacted]
Total Alkalinity as $CaCO_3$	WLAB007	32	[redacted]
Total Hardness as $CaCO_3$	WLAB051	86	[redacted]
Calcium Hardness as $CaCO_3$	WLAB051	65	[redacted]
pH Saturation (pHs) at 20°C	WLAB053	8.6	[redacted]
Chloride as Cl	WLAB046	31	[redacted]
Sulphate as SO_4	WLAB046	34	[redacted]
Free & Saline Ammonia as N	WLAB046	0.1	[redacted]
Ammonium as NH_4	WLAB046	0.1	[redacted]
Calcium as Ca	WLAB015	26	[redacted]
Magnesium as Mg	WLAB015	5	[redacted]
Langelier Index at 20°C (calc)	---	-2.0	[redacted]
Ryznar Index at 20°C (calc)	---	10.7	[redacted]
Corrosivity Ratio (calc)	---	2.5	[redacted]
Leaching Index [LCSI] *	---	1 772	[redacted]
Spalling Index [SCSI] *	---	5	[redacted]
Aggressiveness Index [N] *	---	1 777	[redacted]

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

Important notes:

1. The above aggressiveness index is only applicable for conditions of laminar flow at a mean annual temperature of 20°C.
2. For stagnant/turbulent conditions the aggressiveness index must be corrected.
3. For wet/dry cycling conditions (for example in tidal zones) the aggressiveness index must be corrected.
4. For mean annual temperatures lower/higher than 20°C the aggressiveness index must be corrected.

J. Ngobeza

Technical Signatory:

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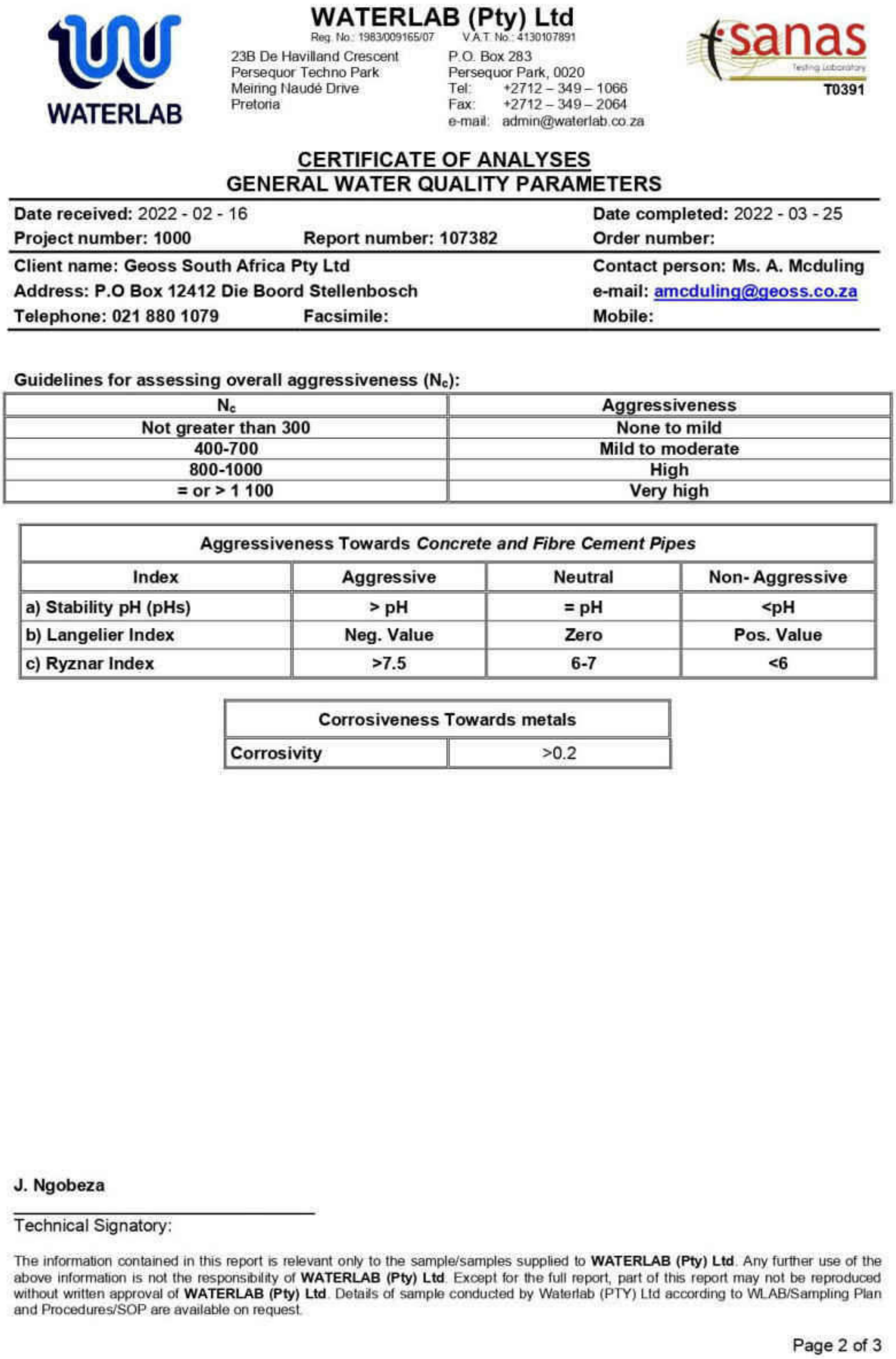
Page 1 of 3



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Testing Laboratory
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CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2022 - 02 - 16		**Date completed:** 2022 - 03 - 25
Project number: 1000	**Report number: 107382**	**Order number:**
Client name: Geoss South Africa Pty Ltd		**Contact person: Ms. A. Mcduling**
Address: P.O Box 12412 Die Boord Stellenbosch		**e-mail:** amcduling@geoss.co.za
Telephone: 021 880 1079	**Facsimile:**	**Mobile:**

Guidelines for assessing overall aggressiveness (N_c):

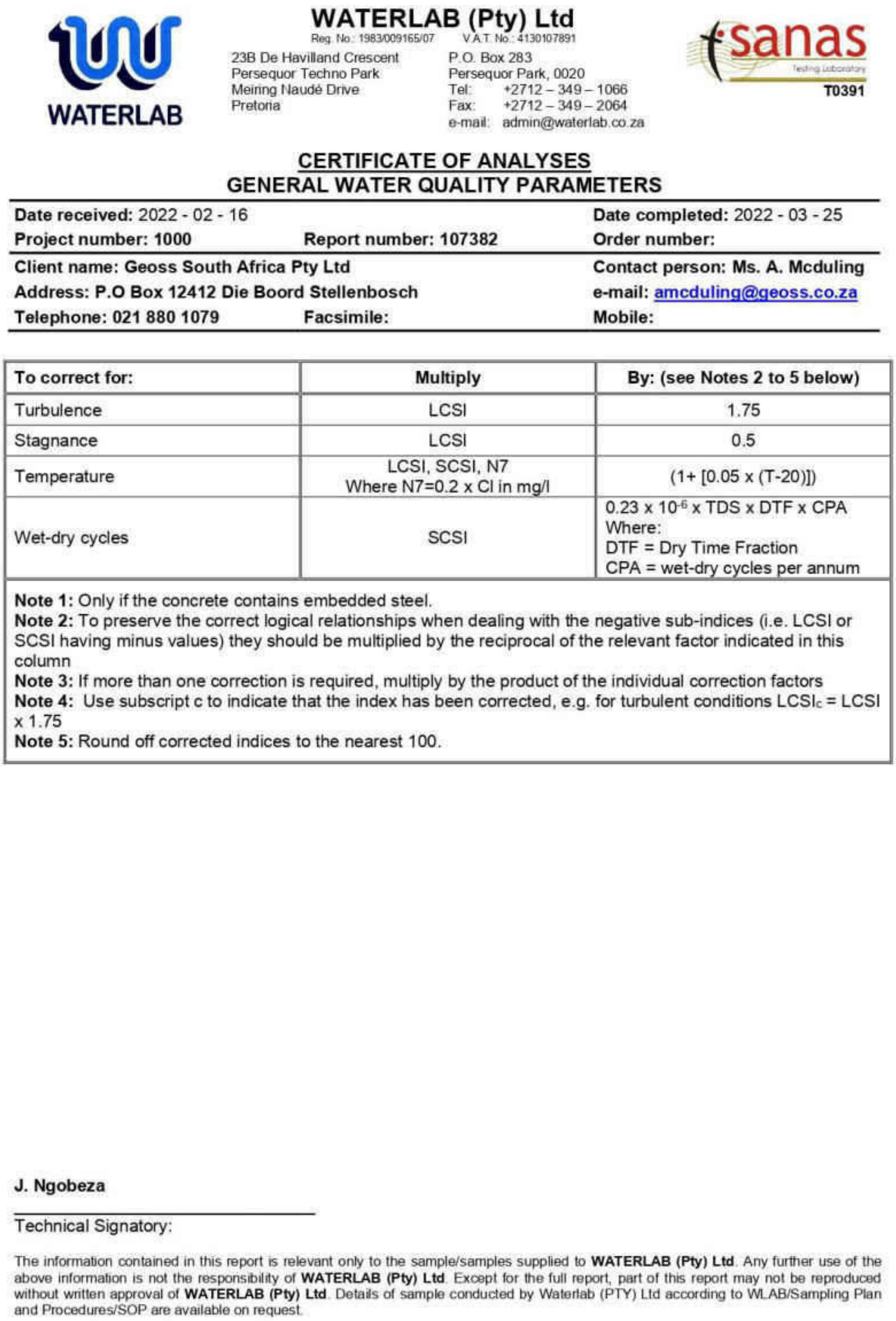
N_c	Aggressiveness
Not greater than 300	None to mild
400-700	Mild to moderate
800-1000	High
= or > 1 100	Very high

Aggressiveness Towards *Concrete and Fibre Cement Pipes*			
Index	Aggressive	Neutral	Non- Aggressive
a) Stability pH (pHs)	> pH	= pH	<pH
b) Langelier Index	Neg. Value	Zero	Pos. Value
c) Ryznar Index	>7.5	6-7	<6

Corrosiveness Towards metals	
Corrosivity	>0.2

J. Ngobeza

Technical Signatory:



WATERLAB

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CERTIFICATE OF ANALYSES
GENERAL WATER QUALITY PARAMETERS

Date received: 2022 - 02 - 16		**Date completed:** 2022 - 03 - 25
Project number: 1000	**Report number: 107382**	**Order number:**
Client name: Geoss South Africa Pty Ltd		**Contact person: Ms. A. Mcduling**
Address: P.O Box 12412 Die Boord Stellenbosch		**e-mail:** amcduling@geoss.co.za
Telephone: 021 880 1079	**Facsimile:**	**Mobile:**

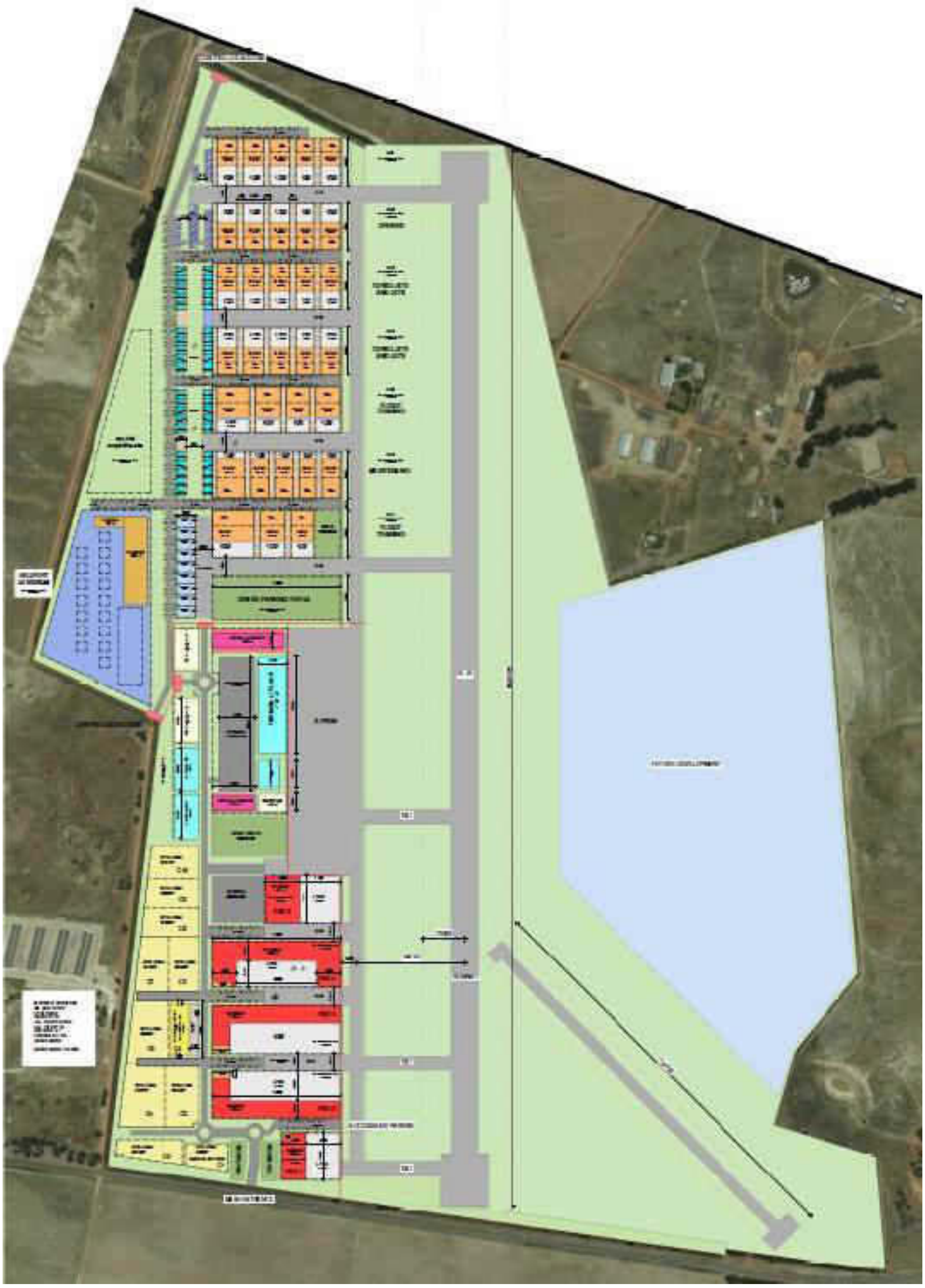
To correct for:	**Multiply**	**By: (see Notes 2 to 5 below)**
Turbulence	LCSI	1.75
Stagnance	LCSI	0.5
Temperature	LCSI, SCSI, N7 Where N7=0.2 x Cl in mg/l	(1+ [0.05 x (T-20)])
Wet-dry cycles	SCSI	0.23 x 10^{-6} x TDS x DTF x CPA Where: DTF = Dry Time Fraction CPA = wet-dry cycles per annum

Note 1: Only if the concrete contains embedded steel.
Note 2: To preserve the correct logical relationships when dealing with the negative sub-indices (i.e. LCSI or SCSI having minus values) they should be multiplied by the reciprocal of the relevant factor indicated in this column
Note 3: If more than one correction is required, multiply by the product of the individual correction factors
Note 4: Use subscript c to indicate that the index has been corrected, e.g. for turbulent conditions $LCSI_c$ = LCSI x 1.75
Note 5: Round off corrected indices to the nearest 100.

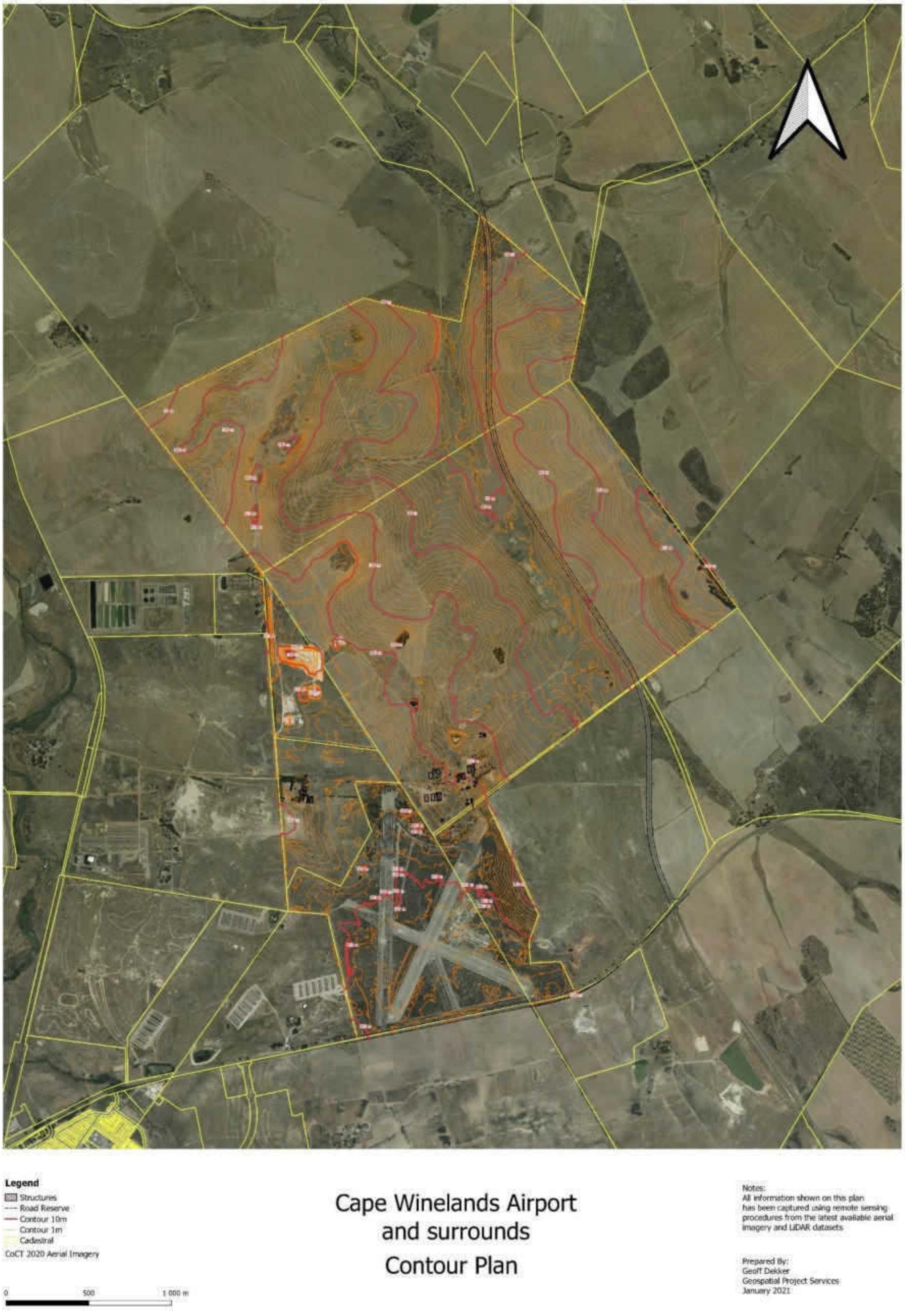
J. Ngobeza

Technical Signatory:

14. APPENDIX F: AVAILABLE PLANS AND SKETCHES



Map 8: Site development plan (Ver. 21D).



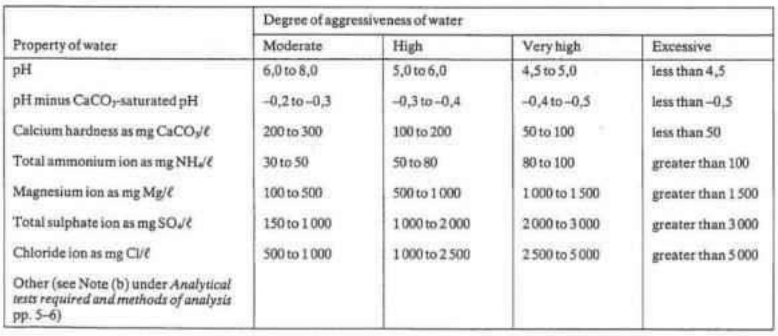
Map 9: LiDAR Data.

15. APPENDIX G: OTHER SUPPORTING INFORMATION

Table 14: Laboratory results for the region surrounding the site (after Stapelberg (2009).

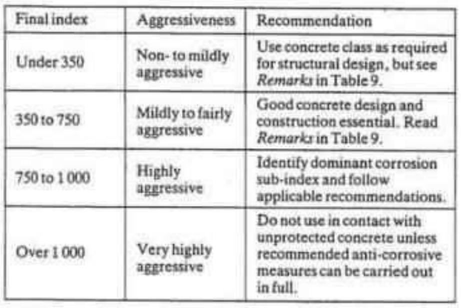
Profile number and depth (m)	**Origin**	**Landform**	**Indicator tests**						**Clay minerals (%)**	**Heave potential**	**Collapse potential**	**Dispersiveness**	**pH/ cond. (mS/m)**	**Lab.**	**Permeability (cm/s)**	**Unified class**	**PRA Class**	**Fm**	**Gm**
			LL **CC**	**PI**		**LS**	**Clay**	**Act %**											
				<425 µm total	**Total**														
5/8 (0,4)	Colluvium (granite)	Plain	-	-	-	-	-	-	N.T.	Low	No	-	-	Geos. Lab.	3.6 x 10^{-3}	SM	A.2.4	2.0	1.49
5/3 (3,0)	Residual shale	Plain	30 0,18	7	6,9	3	2	3.5	Ka/Cl(34) Il/Sm(2)	Low	No	ND3,CT2 SCS 19%	6.79 2232	Geos. Lab.	7.8 x 10^{-6}	ML	A.2.6 (4)	0.09	0.28
5/10 (0,5)	Residual sh. (slight ferr.)	Convex slope	42 0,29	12	11.9	4	40.5	0.3	N.T.	Low	No	-	-	Geos. Lab.	<4 x 10^{-6}	ML	A.7.5 (9)	0.04	0.05

Table 15: General limits for assessment of aggressiveness (Basson, 1989).



Property of water	Degree of aggressiveness of water			
	Moderate	High	Very high	Excessive
pH	6,0 to 8,0	5,0 to 6,0	4,5 to 5,0	less than 4,5
pH minus $CaCO_3$-saturated pH	–0,2 to –0,3	–0,3 to –0,4	–0,4 to –0,5	less than –0,5
Calcium hardness as mg $CaCO_3$/ℓ	200 to 300	100 to 200	50 to 100	less than 50
Total ammonium ion as mg NH_4/ℓ	30 to 50	50 to 80	80 to 100	greater than 100
Magnesium ion as mg Mg/ℓ	100 to 500	500 to 1 000	1 000 to 1 500	greater than 1 500
Total sulphate ion as mg SO_4/ℓ	150 to 1 000	1 000 to 2 000	2 000 to 3 000	greater than 3 000
Chloride ion as mg Cl/ℓ	500 to 1 000	1 000 to 2 500	2 500 to 5 000	greater than 5 000
Other (see Note (b) under *Analytical tests required and methods of analysis* pp. 5–6)				

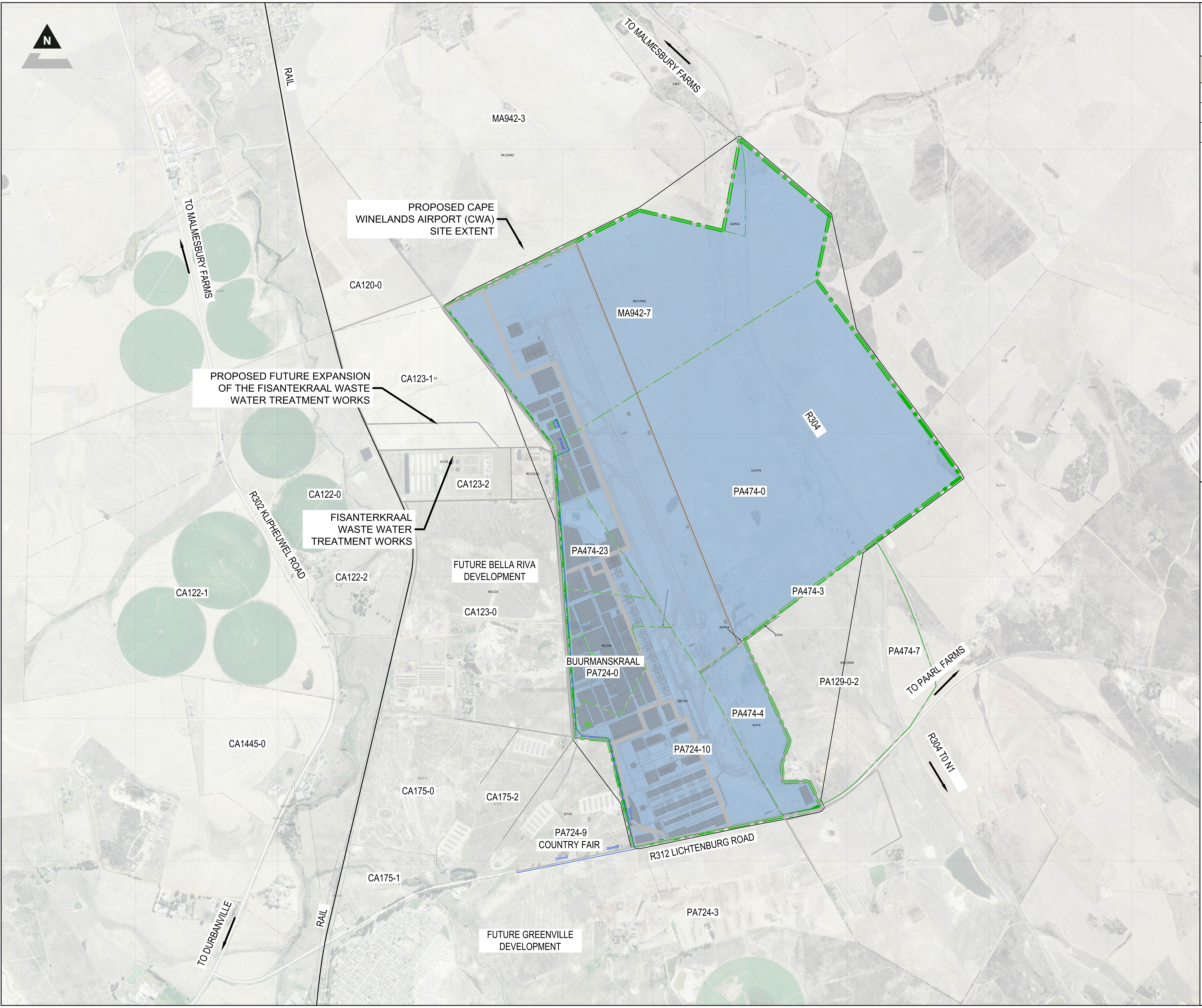
Table 16: Guide for assessing Final Basson Index (Basson, 1989).



Final index	Aggressiveness	Recommendation
Under 350	Non- to mildly aggressive	Use concrete class as required for structural design, but see *Remarks* in Table 9.
350 to 750	Mildly to fairly aggressive	Good concrete design and construction essential. Read *Remarks* in Table 9.
750 to 1 000	Highly aggressive	Identify dominant corrosion sub-index and follow applicable recommendations.
Over 1 000	Very highly aggressive	Do not use in contact with unprotected concrete unless recommended anti-corrosive measures can be carried out in full.

(Last Page)

Appendix E



Plot Date: 17/1/2025 2:13:53 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-001 [C] LOCALITY MAP.DWG

DISCLAIMER

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LEGEND

▬ · ▬ · ▬	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
- - - -	EXISTING CADASTRAL

ZUTARI
IMPACT. ENGINEERED.

CLIENT

CAPE WINELANDS AERO

REV	DATE	REVISION DETAILS	APPROVED
A	24/05/24	FOR INFORMATION	C. TALIP
B	26/08/24	FOR INFORMATION	C. TALIP
C	23/01/25	FOR INFORMATION	C. TALIP

SCALE 1:12 500
SIZE A1
FOR INFORMATION

DRAWN S. BADENHORST
DESIGNED M . HAWKES / M. ALBERTYN
REVIEWED C. TALIP

APPROVED
C. TALIP
DATE
ECSA
Pr Eng
2016091

PROJECT

CAPE WINELANDS AIRPORT

TITLE

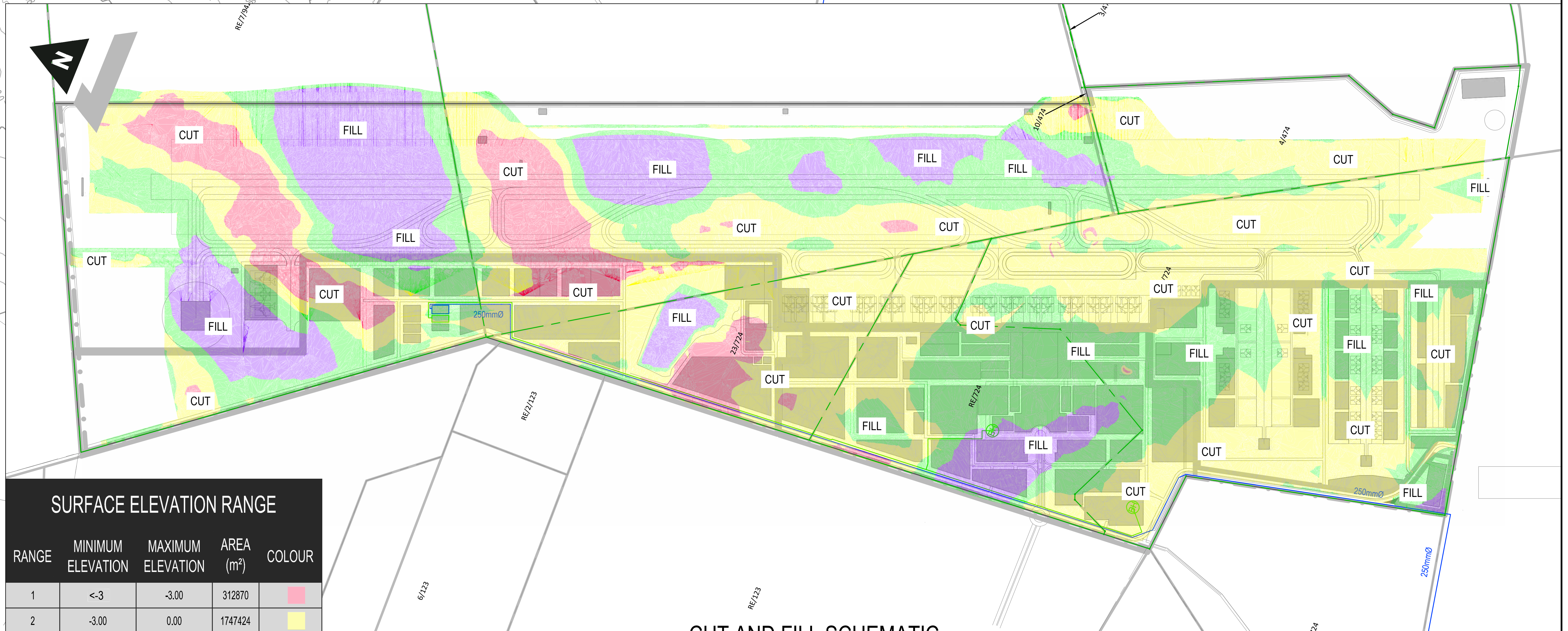
LOCALITY MAP

DRAWING NUMBER

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
A89083 -	0000 -	DRG -	CC -	001 -	C

LEGEND

- PROPOSED FUTURE PASSENGER RAIL SERVITUDE
- CWA SITE BOUNDARY
- PROPOSED CADASTRAL
- EXISTING CADASTRAL
- NGL CONTOURS
- DESIGN CONTOURS
- STORMWATER OVERLAND FLOW ROUTES



SURFACE ELEVATION RANGE

RANGE	MINIMUM ELEVATION	MAXIMUM ELEVATION	AREA (m²)	COLOUR
1	<-3	-3.00	312870	🟥
2	-3.00	0.00	1747424	🟨
3	0.00	3.00	1128037	🟩
4	3.00	>3	554438	🟪

CUT AND FILL SCHEMATIC

SCALE 1:10 000

Plot Date: 17/1/2025 2:38:02 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-101 [B] CONCEPT GRADING PLAN.DWG

ZUTARI
IMPACT. ENGINEERED.

CLIENT
CAPE WINELANDS AERO

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REV	DATE	REVISION DETAILS	APPROVED
A	12/08/24	FOR INFORMATION	C. TALIP
B	23/01/25	FOR INFORMATION	C. TALIP

SCALE AS SHOWN
SIZE A1

FOR INFORMATION

DRAWN S. BADENHORST
DESIGNED M. ALBERTYN
REVIEWED H. BHIKHA

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE CONCEPT
GRADING PLAN

DRAWING No.

PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
A89083	0000	DRG	CC	101	B

LEGEND

- —— - -	CWA SITE BOUNDARY
- ——— - -	PROPOSED CADASTRAL
— — —	EXISITING CADASTRAL
🟥	ASPHALT ROAD SURFACING
🟩	ASPHALT SIDEWALK SURFACING
🟧	PROPOSED PARKING AREA(SURFACING TO BE ASPHALT/ CONCRETE PAVERS)

Plot Date: 17/1/2025 3:10:35 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-200-[F] CONCEPT LAYOUT ROADS.DWG

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IMPACT. ENGINEERED.

CLIENT

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REV	DATE	REVISION DETAILS	APPROVED
A	18/01/22	FOR INFORMATION	C. TALIP
B	07/04/22	FOR INFORMATION	C. TALIP
C	12/08/22	FOR INFORMATION	C. TALIP
D	19/10/23	FOR INFORMATION	C. TALIP
E	12/08/24	FOR INFORMATION	C. TALIP
F	23/01/25	FOR INFORMATION	C.TALIP

SCALE 1:7500
SIZE A1

FOR INFORMATION

DRAWN M. HAWKES
DESIGNED M. HAWKES
REVIEWED C. TALIP

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE CONCEPT LAYOUT ROADS

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	A89083	0000	DRG	CC	200	F

LEGEND

—SW——SW—	PROPOSED STORMWATER PIPES
●	PROPOSED STORMWATER MANHOLES
▬	PROPOSED CATCHPITS / GRIDINLETS
- - - - - -	PROPOSED SLOT/GRID DRAINS(ACO OR GATIC) TO L90 STANDARD
━━━━	AIRSIDE STORMWATER DRAINS
- ——— - —	CWA SITE BOUNDARY
- ——— — —	PROPOSED CADASTRAL
— — —	EXISTING CADASTRAL
🟦	PUBLIC INFRASTRUCTURE(ROADS AND STORMWATER)

REFERENCE:

A89083-0000-DRG-CC-310-QUARRY AS STORMWATER ATTENUATION POND
A89083-0000-DRG-CC-302-CONCEPT STORMWATER PONDS LAYOUT

Plot Date: 17/1/2025 3:14:38 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-302 [F] -303 [D] CONCEPT LAYOUT STORMWATER.DWG

ZUTARI
IMPACT. ENGINEERED.

CLIENT

CAPE WINELANDS • AERO

DISCLAIMER

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REV	DATE	REVISION DETAILS	APPROVED
A	18/01/22	FOR INFORMATION	C. TALIP
B	12/08/22	FOR INFORMATION	C. TALIP
C	19/10/23	FOR INFORMATION	C. TALIP
D	28/05/24	FOR INFORMATION	C. TALIP
E	30/07/24	FOR INFORMATION	C. TALIP
F	23/01/25	FOR INFORMATION	C. TALIP

SCALE	SIZE
AS SHOWN	A1

DRAWN
S. BADENHORST

DESIGNED
H.BHIKHA

REVIEWED
C. TALIP

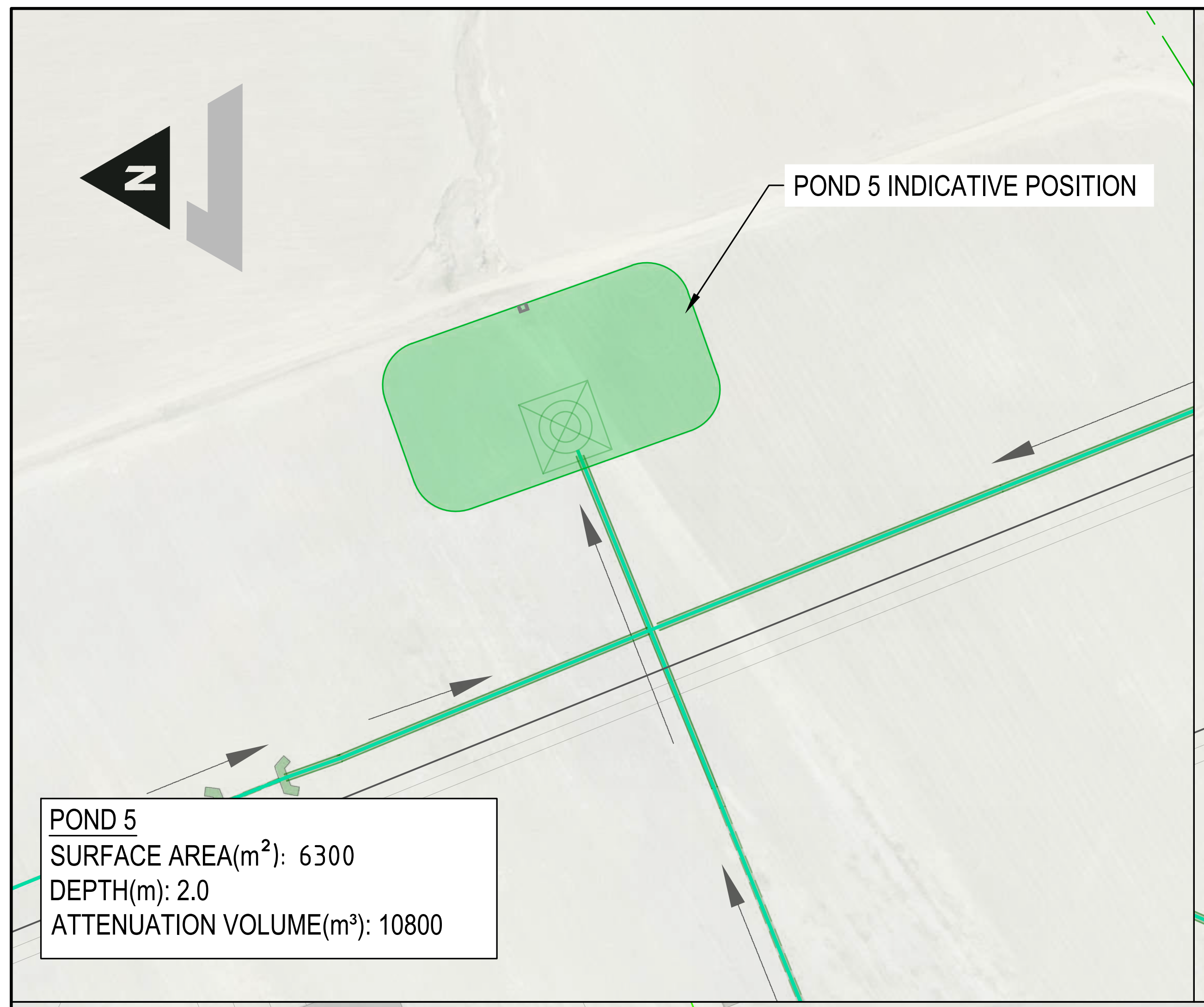
FOR INFORMATION

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

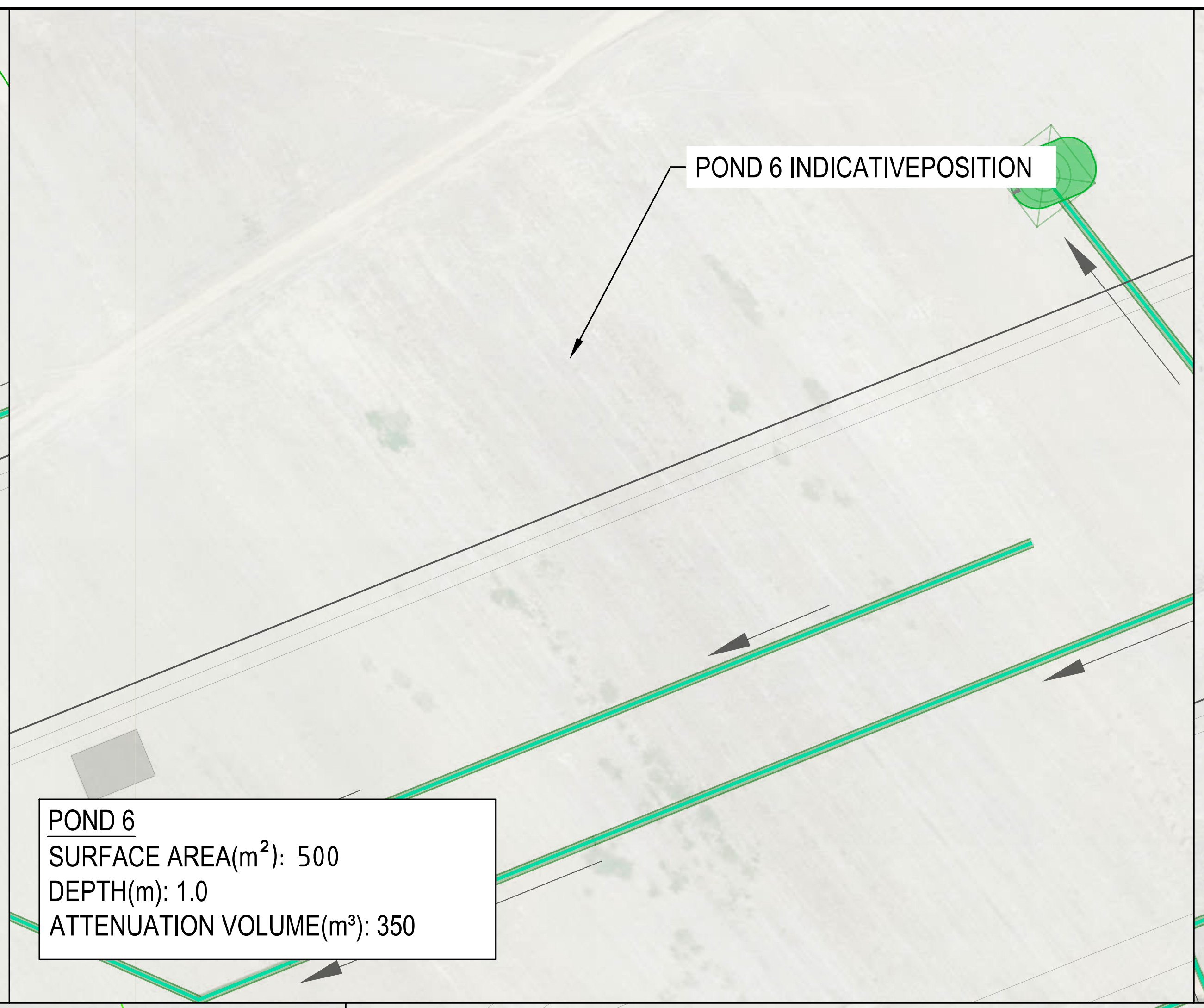
PROJECT CAPE WINELANDS AIRPORT

TITLE CONCEPT LAYOUT
STORMWATER

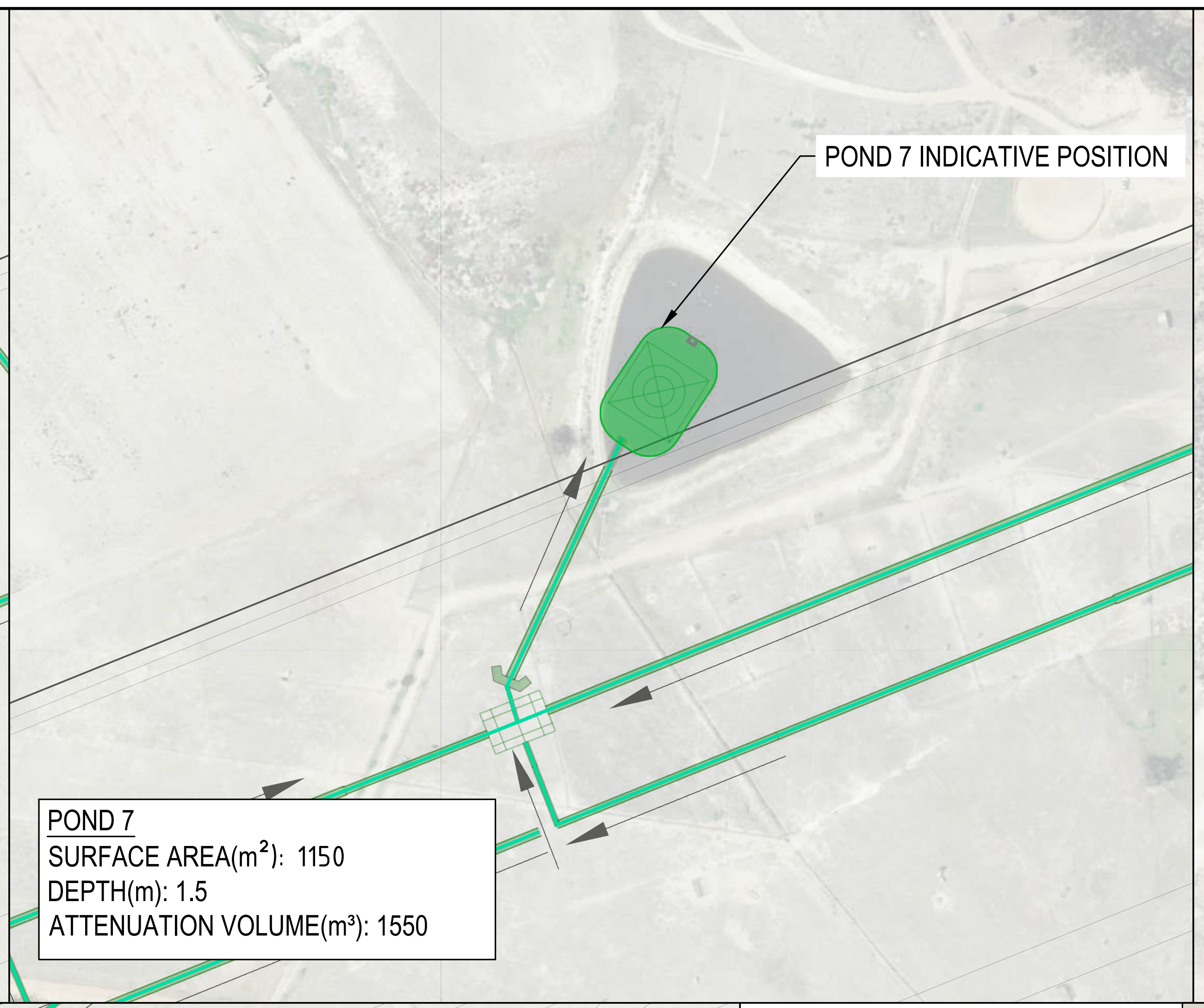
DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	A89083	0000	DRG	CC	302	F



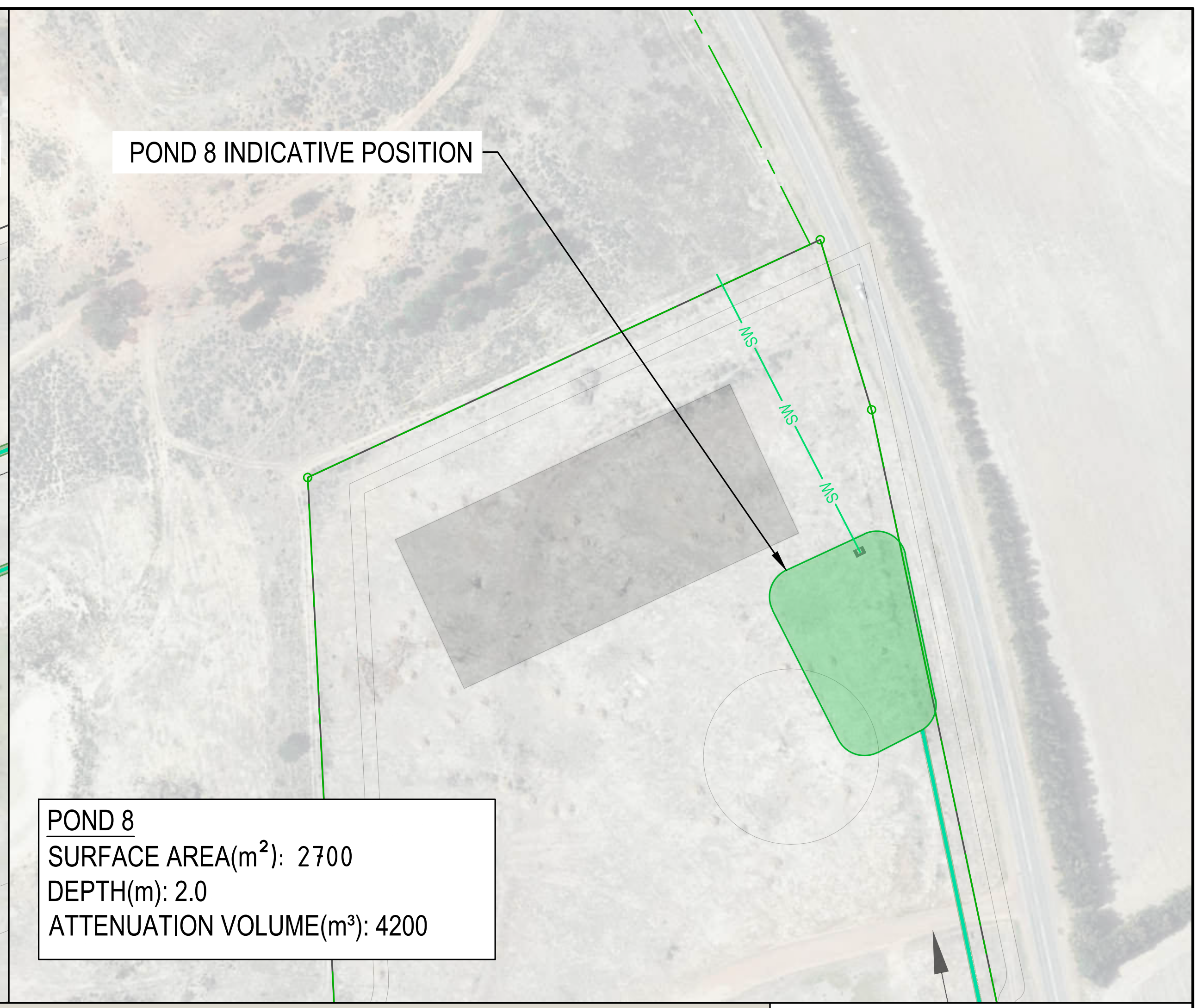
POND 5
SURFACE AREA(m^2): 6300
DEPTH(m): 2.0
ATTENUATION VOLUME(m^3): 10800



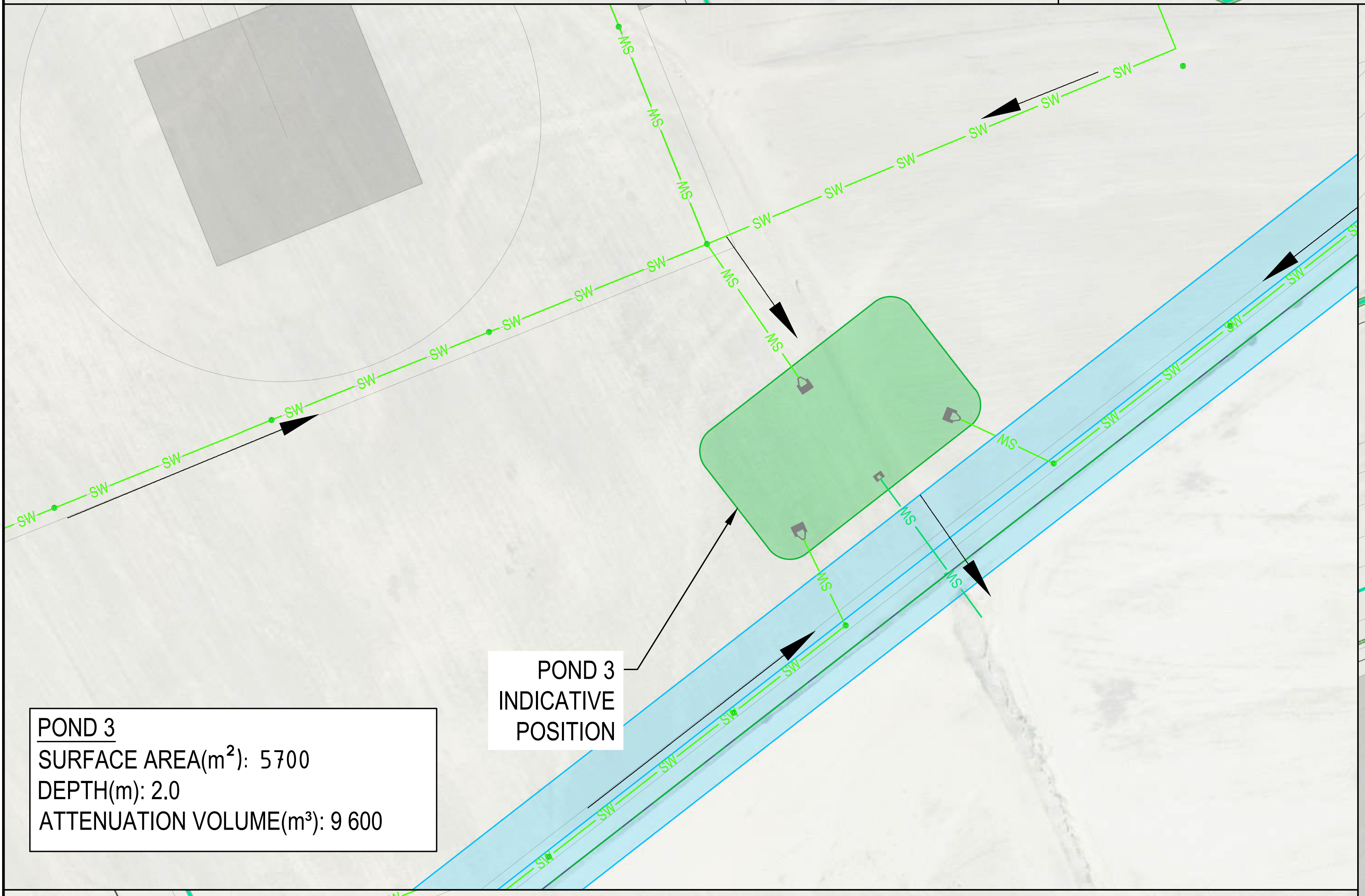
POND 6
SURFACE AREA(m^2): 500
DEPTH(m): 1.0
ATTENUATION VOLUME(m^3): 350



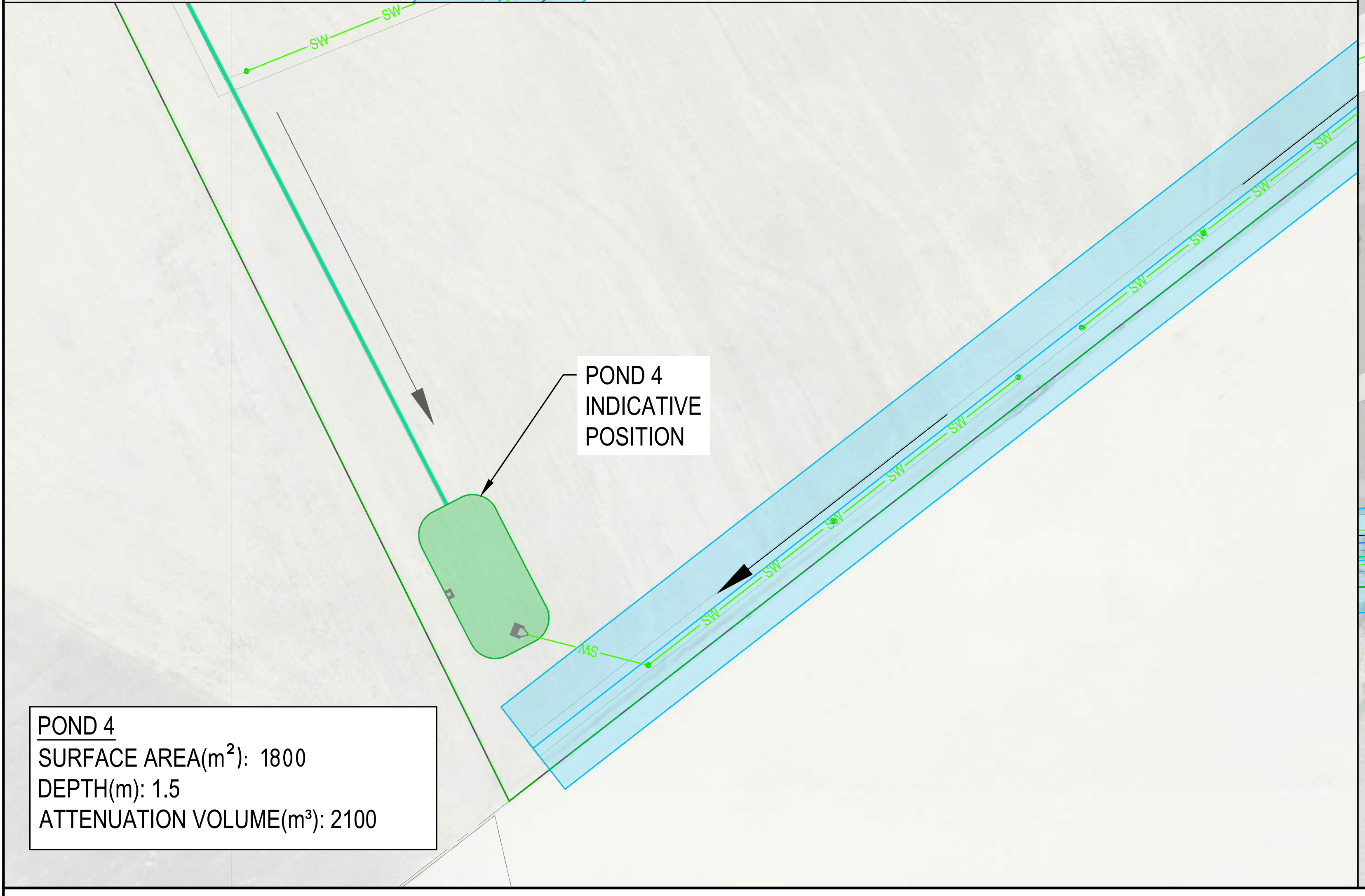
POND 7
SURFACE AREA(m^2): 1150
DEPTH(m): 1.5
ATTENUATION VOLUME(m^3): 1550



POND 8
SURFACE AREA(m^2): 2700
DEPTH(m): 2.0
ATTENUATION VOLUME(m^3): 4200



POND 3
SURFACE AREA(m^2): 5700
DEPTH(m): 2.0
ATTENUATION VOLUME(m^3): 9 600



POND 4
SURFACE AREA(m^2): 1800
DEPTH(m): 1.5
ATTENUATION VOLUME(m^3): 2100

POND 2:
CONVERT QUARRY INTO A
WET POND
DRAIN ALL SITE
STORMWATER TO POND

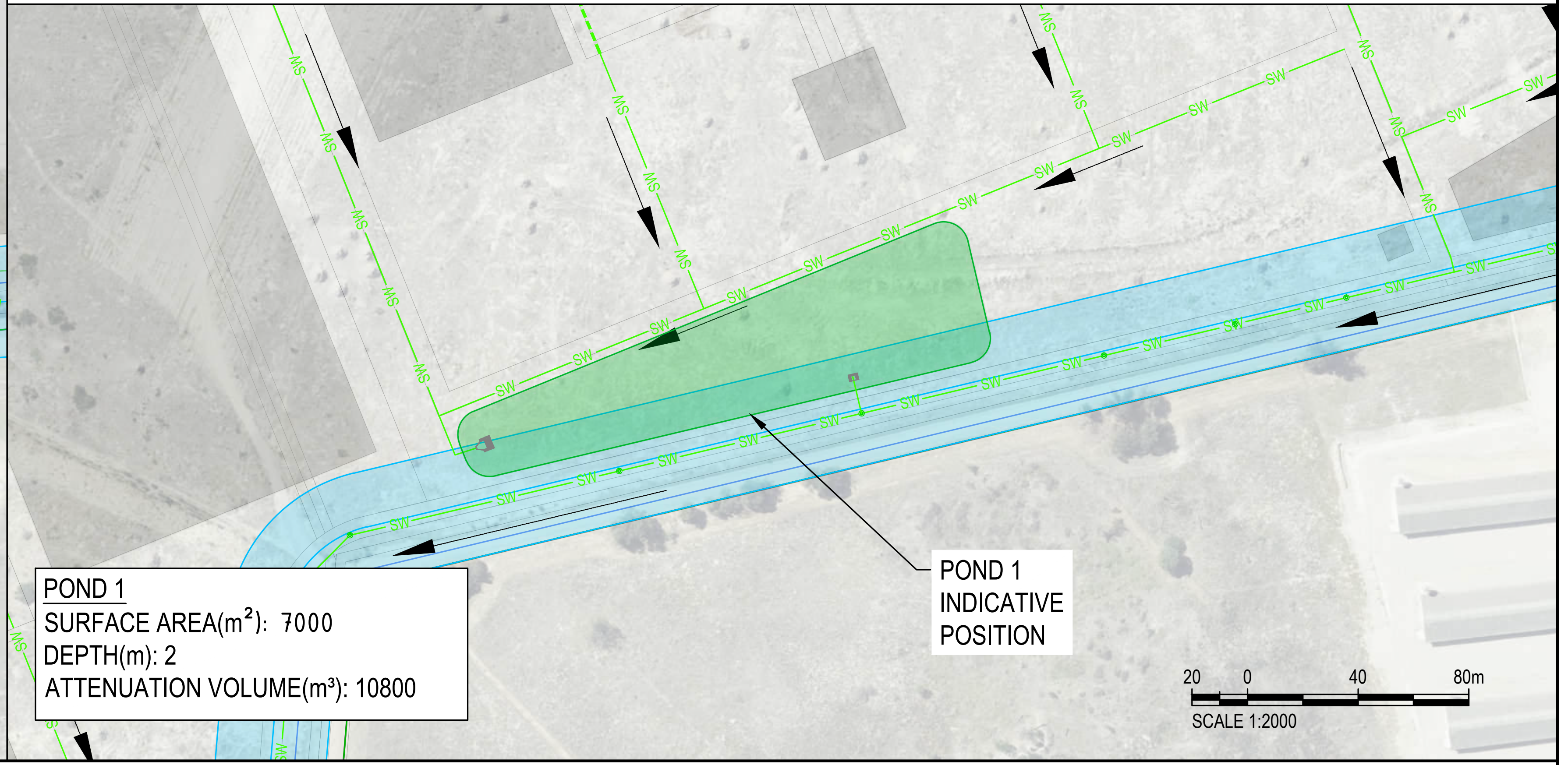
POND 2
SURFACE AREA(m^2): 28 000
DEPTH(m): 5.0
ATTENUATION VOLUME(m^3): 95 000

LEGEND

—SW—SW—	PROPOSED STORMWATER PIPES
●	PROPOSED STORMWATER MANHOLES
▬	PROPOSED CATCHPITS / GRIDINLETS
- - - - -	PROPOSED SLOT/GRID DRAINS(ACO OR GATIC) TO L90 STANDARD
━━━	AIRSIDE STORMWATER DRAINS
—·—·—	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
- - -	EXISTING CADASTRAL

REFERENCE:

A89083-0000-DRG-CC-310-QUARRY AS STORMWATER ATTENUATION POND
A89083-0000-DRG-CC-302-CONCEPT STORMWATER LAYOUT



POND 1
SURFACE AREA(m^2): 7000
DEPTH(m): 2
ATTENUATION VOLUME(m^3): 10800

Plot Date: 17/1/2025 3:00:21 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-302 [F] -303 [D] CONCEPT LAYOUT STORMWATER.DWG

ZUTARI
IMPACT. ENGINEERED.

CLIENT

CAPE WINELANDS AERO

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REV	DATE	REVISION DETAILS	APPROVED
A	10/03/23	FOR INFORMATION	C. TALIP
B	19/10/23	FOR INFORMATION	C. TALIP
C	12/08/24	FOR INFORMATION	C. TALIP
D	23/01/25	FOR INFORMATION	C. TALIP

SCALE	SIZE
AS SHOWN	A1

DRAWN MC. ALBERTYN
DESIGNED A. VAN DER NEST
REVIEWED C. TALIP

FOR INFORMATION

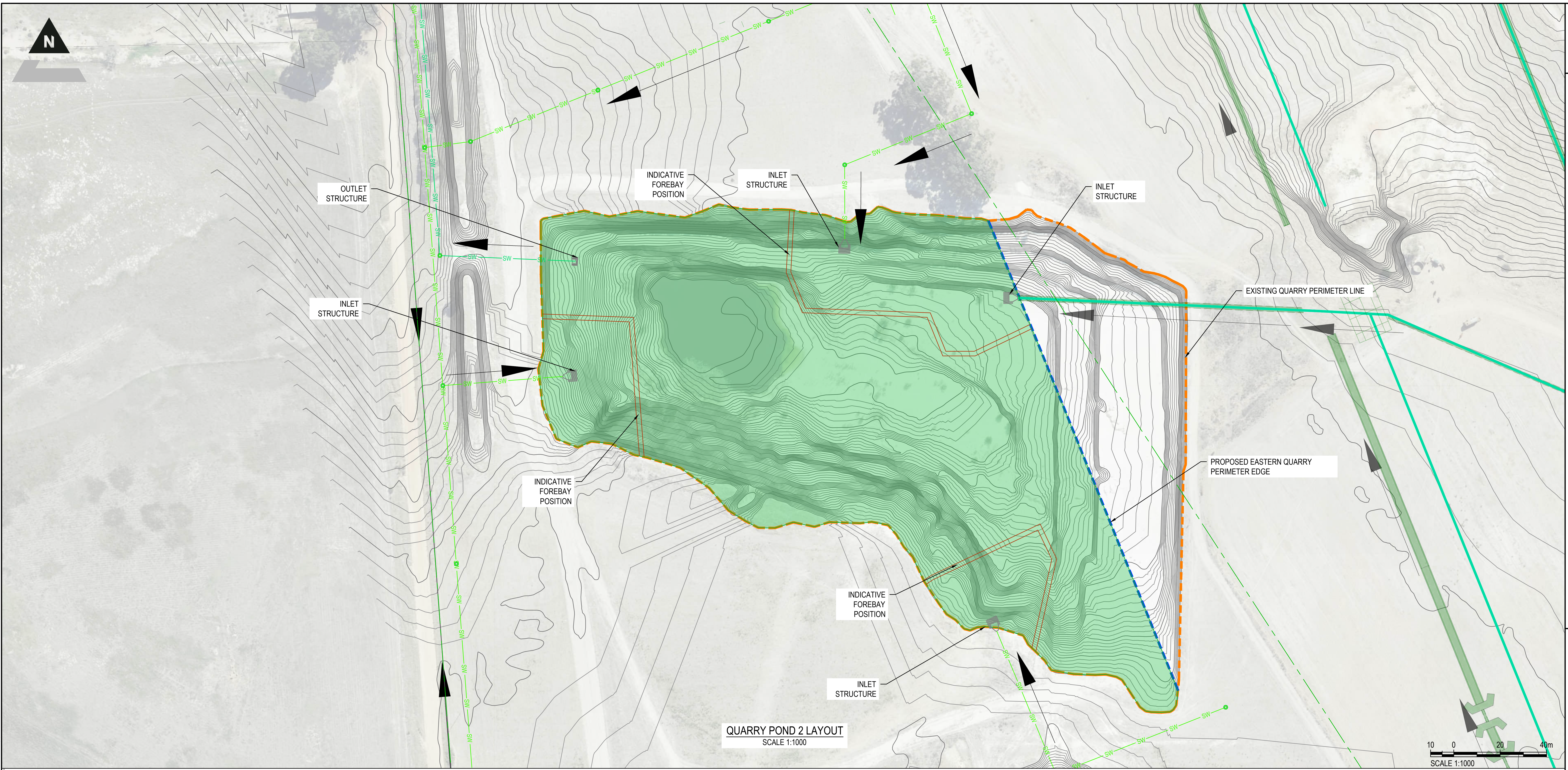
APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

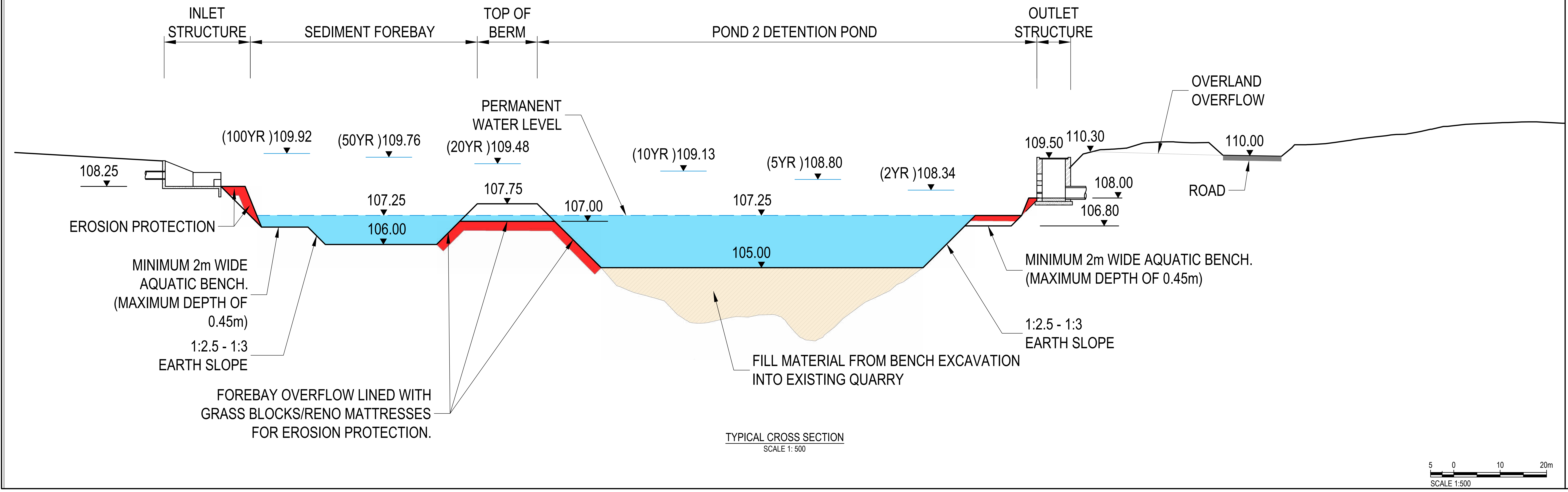
TITLE CONCEPT STORMWATER PONDS LAYOUT

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	A89083	0000	DRG	CC	303	D

Plot Date: 17/1/2025 2:57:20 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-310 [F] QUARRY AS STORMWATER ATTENUATION POND.DWG



QUARRY POND 2 LAYOUT
SCALE 1:1000



TYPICAL CROSS SECTION
SCALE 1: 500

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NOTES:

1. THE PROPOSED BENCHES AND ELEMENTS SEEN IN THIS DRAWING IS SUBJECT TO CHANGE FOLLOWING DETAILED DESIGN.
2. ALL ELEMENTS ARE ALSO SUBJECT TO APPROVAL FROM CoCT'S CATCHMENTS MANGER.
3. ALL RELEVANT PARTIES TO BE CONSULTED, FOR EXAMPLE BIRD STRIKE CONSULTANT.

LEGEND

—SW——SW—	PROPOSED STORMWATER PIPES
●	PROPOSED STORMWATER MANHOLES
▬	PROPOSED CATCHPITS / GRIDINLETS
━━━	AIRSIDE STORMWATER DRAINS
- —— - —	CWA SITE BOUNDARY
- —— - —	PROPOSED CADASTRAL
—— - - ——	EXISTING CADASTRAL

REFERENCE:

A89083-0000-DRG-CC-302-CONCEPT STORMWATER LAYOUT
A89083-0000-DRG-CC-303-CONCEPT STORMWATER PONDS LAYOUT

ZUTARI
IMPACT. ENGINEERED.

CLIENT

CAPE WINELANDS • AERO

REV	DATE	REVISION DETAILS	APPROVED
A	01/11/22	FOR INFORMATION	C. TALIP
B	28/11/22	FOR INFORMATION	C. TALIP
C	13/03/23	FOR INFORMATION	C. TALIP
D	19/10/23	FOR INFROMATION	C. TALIP
E	12/08/24	FOR INFORMATION	C. TALIP
F	23/01/25	FOR INFORMATION	C. TALIP

SCALE
AS SHOWN

SIZE
A1

FOR INFORMATION

DRAWN
S. BADENHORST

DESIGNED
A. VAN DER NEST

REVIEWED
C. TALIP

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
2016091

PROJECT

CAPE WINELANDS AIRPORT

TITLE

QUARRY AS STORMWATER
ATTENUATION POND

DRAWING NUMBER

PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
A89083	-	0000	-	DRG	-	CC	-	310	-	F

INFRASTRUCTURE

1. NON POTABLE STORAGE TANK
   SIZE: 2.9 ML FOOTPRINT: 2500m²
2. PACKAGE WASTE WATER TREATMENT PLANT
   SIZE:1260 kL/day FOOTPRINT: 500m²
3. PUMP STATION
   SIZE:15L/s FOOTPRINT: 315m²
4. PRIMARY SETTLING TANK
   FOOTPRINT: 272m²
5. BRINE EVAPORATION POND
   FOOTPRINT: 1136m²
6. SLUDGE PROCESSING AREA
   FOOTPRINT: 200m²
7. EMERGENCY OVERFLOW STORAGE POND
   SIZE: 1260m^3 FOOTPRINT: 2565m²

LEGEND

— — —	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
— — —	EXISTING CADASTRAL
— S — S —	PROPOSED FOUL SEWER GRAVITY MAINS
●	PROPOSED FOUL SEWER MANHOLES
— S/RM —	PROPOSED FOUL SEWER RISING MAIN
— TE —	PROPOSED TREATED EFFLUENT MAIN

SEWER NOTES:

1. ALL GRAVITY MAINS TO BE uPVC HEAVY DUTY CLASS 34 PIPES COMPLYING TO SANS 791.
2. PIPE BEDDING: CLASS B BEDDING
3. DEPTH OF COVER TO PIPE: 1m MINIMUM
4. NO BENDS PERMITTED IN GRAVITY PIPE NETWORK

Plot Date: 17/1/2025 2:50:05 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-511-512_CONCEPT LAYOUT FOUL SEWER [C][C].DWG

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REV	DATE	REVISION DETAILS	APPROVED
A	24/06/24	FOR INFORMATION	C. TALIP
B	12/08/24	FOR INFORMATION	C. TALIP
C	23/01/25	FOR INFORMATION	C. TALIP

SCALE 1:5000
SIZE A1

FOR INFORMATION

DRAWN MC. ALBERTYN
DESIGNED M. HAWKES//MC. ALBERTYN
REVIEWED C. TALIP

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE
CONCEPT LAYOUT
FOUL SEWER OPTION 1
(ON SITE TREATMENT)

DRAWING No.	PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
	A89083	–	0000	–	DRG	–	CC	–	511	–	C

LEGEND

— — —	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
———	EXISTING CADASTRAL
— S — S —	PROPOSED FOUL SEWER GRAVITY MAINS
◉	PROPOSED FOUL SEWER MANHOLES
— S/RM —	PROPOSED FOUL SEWER RISING MAIN

SEWER NOTES:

1. ALL GRAVITY MAINS TO BE uPVC HEAVY DUTY CLASS 34 PIPES COMPLYING TO SANS 791.
2. PIPE BEDDING: CLASS B BEDDING
3. DEPTH OF COVER TO PIPE: 1m MINIMUM
4. NO BENDS PERMITTED IN GRAVITY PIPE NETWORK

Plot Date: 17/1/2025 2:53:29 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-511-512_CONCEPT LAYOUT FOUL SEWER [C][C].DWG

ZUTARI
IMPACT. ENGINEERED.

CLIENT
CAPE WINELANDS • AERO

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REV	DATE	REVISION DETAILS	APPROVED
A	24/06/24	FOR INFORMATION	C. TALIP
B	12/08/24	FOR INFORMATION	C. TALIP
C	23/01/25	FOR INFORMATION	C. TALIP

SCALE 1:5000
SIZE A1
DRAWN M. HAWKES
DESIGNED M. HAWKES
REVIEWED C. TALIP

FOR INFORMATION

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE
CONCEPT LAYOUT
FOUL SEWER OPTION 2
TO FISANTEKRAAL WWTW

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	A89083	0000	DRG	CC	512	C

INSET A: WASTE WATER TREATMENT AREA

SCALE 1:1000

INFRASTRUCTURE

1. NON POTABLE STORAGE TANK
2. PACKAGE WASTE WATER TREATMENT PLANT
3. PRIMARY SEWAGE LIFT STATION
4. PRIMARY SEWER PUMP STATION
5. BRINE EVAPORATION POND
6. SLUDGE PROCESSING AREA
7. EMERGENCY OVERFLOW STORAGE POND

LEGEND

— — —	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
— — —	EXISTING CADASTRAL
—S—S—	PROPOSED FOUL SEWER GRAVITY MAINS
●	PROPOSED FOUL SEWER MANHOLES
—S/RM—	PROPOSED FOUL SEWER RISING MAIN
—TE—	PROPOSED TREATED EFFLUENT MAIN

SEWER NOTES:

1. ALL GRAVITY MAINS TO BE uPVC HEAVY DUTY CLASS 34 PIPES COMPLYING TO SANS 791.
2. PIPE BEDDING: CLASS B BEDDING
3. DEPTH OF COVER TO PIPE: 1m MINIMUM
4. NO BENDS PERMITTED IN GRAVITY PIPE NETWORK

Plot Date: 24/1/2025 3:40:48 pm Office: ZACPT Filename: C:\USERS\HIRNA.BHIKHA\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-513_CONCEPT LAYOUT FOUL SEWER [A].DWG

ZUTARI
IMPACT. ENGINEERED.

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REV	DATE	REVISION DETAILS	APPROVED
A	23/01/25	FOR INFORMATION	C. TALIP

SCALE: 1:5000
SIZE: A1

FOR INFORMATION

DRAWN: H. BHIKHA
DESIGNED: H. BHIKHA
REVIEWED: C. TALIP

APPROVED: C. TALIP
DATE
ECSA Pr Eng 20160091

PROJECT: CAPE WINELANDS AIRPORT

TITLE: CONCEPT LAYOUT
FOUL SEWER OPTION 3
(PREFERRED)

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	A89083	0000	DRG	CC	513	A

WATER TANK SIZE

DESCRIPTION	VOLUME(kL)
POTABLE WATER - 48H STORAGE	5000
NON-POTABLE WATER - 48H STORAGE	3000
FIRE WATER STORAGE	>250

LEGEND

— — —	CWA SITE BOUNDARY
— — —	PROPOSED CADASTRAL
— — —	EXISITING CADASTRAL
—PW—PW—	PROPOSED POTABLE WATER MAIN
—FW—FW—	PROPOSED SPRINKLER MAIN/FIRE WATER
—TE—	PROPOSED TREATED EFFLUENT MAIN

WATER NOTES:

1. PIPE MATERIAL & CLASS AS FOLLOWS:
   POTABLE WATER MAIN: uPVC CLASS 12
   FIRE WATER MAIN: uPVC CLASS 16
   TREATED EFFLUENT MAIN: uPVC CLASS 12
2. BEDDING AS FOR FLEXIBLE PIPES
3. DEPTH OF COVER TO TOP OF PIPE: 1m MINIMUM
4. FIRE WATER TO SUPPLY HYDRANT AND SPRINKLERS SITE WIDE

REFERENCES:

A89083-0000-DRG-CC-602-WATER SUPPLY LAYOUT[E]

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IMPACT. ENGINEERED.

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DISCLAIMER

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REV	DATE	REVISION DETAILS	APPROVED
A	18/02/22	FOR INFORMATION	C. TALIP
B	22/02/22	FOR INFORMATION	C. TALIP
C	12/08/22	FOR INFORMATION	C. TALIP
D	19/10/23	FOR INFORMATION	C. TALIP
E	24/05/24	FOR INFORMATION	C. TALIP
F	12/08/24	FOR INFORMATION	C. TALIP
G	23/01/25	FOR INFORMATION	C. TALIP

SCALE 1:7500
SIZE A1

FOR INFORMATION

DRAWN S. BADENHORST
DESIGNED M. HAWKES / M. ALBERTYN
REVIEWED C. TALIP

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE CONCEPT
WATER RETICULATION LAYOUT

DRAWING No.	PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
	A89083	–	0000	–	DRG	–	CC	–	601	–	G

LEGEND

🟩 - — - -	CWA SITE BOUNDARY
- — - -	PROPOSED CADASTRAL
— - - —	EXISTING CADASTRAL
— WS —	PROPOSED BOREHOLE SUPPLY WATER - TO GROUND WATER TANK
BH	PROPOSED BOREHOLE
—W—W—	PROPOSED CoCT SUPPLY WATER PIPE - TO POTABLE STORAGE TANKS

WATER NOTES:

1. PIPE SIZES SHOWN ARE INDICATIVE AND TO BE CONFIRMED DURING DETAIL DESIGN STAGE.
2. ALL WATER MAINS TO BE UPVC CLASS 12.
3. BEDDING AS FOR FLEXIBLE PIPES
4. DEPTH OF COVER TO TOP OF PIPE: 1m MINIMUM

REFERENCES:

A89083-0000-DRG-CC-601-WATER RETICULATION LAYOUT

Plot Date: 17/1/2025 2:46:32 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-601 [G] -602 [G] CONCEPT LAYOUT WATER RETICULATION BOREHOLE CONNECTION.DWG

ZUTARI
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CLIENT

CAPE WINELANDS • AERO

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REV	DATE	REVISION DETAILS	APPROVED
A	18/02/22	FOR INFORMATION	C. TALIP
B	22/02/22	FOR INFORMATION	C. TALIP
C	12/08/22	FOR INFORMATION	C. TALIP
D	19/10/23	FOR INFORMATION	C. TALIP
E	24/05/24	FOR INFORMATION	C. TALIP
F	12/08/24	FOR INFORMATION	C. TALIP
G	23/01/25	FOR INFORMATION	C. TALIP

SCALE 1:7500
SIZE A1

DRAWN S. BADENHORST
DESIGNED M. HAWKES / M. ALBERTYN
REVIEWED C. TALIP

FOR INFORMATION

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT CAPE WINELANDS AIRPORT

TITLE CONCEPT WATER SUPPLY LAYOUT

DRAWING No.

PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
A89083	–	0000	–	DRG	–	CC	–	602	–	G

Plot Date: 17/1/2025 2:42:41 pm Office: ZACPT Filename: C:\USERS\ALITHA.DLABANTU\ZUTARI\A89083 - DOCUMENTS\04 GRAPHICS AND DESIGN\03 PRJ DEL\503 CADD\DRAWINGS\JAN 2025 - MASTERPLAN REV 15\A89083-0000-DRG-CC-700 [F] CONCEPT ELECTRIC AND TELECOMS LAYOUT.DWG

LEGEND

	CWA SITE BOUNDARY
	PROPOSED CADASTRAL
	EXISTING CADASTRAL
—T—T—	PROPOSED TELECOMMS 2No x 110mm Dia SLEEVES
●	PROPOSED SLEEVES MANHOLE
—E—E—	PROPOSED ELECTRICAL SLEEVES 4No x 160mm Dia

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REV	DATE	REVISION DETAILS	APPROVED
A	18/01/22	FOR INFORMATION	C. TALIP
B	12/08/22	FOR INFORMATION	C. TALIP
C	19/10/23	FOR INFORMATION	C. TALIP
D	24/05/24	FOR INFORMATION	C. TALIP
E	12/08/24	FOR INFORMATION	C. TALIP
F	23/01/25	FOR INFORMATION	C. TALIP

SCALE	SIZE
1:5000	A1

DRAWN
S. BADENHORST

DESIGNED
M. HAWKES / M. ALBERTYN

REVIEWED
C. TALIP

FOR INFORMATION

APPROVED
DATE
C. TALIP
ECSA
Pr Eng
20160091

PROJECT
CAPE WINELANDS AIRPORT

TITLE
CONCEPT LAYOUT
ELECTRICAL & TELECOM SLEEVES

DRAWING No.

PROJECT No.		WBS		TYPE		DISC		NUMBER		REV
A89083	–	0000	–	DRG	–	CC	–	700	–	F

Appendix F

No.	Unique Code	Phase	Occupancy	Ground Area (m^2)	PRIMARY USE	AIRPORT USE	FLOORS	COVERAGE (%)	Building Area (m^2)	Parking Bays	Equivalent Bulk (m^2)	Red book demand categorisation
1	A01	1	PASSENGER TERMINAL BUILDING	13979	Transport Use	Terminal Building	2	1	27958	0	27958	Terminal Building
2	A02.1	1	CAR RENTAL	1725	Transport Use	Rental Cars	1	1	1725	606	1725	Business/Commercial
3	A03	1	GA/VIP/GOVERNMENT TERMINAL	6419	Transport Use	Customs and Immigration	1	0.568990497	3652	392	3652.35	Business/Commercial
4	A10.1B	1	FBO 1	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0	861	Yard Connection
5	A10.2B	1	FBO 2	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0	861	Yard Connection
6	A10.3B	1	FBO 4	1230	Transport Use	Warehouse for storage of airfreight	1	0.7	861	0	861	Yard Connection
7	A10.4B	1	FBO 3	1220	Transport Use	Warehouse for storage of airfreight	1	0.7	854	0	854	Yard Connection
8	A15.2	3	TERMINAL RESERVE	4468	Transport Use	Terminal Building	2	1	8936	0	8936	Terminal Building
9	A15.3	3	TERMINAL RESERVE	1843	Transport Use	Terminal Building	2	1	3686	0	3686	Terminal Building
10	A15.4	4	TERMINAL RESERVE	9289	Transport Use	Terminal Building	2	1	18578	0	18578	Terminal Building
11	A15.5	4	TERMINAL RESERVE	6308	Transport Use	Terminal Building	2	1	12616	0	12616	Terminal Building
12	A15.7	2	TERMINAL RESERVE	5011	Transport Use	Terminal Building	2	1	10022	0	10022	Terminal Building
13	A15.8	2	TERMINAL RESERVE	5210	Transport Use	Terminal Building	2	0.648848369	6761	0	6761	Terminal Building
14	B05	1	ASS	7216	Transport Use	Airport Administration	0	0	0	0	0	Yard Connection
15	B07	1	CATERING BUILDING	6400	Transport Use	Catering	0	0	0	0	0	Business/Commercial
16	B14.1	1	OPS	1500	Transport Use	Airport Administration	2	0.6	1800	0	1800	Business/Commercial
17	B14.2	1	OPS	7472	Transport Use	Airport Administration	1	0.7	5230	0	5230.4	Business/Commercial
18	B14a	1	AIR TRAFFIC CONTROL TOWER	3403	Transport Use	Air Traffic Control	2	0.2	1361	0	1361.2	Business/Commercial
19	E.2	1	RESTAURANT	1999	Restaurant	Non Airport Use	1	0.5	1000	0	999.5	Business/Commercial
20	E04.12	1	AIRPORT USE	6315	Shop	Non Airport Use	1	0.5	3158	0	3157.5	Business/Commercial
21	E04.3	3	AIRPORT USE	11170	Transport Use	Airport Administration	2	0.467815577	10451	0	10451	Business/Commercial
22	E04.4	1	AIRPORT USE	9144	Consent Use	Non Airport Use	1	0.5	4572	0	4572	Business/Commercial
23	E04.5	1	AIRPORT USE	9342	Transport Use	Airport Administration	1	0.5	4671	0	4671	Business/Commercial
24	E04.6	1	RETAIL	19563	Shop	Non Airport Use	2	0.45	17607	0	17606.7	Business/Commercial
25	E04.7	2	AIRPORT USE	5928	Transport Use	Passenger Services	1	0.78879892	4676	0	4676	Business/Commercial
26	E04.8	2	AIRPORT USE	27081	Transport Use	Airport Administration	2	0.4	21665	0	21664.8	Business/Commercial
27	A16	1	GA CLUBHOUSE & FUELING	5204	Restaurant	Non Airport Use	2	0.301787087	3141	0	3141	Business/Commercial
28	E01.1	1	AIRPORT USE: HOTEL 1	2623	Consent Use	Non Airport Use	3	0.6	4721	0	4721.4	Hotel
29	E01.2	2	AIRPORT USE: HOTEL 2	2623	Consent Use	Non Airport Use	3	0.6	4721	0	4721.4	Hotel
30	B03	1	MRO HANGER	22961	Transport Use	Aircraft Maintenance and Refurbishment	1	1	22961	0	22961	Yard Connection
31	B06	1	AIRPORT MAINTENANCE	10041	Transport Use	Aircraft Maintenance and Refurbishment	1	0.3	3012	0	3012.3	Industrial
32	B08	1	GSE MAINTENANCE	5997	Transport Use	Ground Support Equipment	1	0.7	4198	0	4197.9	Industrial
33	B09.1	1	GSE STAGING AREA	3998	Transport Use	Ground Support Equipment	0	0	0	0	0	Industrial
0	B09.2	1	GSE STAGING	3819	Transport Use	Ground Support Equipment	0	0	0	0	0	Industrial
34	E04.14	1	AIRPORT USE	4820	Transport Use	Ground Support Equipment	0	0	0	0	0	Industrial
35	E04.15	1	AIRPORT USE	9094	Transport Use	Ground Support Equipment	0	0	0	0	0	Industrial
36	A15.1	3	PIER EXPANSION RESERVATION	4126	Transport Use	Terminal Building	0	0	0	0	0	Yard Connection
37	A15.6	3	PIER EXPANSION RESERVATION	5910	Transport Use	Terminal Building	1	0	0	0	0	Yard Connection
38	C12	1	RDTS	225	Transport Use	Air Traffic Control	2	0.5	225	0	225	Yard Connection
39	D01.1	1	LOCALIZER	265	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
40	D01.2	1	LOCALIZER	265	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
41	D02.1	1	GLIDEPATH ANTENNA	500	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
42	D02.2	1	GLIDEPATH ANTENNA	500	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
43	D03.1	1	PAPI	252	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
44	D03.2	1	PAPI	252	Transport Use	Air Traffic Control	0	0	0	0	0	Yard Connection
45	A02.2	1	CAR RENTAL	11666	Transport Use	Parking	0	0	0	250	0	Business/Commercial
46	A04.1	1	PUBLIC TRANSPORT	7516	Transport Use	Parking	0	0	0	289	0	Parking Grounds(car park)
47	A04.2	1	PICK UP & DROP OFF	5569	Transport Use	Parking	0	0	0	120	0	Parking Grounds(car park)
48	A08	2	PARKING	33217	Warehouse	Non Airport Use	0	0	0	95	0	Parking Grounds(car park)
49	A08.1	1	PARKING	1827	Transport Use	Parking	0	0	0	1015	0	Parking Grounds(car park)
50	A08.2	1	PARKING	19515	Transport Use	Parking	0	0	0	3769	0	Parking Grounds(car park)
51	A08.4	1	PARKING	13469	Transport Use	Parking	0	0	0	559	0	Parking Grounds(car park)
52	A08.5	1	PARKING	10753	Transport Use	Parking	0	0	0	155	0	Parking Grounds(car park)
53	A08.6	1	PARKING	2987	Transport Use	Parking	0	0	0	60	0	Parking Grounds(car park)
54	B01	1	AIRCRAFT PARKING POSITION	7225	Transport Use	Aircraft Taxiway	0	0	0	0	0	Parking Grounds(car park)
0	B02	1	MRO APRON	15374	Transport Use	Apron	0	0	0	0	0	0
55	B11	1	SPECIAL CARGO FACILITY	1575	Transport Use	Warehouse for handling of airfreight	1	0.75	1181	0	1181.25	Warehousing
56	B11.1	1	CARGO TERMINAL	3500	Transport Use	Warehouse for handling of airfreight	1	1	3500	0	3500	Warehousing
57	B11.2	2	CARGO	17436	Transport Use	Warehouse for handling of airfreight	1	0.5	8718	0	8718	Warehousing
58	B11.3	1	CARGO	14043	Transport Use	Warehouse for handling of airfreight	1	0.5	7022	0	7021.5	Warehousing
59	B11.4	2	CARGO	22545	Transport Use	Warehouse for storage of airfreight	1	0.5	11273	0	11272.5	Warehousing
60	B12	1	CARGO APRON	10589	Transport Use	Warehouse for storage of airfreight	0	0	0	0	0	Warehousing
61	E04.1	2	AIRPORT USE	18348	Transport Use	Warehouse for storage of airfreight	1	0.75	13761	0	13761	Warehousing
62	E04.13	1	AIRPORT USE	4636	Transport Use	Hangars (Storage of Aircraft)	1	0.74525453	3455	0	3455	Warehousing
63	E04.16	2	AIRPORT USE	10993	Transport Use	Warehouse for handling of airfreight	1	0.7	7695	0	7695.1	Warehousing
64	E04.2	3	AIRPORT USE	7660	Transport Use	Warehouse for storage of airfreight	1	0.75	5745	0	5745	Warehousing
65	E04.9	1	AIRPORT USE	3819	Transport Use	Warehouse for handling of airfreight	2	0.507724535	3878	0	3878	Warehousing
66	A10.1A	1	FBO 1	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0	4050.9	Yard Connection
67	A10.2A	1	FBO 2	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0	4050.9	Yard Connection
68	A10.3A	1	FBO 4	5787	Transport Use	Warehouse for storage of airfreight	1	0.7	4051	0	4050.9	Yard Connection
69	A10.4A	1	FBO 3	5798	Transport Use	Warehouse for storage of airfreight	1	0.7	4059	0	4058.6	Yard Connection
70	A11.1	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
71	A11.10	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
72	A11.11	3	GA HANGERS	4678	Transport Use	Hangars (Storage of Aircraft)	1	0.7	3275	0	3274.6	Yard Connection
73	A11.12	1	GA HANGERS	4971	Transport Use	Hangars (Storage of Aircraft)	1	0.7	3480	0	3479.7	Yard Connection
74	A11.13	1	GA HANGERS	8512	Transport Use	Hangars (Storage of Aircraft)	1	0.7	5958	0	5958.4	Yard Connection
75	A11.2	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
76	A11.3	2	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
77	A11.4	3	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
78	A11.5	4	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
79	A11.6	4	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
80	A11.7	3	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
81	A11.8	2	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection

No.	Unique Code	Phase	Occupancy	Ground Area (m^2)	PRIMARY USE	AIRPORT USE	FLOORS	COVERAGE (%)	Building Area (m^2)	Parking Bays	Equivalent Bulk (m^2)	Red book demand categorisation
82	A11.9	1	GA HANGERS	3200	Transport Use	Hangars (Storage of Aircraft)	1	0.7	2240	0	2240	Yard Connection
83	B10.1	1	FUEL FARM	6797	Transport Use	Fuel Storage	0	0	0	0	0	Industrial
84	B10.2	1	FUEL FARM	6797	Transport Use	Fuel Storage	0	0	0	0	0	Industrial
85	B13	1	ARFF	14536	Transport Use	Firefighting and Rescue	1	0.3	4361	0	4360.8	Yard Connection
86	B17.1	1	ACCESS CONTROL	102	Transport Use	Security	1	0.6	61	0	61.2	Yard Connection
87	B17.2	1	ACCESS CONTROL	100	Transport Use	Security	1	0.6	60	0	60	Yard Connection
88	B17.3	1	ACCESS CONTROL	100	Transport Use	Security	1	0.6	60	0	60	Yard Connection
89	B24.1	1	SUBSTATION	260	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
90	C01	1	POTABLE WATER	1250	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
91	C02	1	GROUNDWATER TREATMENT	1000	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
92	C03	1	WATER PUMPSTATION	1000	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
93	C04	1	NON-POTABLE WATER	2500	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
94	C05	1	SOLID WASTE	1250	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
95	C06	1	WTWW + LIFT STATION	1250	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
96	C07	2	BIOGAS PLANT	30879	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
97	C08	1	ESKOM INCOMING & LS SUBSTATION	8432	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
98	C08	1	ESKOM INCOMING & LS SUBSTATION	7056	Utility Service	Substation	0	0	0	0	0	Yard Connection
99	C09	1	ENERGY CENTRE	3250	Utility Service	0	0	0	0	0	0	Yard Connection
100	C10	1	FIREFIGHTING WATER PUMP STATION	440	Transport Use	Firefighting and Rescue	0	0	0	0	0	Yard Connection
101	C11	1	SUBSTATION	460	Utility Service	0	0	0	0	0	0	Yard Connection
102	C11.1	1	SUBSTATION	408	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
103	C11.1	1	AS SS	600	0	0	0	0	0	0	0	Yard Connection
104	C11.2	1	SUBSTATION	408	Utility Service	Non Airport Use	0	0	0	0	0	Yard Connection
105	C11.2	1	LS SS	600	Utility Service	0	0	0	0	0	0	Yard Connection
106	E.1	1	AERO VINTAGE	1999	Transport Use	Hangars (Storage of Aircraft)	2	0.5	1999	0	1999	Yard Connection
107	PH.1	1	HELIPORT	6220	Transport Use	Heliport	1	0.2	1244	0	1244	Yard Connection
108	PH.2	1	HELIPORT	6220	Transport Use	Heliport	1	0.2	1244	0	1244	Yard Connection
109	PH.3	1	HELIPORT	992	Transport Use	Heliport	1	0.5	496	0	496	Yard Connection
110	PH.4	1	HELIPORT	992	Transport Use	Heliport	1	0.5	496	0	496	Yard Connection
111	PH.5	1	HELIPORT	8938	Transport Use	Heliport	1	0.506265384	4525	0	4525	Yard Connection
112	A08.3	4	CARPARK / EVTOL	19590	Multiple Parking Garage	Non Airport Use	0	0	0	1100	0	Parking Grounds(car park)
113	F01	1	SERVICE STATION	9075	Consent Use	Non Airport Use	1	0.15	1361	0	1361.25	Garage and filling station
114	"00"	1	LANDSCAPED AREA	0	Consent Use	Non Airport Use	0	0	0	0	0	Park - Grounds Only
115	"00"	4	LANDSCAPED AREA	16538	Consent Use	Non Airport Use	0	0	0	0	0	Park - Grounds Only
			TOTAL	**736791**				**TOTAL**	**350000**	**8410**	**350000**	

Appendix G

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD
Making progress possible. Together.

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E-mail: water.info@capetown.gov.za

Evaluator: S.M. Mgabhi

30 November 2021

Zenobia Lewis
Zenobia.Lewis@zutari.com
Contact: 073 152 5472

COMMENT ON WATER AND SANITATION CAPACITY: CAPE WINELANDS AIRPORT DEVELOPMENT ON PORTION 10 OF FARM JOOSTENBERG'S VLAKTE 725 AND PORTION 4 OF FARM JOOSTENBERG'S KLOOF 474.

BACKGROUND

The applicant intends to undertake a redevelopment of Cape Winelands Airport on Portion 10 of farm Joostenberg's Vlakte 725 and Portion 4 of farm Joostenberg's Kloof 474 in Cape Farms.

The development land area covering approximately 151 Ha in extent will consist of runways, hangars, commercial buildings, retail or office and a fuel station. The proposed development site is in the suburb of Cape Farms, north of the R312 and west of the R304, as shown on the locality plan in Figure 1 (see the letter of request attached).

This letter provides an overview of the existing water and sewer infrastructure near the proposed development sites, including the foreseeable impact on the infrastructure caused by the proposed development. Furthermore, this letter includes the associated conditions and technical requirements applicable to the proposed development.

Table 1: Applicant (calculated) Water and Sewer demands flow.

SITE INFORMATION		WATER				SEWER	
Land Use	Area (m^2)	Rate ($L/m^2/d$)	Demand (kL/d)	Peak Flow* (l/s)	Fire Flow (l/s)	ADWF (kL/d)	Peak Flow* (l/s)
Warehousing	50327	3	151	5.77	215	121	2.10
Hangar Only	61289	3	184	7.02		147	2.55
Business	9369	6.5	60.9	2.33		48.7	0.85
Retail	20353	6.5	132	5.05		106	1.84
Office	6659	6.5	43.3	1.65		34.6	0.60
Airport	2810	6.5	18.3	0.70		14.61	0.25
Total			**590**	**22.5**	**215**	**472**	**8.19**

Notes:

- *Based on rates and Sewer to AADD ratio of 0.8 (Provided by the applicant; see also Redbook 2019, Table K.4)*
- ** Water peak factor (PF) = 3.3 and the Sewer PF = 1.5 (suggested by the applicant)*
- *Fire flow = 215 L/s – High risk 2: industrial (fuel station), business (Provided by the applicant; Redbook 2019, Table J.17)*
- *Water peak flow excludes the 15% losses (3.38 L/s) suggested by the applicant.*

WATER RETICULATION

The proposed development is near the Spes Bona Distribution zone and the Fisantekraal pressure management (PRV) zone. Both zones are within the Northern network, supplied by external bulk water mains from the Voelvlei WTP clear well via Spes Bona Tanks.

The City's water reticulation model indicates a 150 mm Ø water main in Farm CA175-2. The 150 mm Ø water main connects to a water pump station (PS) north of the Fisantekraal Township and southwest of the proposed development site. The 150 mm Ø water main and the pump station appears to be the closest existing water infrastructure to the proposed development site.

Table 2 shows the flow properties of the water pipes associated with the proposed development.

Table 2: Existing water mains near the proposed development

WATER MAINS SERVICING THE PROPOSED SITES						
Pipes/ Street	Location relative to the Site	Ø (mm)	Flow (l/s)	Velocity (m/s)	Pressure (m)	
					Peak	Static
Farm CA175-2 Pipe	*Southwest*	150	33.5	1.90	121	126
Spes Bona DBM	*Southwest*	800	110	0.22	62.10	62.36

The 800 mm Ø DBM from Spes Bona reservoir appears to have sufficient capacity to supply the proposed development. The 150 mm Ø water main has a demand peak flow of 33.5 l/s and a corresponding velocity of 1.90 m/s. This velocity is higher than the standard maximum peak demand Flow velocity of 1.5 m/s as suggested in the Redbook 2019.

Water Masterplan Items:

The City's 2018 Sewer Master Plan Wall Maps proposes a bulk water pipe along the Lichtenberg Road, on the southern border of the proposed development site. The bulk line is to be supplied by the existing external bulk-water main from the Voelvlei water treatment plant and reservoirs via a proposed 300 ML bulk water reservoir. The 300 ML bulk-water reservoir with proposed location on Farm CA119-0 directly eastward the Spes Bona reservoir and westward the Klipheuwel Road.

BULK WATER

There is no infrastructure within and across the boundaries of the proposed development under the control of the City of Cape Town's Bulk Water Branch. The bulk supply system has sufficient water resources, storage and conveyance capacity to supply the estimated average annual daily demand (AADD) of 590 kL/day from this development.

SEWER RETICULATION

Based on our system data, there is no City of Cape Town's sewer infrastructure supporting the proposed development. Fisantekraal Wastewater Treatment Works (WwTW) is the nearest sewer catchment to the proposed development.

The City's sewer reticulation model indicates a sewer pumping station (Fisantekraal 2 PS) located adjacent to the east border of Erf 177 in Fisantekraal Township. The Fisantekraal 2 PS and associated sewer network are the closest sewer infrastructure to the proposed development. This infrastructure drain to Kraaifontein WwTW via Fisantekraal 1 PS.

There is also a sewer rising mains east of Klipheuwel Road, which leads to the existing Fisantekraal WwTW. Fisantekraal WwTW is the closest sewer treatment works located northwest of the proposed development.

Sewer Masterplan Items:
The City's 2018 Sewer Master Plan Wall Maps proposes a 200 mm Ø new sewer collector south of Lichtenberg Road. This sewer appears to be an ideal collector for the proposed development. It is part of the proposed sewer infrastructure upgrade to service the later phases of the Greenville development on the east side of Mosselbank River. The infrastructure upgrade includes other sewer collectors, bulk sewer, sewer pumping station and its rising main.

The (proposed sewer pump station) rising main will drain directly to the recently installed 750 mm Ø bulk sewer in Baobab Road westward the new Greenville Housing development, west of the Mosselbank River. For infrastructure improvement to support the proposed development, the applicant may need to engage with our reticulation projects team headed by Anic Smit (Abraham.Smit@capetown.gov.za).

WASTEWATER TREATMENT

The proposed development will likely fall within the catchments of the Fisantekraal Wastewater Treatment Works (WwTW). Fisantekraal WwTW has sufficient unallocated spare capacity to accommodate the estimated sewer load of 472 kL/day.

CONCLUSION

Based on our system data, the Fisantekraal WwTW have sufficient capacity to accommodate the proposed development according to current flows.

However, both sewer and water infrastructure may require improvement to support this development.

The need for sewer infrastructure improvement requires liaison with the City of Cape Town's reticulation projects team headed by Anic Smit (Abraham.Smit@capetown.gov.za).

CONDITIONS

The development may proceed subject to the following conditions:

1. Development contributions will be payable as per the DC policy, to be quantified by the Reticulation Regional Head.
2. All costs relating to connection, alterations to or provision of new water and sewerage services will be for the account of the applicant.
3. The developer is to provide evidence of water saving measures incorporated in the development
4. All link services need to be in place prior to the occupation of any building.

ADDITIONAL TECHNICAL REQUIREMENTS

1. The water and sewer capacities allocated according to this document shall not be reserved if not taken up before the lesser of 5 years or the approved development period.
2. The owner is responsible for application for the new water meter or sewer connection including for relocation, at the standard tariff to the Reticulation District Head.
3. Water and Sanitation municipal services are to be designed according to Departmental Service Standards and be approved prior to construction.
4. Handover of any municipal water and sanitation services will be subject to quality control during construction.
5. Storm water ingress to be eliminated from sewer system.

GENERAL/ DISCLAIMER

1. Information provided is based on best available data.
2. The flows and pressures provided in this comment are theoretical and not measured

Yours Faithfully

2021/12/01

X Manie

Signed by: Shamile Manie

On behalf of

Zolile Basholo

DIRECTOR: WATER & SANITATION DEPARTMENT, TECHNICAL SERVICES.

Table 5: For City of Cape Town Water and Sanitation Department Internal use:

BRANCH	CONTACT PERSON	INPUT PROVIDED
Master Planning	S.M. Mgabhi (Evaluator) S. Manie	2021/10/13 2021/10/ (Revised) 2021/10/
Bulk Water		Based on theoretical data
Reticulation - Water		2021/10/
Reticulation - Sewer		2021/10/
Wastewater Treatment	Sven Sotemann	2021/10/

CITY OF CAPE TOWN
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Our Ref. : 20220316_M 16/03/2022

Marno Pretorius
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COMMENT ON HYDRAULIC WATER MODELLING ANALYSIS FOR FOR CAPE WINELANDS AIRPORT

Background

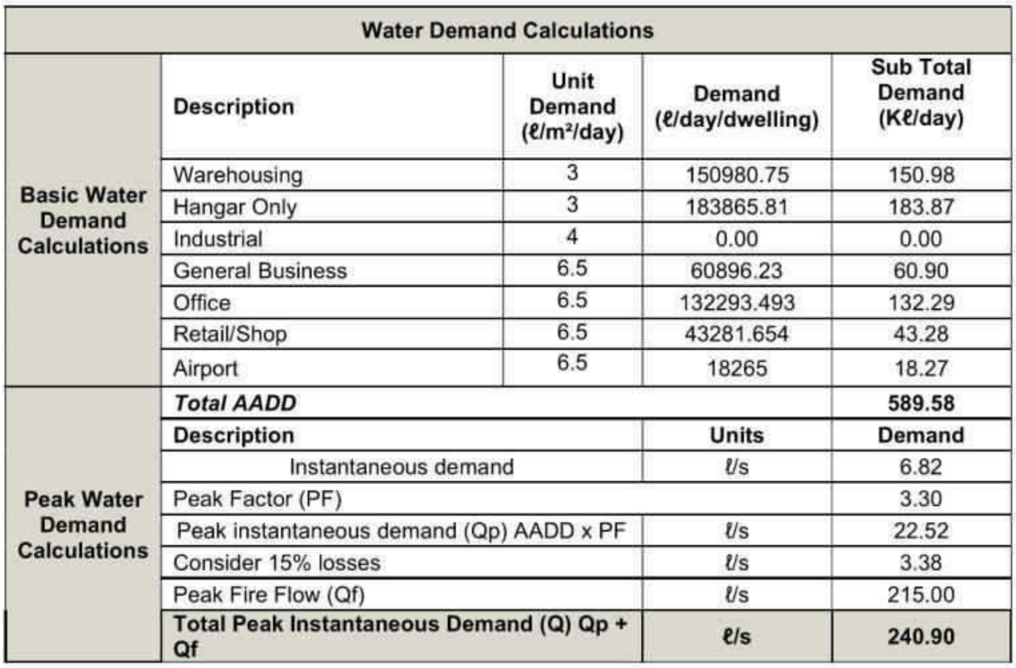
The applicant wishes to establish a mixed use development which would consist with retail shops, offices, industrial and warehousing. The proposed development is located on portion 10 of Farm 724 and Portion 4 of Farm 474 and is currently occupied by an airport.

The applicant has requested modelling of the proposed development to determine what demands the existing infrastructure would be able to support. The details of the request are as follows:

- Modelling of existing pipelines
- Modelling future pipelines (400 mm Ø marked as MP NT-5)
- Known future developments to be taken into account (Bella Reva, Greenville and the Poultry farm)

This letter discusses the results of the modelling exercise.

Table 1.1: Water demands as provided by consultant



Water Demand Calculations				
	Description	Unit Demand (ℓ/m²/day)	Demand (ℓ/day/dwelling)	Sub Total Demand (Kℓ/day)
Basic Water Demand Calculations	Warehousing	3	150980.75	150.98
	Hangar Only	3	183865.81	183.87
	Industrial	4	0.00	0.00
	General Business	6.5	60896.23	60.90
	Office	6.5	132293.493	132.29
	Retail/Shop	6.5	43281.654	43.28
	Airport	6.5	18265	18.27
Peak Water Demand Calculations	***Total AADD***			**589.58**
	Description		**Units**	**Demand**
	Instantaneous demand		ℓ/s	6.82
	Peak Factor (PF)			3.30
	Peak instantaneous demand (Qp) AADD x PF		ℓ/s	22.52
	Consider 15% losses		ℓ/s	3.38
	Peak Fire Flow (Qf)		ℓ/s	215.00
	Total Peak Instantaneous Demand (Q) Qp + Qf		**ℓ/s**	**240.90**

** As provided by consultant.*

Overview of supply

The general area is supplied via a 250 mm Ø and 450 mm Ø running parallel to Lichtenburg Road. The 250 mm Ø appears to be almost fully utilized supplying Fistantekraal PRV zone as well as Greenville.

Model setup

Our theoreical model was reconfigured according to planning diagrams provided by the applicant. Details are as follows:

A. Direct supply to Cape Winelands
- A schematic line of 400 mm Ø feeding off the existing 450 DN (Marked MP NT5).
- This 400 mm Ø was reduced to a 200 mm Ø main at the proposed development (arbitrarily chosen)

B. General supply to area

Schematic ring mains were included as per the applicant's diagrams.
- MP NT 1.8 : 400 mm Ø ring main suppying Greenville
- MP-NT-5.3 : 250 mm Ø main suppying Greenville
- Water main along Boy Briers upgraded to 400 DN to match diagram
- A schematic 250 mm Ø was created to supply the Bella Riva development.

C. Pressure Management
- Two scematic PRV's inserted downstream of the 450 mm Ø feeds to Fistantekraal/ Greenville. This resulted in reducing demand off the 450 mm Ø and increased realiance on the 250 mm Ø .

Note: The 250 mm Ø supply was not used to supply Cape Winelands. This was due to two reasons:
- An existing farm currently uses a significant demand.
- The two PRV's downstream of the 250 mm Ø has reported numerous intermitted pressure drops throughout the year.

Details can be seen in the map created "DWG 1: Model Setup".

Modelled Scenarios and results

The table below provides details on how each development was configured in this exercise.

Table 1: Simplified Model supply configuration

	Full Demand [DWG2]	**PRV Setups [DWG's 4 & 5]**
Cape Winelands	Supplied by 450 mm Ø	Supplied by 450 mm Ø
Bella Riva	Supplied by 450 mm Ø	Supplied by 450 mm Ø
County Fair	Supplied by 450 mm Ø. New demand only (Existing demand excluded).	Same as previous but under pressure management
Greenville	Demand split between 250 mm Ø and 450 mm Ø	Same as previous but under pressure management
Fistantekraal	Unchanged Supplied by 250 mm Ø	Same as previous but under pressure management

Model Scenarios

This section briefly discusses the various modelled scenarios. Results can be found in the table 2 on the next page.

A. No Pressure Management [DWG 2]

Once all schematic lines were inserted, the model was fully loaded. This resulted in the 450 mm Ø experiencing high velocites of 1.5 m/s . The 250 mm Ø supply line however appeared to have some spare capacity and had a velocity of 0.72 m/s.

B. Pressure management for Greenville and Fisantekraal [DWG 5].

Two schematic PRV's were inserted and the existing Fistantekraal PRV's settings were increased to 46m pressure from 40m. This increased the ultilization of the 250 mm Ø and decreased the utilization of the 450 mm Ø . Despite this the 450 mm Ø still experienced velocity of 1.2 m/s. Pressures within the Greenville and Fistekraal were on average 47m with some pockets experiening a pressure head of 24-25m of pressure which is acceptable.

Despite this attempt, the velocity within the 450 mm Ø could only be reduced to 1.2 m/s. The pressures within Fistantekraal and Greenville were above the minimum required of 24m.

We proceeded to test the configuration by loading the demands in increments of 25%. At first glance it appeared that it may be possible to accommodate up to 50% of the demand with pipe velocites at 1.27 m/s within the 450 mm Ø .

C. Modelling existing on site constraints [DWG 7].

Currently the area experiences intermittent drops in pressure throughout the year.

An investigation into the PRV data of Fistantekraal 1 & 2 revealed two potential operational issues on the 250 mm Ø line:

- A high spike in water demand downstream causing pressure drops at Fistantekraal 1
- Intermittent pressure drops upstream of the 250 mm Ø causing pressure drops in both PRV's.

As a result of the above, it is likely that Fistantekraal/ Greenville will rely more on the 450 mm Ø during these pressure drops.

The model was re-run within increments of 25%. Of the modelled scenarios it appears that the system will only be able to accommodate up to 25% of the proposed demand at the Cape Winelands airport (5.63 l/s). Even at this demand velocities were at 1.38 m/s. However this will only occur during the intermittent pressure drops. Most of the time the velocity within the 450 mm Ø would be expected to be around 1.24 m/s.

Table 2: Summary of Model Results*

Scenario	Existing 450 mm Ø supply	Existing 250 mm Ø supply	Surrounding developments	Comments / Other issues
Full Demand No PRV's [DWG2]	V = 1.5 P = 104	V = 0.72 P = 115	Ave. V = 0.40 Ave. P = 76	Velocity in 450 mm Ø supply too high. Isolated pockets pipes with V > 1.5 m/s in Fistantekraal
0% Demand PRV [DWG 4]	V = 1.2 P = 111	V = 1.2 P = 103	Ave. V= 0.35 Ave. P = 47	At zero demand, both pipelines reach maximum acceptable velocity.
25% Demand + PRV's [DWG 5-1]	V = 1.24 P = 110	V= 1.2 P = 103	Ave. V = 0.35 Ave. P = 47	25% of AADD appears to be theoretically feasible with sufficient pressure management.
50% Demand + PRV's [DWG 5-2]	V = 1.27 P = 109	V= 1.2 P = 103	Ave. V = 0.36 Ave. P = 47	At first glance, this appears feasible. However there are on site constraints.
75% Demand + PRV's [DWG 5-3]	V= 1.31 P = 109	V= 1.2 P = 103	Ave. V= 0.36 Ave. P = 46	450 mm Ø and 250 mm Ø at maximum velocity thresholds.
100% Demand + PRV's [DWG 5-4]	V= 1.34 P = 107	V= 1.2 P = 103	Ave. V= 0.36 Ave. P = 46	450 mm Ø and 250 mm Ø at maximum velocity thresholds.
FIRE [DWG 6]	V= 2.57 P = 68	V= 1.68 P = 82	Ave. V= 0.5 Ave. P = 39	It would be recommended to have on site storage for fire support.
250 mm Ø issues & 100% demand [DWG 7-1]	V= 1.5 P = 104	V= 0.72 P = 38	Ave. V= 0.39 Ave. P = 34	Some pockets with 22m of pressure
250 mm Ø issues & 50% demand [DWG 7-2]	V= 1.42 P = 107	V= 0.72 P = 40	Ave. V= 0.39 Ave. P = 34	Some pockets with 22m of pressure
250 mm Ø issues & 25% demand [DWG 7-2]	V= 1.38 P = 108	V= 0.72 P = 40	Ave. V= 0.38 Ave. P = 34	Some pockets of Pressure around 22m

V = Water Velocity (in m/s)
P = Pressure Head (m)
* Analysis focusses on supply lines. Pipe Diameters < 140 mm Ø excluded from table results

Current Risks

- There is a current intermittent drop in pressure within the 250 mm Ø which supplies the Fisantekraal area.
- The pressure drops may affect availability for fire flow. On site storage tanks for fire may mitigate this risk.

Master Planning items

The general vicinity has been targetted by both the 2015 and 2018 master plans. The master plan has called the following:

- A New Transfer reservoir (Spes Bona)
- A new reservoir linked to the transfer reservoir (Muldersvlei)
- New pipelines to supply future areas.

These items are labled as follows:

- BLK-PM10 : Pipeline between Muldersvlei and Transfer reservoir
- SPB-P01: Supply to future zone from Spes Bona reservoir
- BLK-PM1: 300 Ml Muldersvlei reservoir

Timing and implementation of the reservoirs items will have to be discussed with our Bulk Water branch. Implementation of reticulation pipelines will have to be discussed with our reticulation district heads.

Implementation of the Master Plan items may unlock sufficient capacity to support the full demand of the proposed development.
In addition to the above The Bulk water branch is looking to increase water security and supply (BWAS and alternative water sources).

The general contact detail for our Bulk water branch is: **BulkWater.Info@capetown.gov.za**

Concluding remarks

After numerous modelling numerous scenarios and configurations it appears that accomodations can only be made for up to 25% (5.63 l/s) of the proposed demand. Additional infrastructure (as recommended by the Master Plan would need to be implemented to accommodate the full demand of 22,52 l/s.

General/ Disclaimer

1. Information provided is based on best available data.
2. The flows and pressures provided in this analysis are theoretical and not measured.
3. This analysis contains schematic pipelines and associated infrastructure. Final implementation may differ.
4. All diameters, levels, dimensions and positions of existing infrastructure provided need to be checked on site.
5. This comment covers a theoretical modelling exercise and does not include inputs or commentary from our sister branches.

6. These comments do not confer a right to develop. A formal development application will be required for submission to the City of Cape Town.

Yours Faithfully

Shamile Manie
PPO: Master Planning

On behalf of
Zolile Basholo
DIRECTOR: TECHNICAL SERVICES

REPORT CONTRIBUTIONS

BRANCH	CONTACT PERSON	INPUT PROVIDED
Master Planning	T Adams (evaluator) S Manie	Modelling Oversight / checking

Appendix H

Borehole Yield and Quality Testing at Cape Winelands Airport, Fisantekraal, Western Cape.

REPORT: GEOSS Report No: 2022/04-12 **PREPARED FOR:** Mark Wilkinson Cape Winelands Airport Ltd. Email: mark@capewinelands.aero	**PREPARED BY:** Ashleigh Tomlinson GEOSS South Africa (Pty) Ltd Unit 12, Technostell Building, 9 Quantum Street, Technopark Stellenbosch 7600 Tel: (021) 880-1079 Email: info@geoss.co.za (www.geoss.co.za)

14 April 2022

EXECUTIVE SUMMARY

GEOSS South Africa (Pty) Ltd was appointed by Mark Wilkinson of Cape Winelands Airport Ltd. to conduct yield and groundwater quality testing of one borehole at Cape Winelands Airport, Fisantekraal, Western Cape. The yield testing was undertaken by ATS under the supervision of GEOSS between the 05th and the 08th of April 2022. The yield testing was conducted for a 24-hour period. It is recommended the groundwater abstraction adheres to the below mentioned parameters. Aquifer over-abstraction is unlikely to occur if these rates are adhered to and if the borehole is managed through long-term monitoring data.

Borehole Details				
Borehole Name	**Latitude (DD)**	**Longitude (DD)**	**Borehole Depth (m)**	**Inner Diameter at pump depth (mm)**
CWA_EastBH	-33.84071°	18.53738°	100	158
Abstraction Details				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
CWA_EastBH	1.0	24	0	86 400
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
CWA_EastBH	93	85	72	42.22

* Typical water level expected during long-term production

Through long-term water level monitoring data, the abstraction volume can be optimised by adjusting the abstraction rate. It is therefore recommended that the borehole is equipped with a pump operating through a variable speed drive so that adjustments can be easily made.

From the laboratory results, the groundwater from this borehole is of “marginal” water quality for human consumption, with elevated turbidity levels related to high concentrations of iron and manganese in the groundwater. Both these parameters may have aesthetic effects such as red staining on building walls. The iron may also precipitate, which can contribute to blocking pipes and pumps and even the borehole fractures, should the borehole be managed incorrectly. There is also an elevated concentration of chloride in the groundwater. This water is not suitable for domestic use without treatment.

The iron has the potential to clog a borehole pump if the pump is switched on and off frequently. To address this, it is recommended to maintain a constant continuous pumping schedule as much as possible. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps. It is also recommended to pump the water into settling tanks to allow iron settling prior to use. If the demand from the borehole is less than 86 400 L/day, it would be better that a smaller pump be installed, limiting groundwater level fluctuation in the borehole, but still meeting the demand.

To facilitate monitoring and informed management of a borehole, it is highly recommended that a borehole be equipped with the following monitoring infrastructure and equipment:

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m. This allows for a 'window' of access down the borehole which enables manual water level monitoring and can house an electronic water level logger
- Installation of an electronic water level logger (for automated water level monitoring)
- Installation of a sampling tap (to monitor water quality)
- Installation of a flow volume meter (to monitor abstraction rates and volumes)

This report is an important document for obtaining the legal authorisation with regard to the use of the groundwater with the Department of Water and Sanitation. However, this does not constitute a Geohydrological Assessment report in support of a WULA, which would be required and needs to incorporate the information from this report.

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ABBREVIATIONS

AD	available drawdown
bh	borehole
CDT	constant discharge test
DWA	Department of Water Affairs (pre- 1994)
DWAF	Department of Water Affairs and Forestry (1994 – 2009)
DWS	Department of Water and Sanitation (2009 – ….)
ID	inner diameter
L/s	litres per second
L/d	litres per day
m^2/d	meters squared per day
m	metres
mbgl	metres below ground level
RWL	rest water level below ground level
T	Transmissivity

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)].

Available drawdown: Available drawdown in a borehole is the difference between the rest water level or piezometric surface and the depth that the water level may drop to (typically major water bearing unit, boundary inflection or pump depth).

Dynamic water level: The stabilised water level in the borehole during production over long periods of time.

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.

Rest water level: The groundwater level in a borehole not influenced by abstraction or artificial recharge.

Sustainable yield: Sustainable yield is defined as the rate of withdrawal that can be sustained by an aquifer without causing an unacceptable decline in the hydraulic head or deterioration in water quality in the aquifer.

Transmissivity: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

Suggested citation for this report:

GEOSS (2022). Borehole Yield and Quality Testing at Cape Winelands Airport, Fisantekraal, Western Cape. Report Number: 2022/04-12. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.

Cover photo:

Rig set up during the testing of CWA_EastBH

GEOSS project number:

2021_09-4505 Phase D2

Reviewed by:

Reuben Lazarus & Dale Barrow – 14 April 2022.

1. INTRODUCTION

GEOSS South Africa (Pty) Ltd was appointed by Mark Wilkinson of Cape Winelands Airport Ltd. to conduct yield and water quality testing of a borehole at Cape Winelands Airport, Fisantekraal, Western Cape.

The borehole (CWA_EastBH), was tested by ATS under the supervision of GEOSS between the 05th and the 08th of April 2022, details of this are presented in this report. The borehole details are presented in **Table 1** below and spatially in **Figure 1.**

Table 1: Borehole Details

Borehole	Latitude (DD-WGS84)	Longitude (DD-WGS84)	Depth (m)
CWA_EastBH	-33.76452 °	18.73271 °	100

2. YIELD TESTING

2.1 Methodology

The yield testing was undertaken by ATS under the supervision of GEOSS between the 05th and the 08th of April 2022 and carried out according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This included a Step Test, Constant Discharge Test and recovery monitoring. For the Step Test the borehole is pumped at a constant rate for one-hour intervals and the flow rates are incrementally increased for each step. This test is followed by a Constant Discharge Test (CDT) where the borehole is pumped at a constant rate for an extended period of time, followed by recovery monitoring. The water level drawdown is monitored at pre-determined intervals during these tests (drawdown refers to the difference in water level from the rest water level (RWL) measured before commencement of the yield test). All raw data and measurements taken during the actual yield test are presented in **Appendix A.**

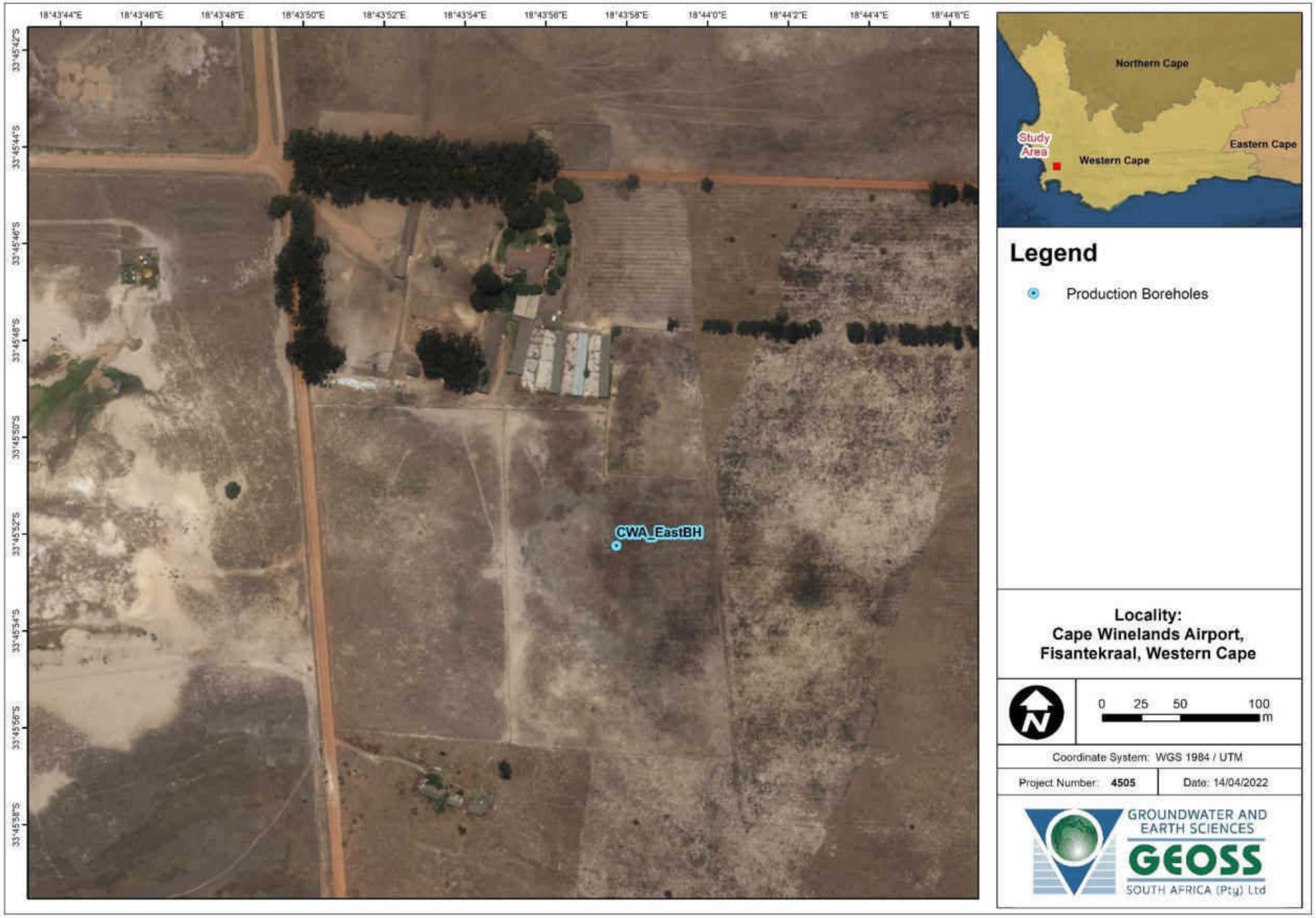


Figure 1: Borehole Locality Map

The yield test data was analysed using the excel-based FC program, developed by the IGS (Institute for Groundwater Studies) in Bloemfontein. The sustainable yield of the borehole was calculated based upon long-term extrapolations of the CDT data according to (1) the Cooper-Jacob approximation of the Theis solution for confined aquifers, (2) the Barker Generalised Radial Flow Model (GRF) for hydraulic tests in fractured rock and (3) the Flow Characteristic (FC) method(s) using first and second derivative calculations. Boundary conditions are accounted for in multiplication factors to the rate of drawdown (derivatives), according to each of the above three methods. These three methods are briefly described below.

1. The Cooper-Jacob approximation of the Theis solution for confined aquifers was designed for porous media aquifers, where infinite acting radial flow (IARF) was observed during the pumping of a borehole. The application of this method to fractured aquifers was discussed by Meier et al (1998), concluding that T estimates using the Cooper-Jacob analysis gave an effective T for the fracture zone. The Cooper-Jacob analysis (and more accurately the Theis method) is therefore viable for analysing pumping test data for fractured aquifers where IARF is observed. The parameters are then used to predict theoretical long-term drawdowns.
2. The Barker GRF Model (Barker, 1988) uses fracture hydraulic conductivity, fracture storativity and flow domain to predict drawdown due to abstraction in a borehole in a fractured medium. By changing these values, a curve of drawdown predictions can be made to fit real world data and therefore predict theoretical long-term drawdowns.
3. The FC methods are the Basic FC, the FC Inflection Point and the FC Non-Linear. The Basic FC and the FC Inflection Point methods make use of the derivatives of the drawdown data to predict theoretical long-term drawdowns and the scale back factors are applied to selected available drawdowns. The FC Non-Linear method uses curve fitting of the Step Test data to predict theoretical long-term drawdowns. Due to the short nature of the Step Test, this method is usually not included if the other methods of analysis differ from it.

In all three methods, the available drawdown was carefully selected to ensure that the flow regime described by the analytical solution is not extrapolated beyond its applicable depth, which may easily result in an overuse of the resource. For CWA_EastBH, this was 43 m, calculated as the geomean of the maximum drawdown reached during the CDT and the drawdown to the original pump depth. A two-year extrapolation time without recharge to the aquifer was selected as per the recommendations within the FC method program.

Water samples were collected at the end of the yield test and submitted for inorganic chemical and microbial analysis.

2.2 Yield Testing at CWA_EastBH

The yield testing was conducted between the 05th and the 08th of April 2022. The borehole was measured at a depth of 100 meters before the start of the test. The test pump was installed at a depth of 89.8 meters below ground level (mbgl). The RWL at the start of the test was 40.32 mbgl.

During the Step Test, the water level was drawn down 36.41 meters below the rest water level (76.73 mbgl) at the end of the 4th step rate of 4 L/s. **Figure 2** shows the time-series drawdown for the Step Test.

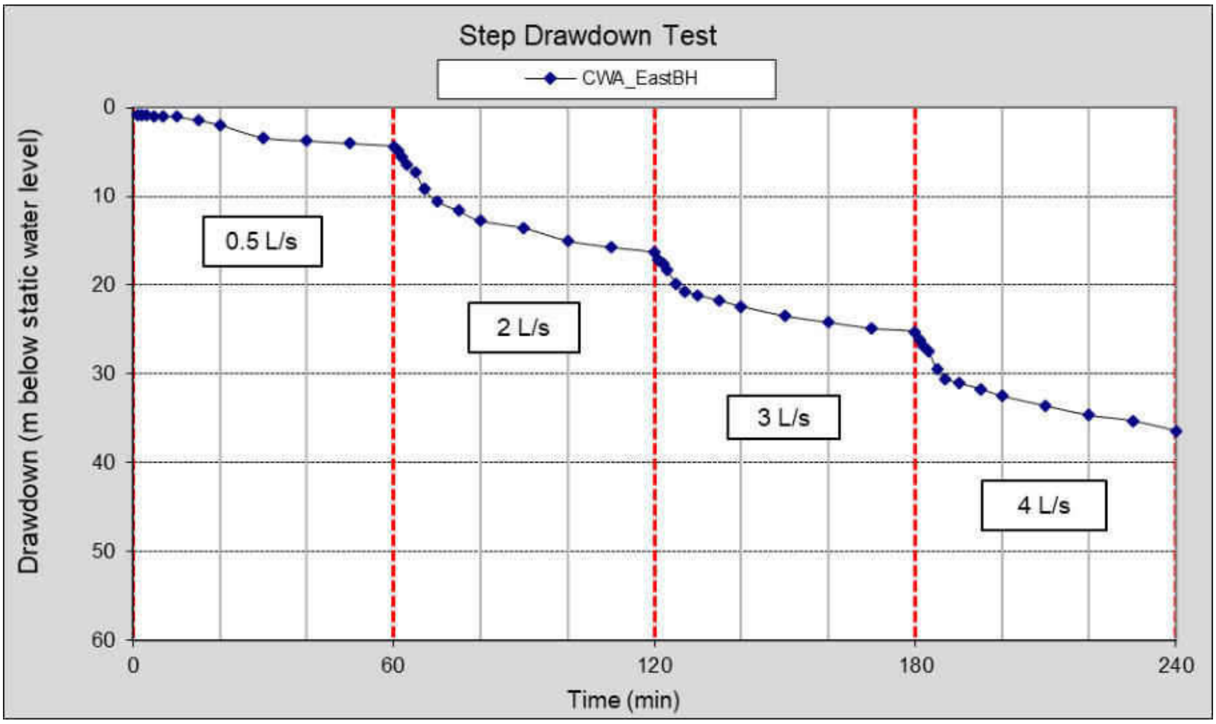


Figure 2: Step Test drawdown data for CWA_EastBH.

The water level recovered to 42.22 mbgl after the step test, before the CDT was started. Based on the results of the Step Test, the CDT was conducted at a rate of 3.3 L/s. At the end of the 24-hour period, the water level had drawn down 42.97 meters below the rest water level (85.19 mbgl). The semi-log plot of the drawdown is presented in **Figure 3**.

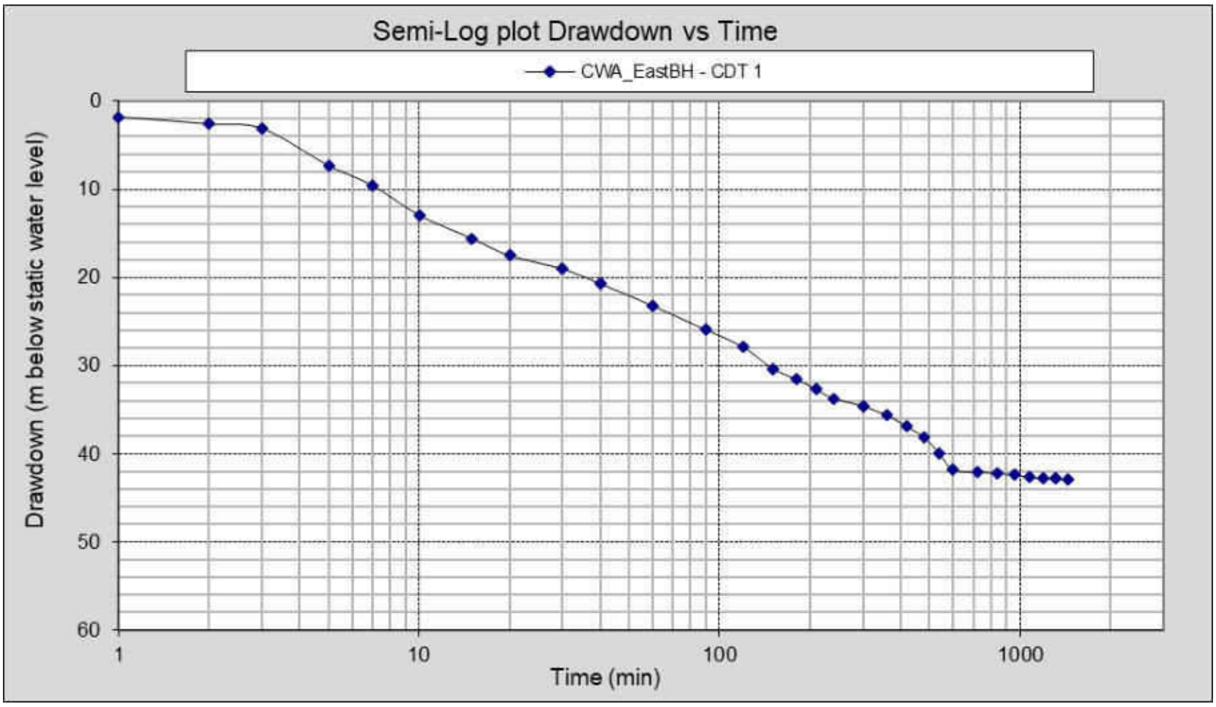


Figure 3: Semi-Log Plot of drawdown during the CDT of CWA_EastBH (3.3 L/s).

The recovery of the water level was monitored after the CDT and is presented in **Figure 4**. The recovery of the water level is moderate, attaining 97.8 % recovery after 24 hours.

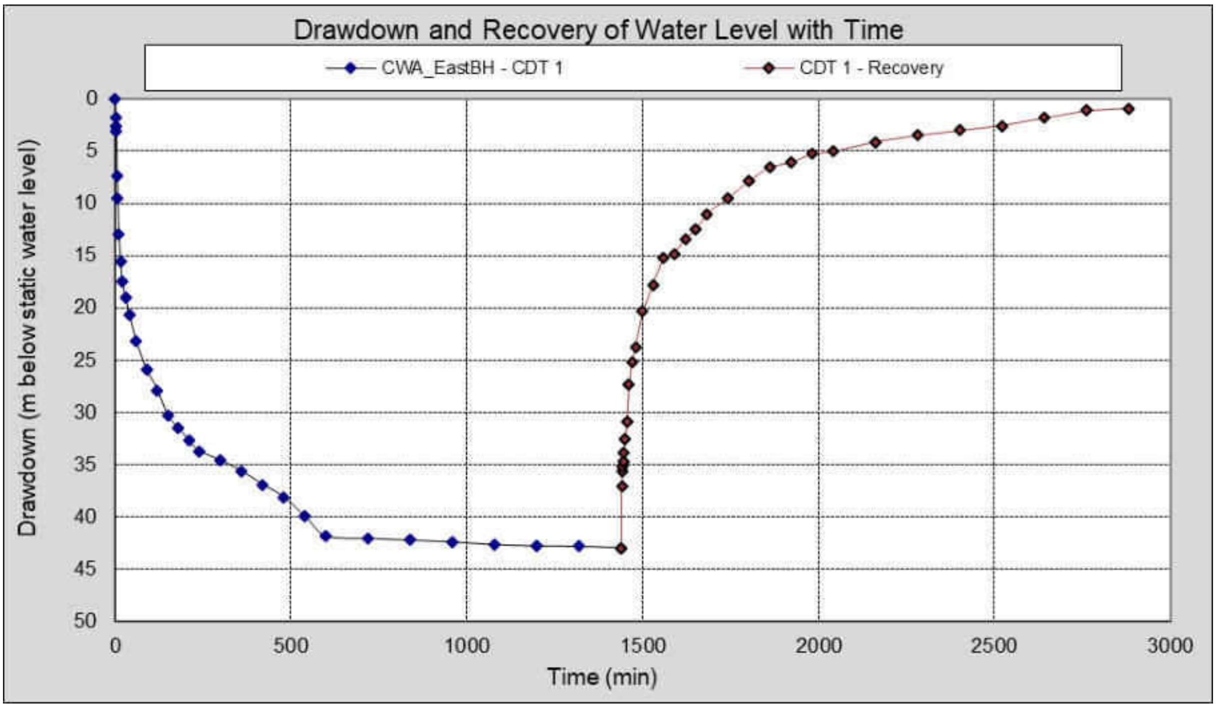


Figure 4: Time-series drawdown and recovery for CWA_EastBH (3.3 L/s).

Several methods were used to assess the yield test data as presented in **Table 2.** It is recommended that the borehole can be abstracted from at a rate of up to 1.0 L/s for up to 24 hours per day. The assessments were based on an available drawdown of 43 meters.

Table 2: Yield Determination - CWA_EastBH

<table>
<tr><th colspan="4">CWA_EastBH</th></tr>
<tr><th>Method</th><th>Sustainable Yield (L/s)</th><th>Late T (m^2/d)</th><th>AD used</th></tr>
<tr><td>Basic FC</td><td>1.0</td><td>2.9</td><td>43</td></tr>
<tr><td>Cooper-Jacob</td><td>1.0</td><td>3.7</td><td>43</td></tr>
<tr><td>FC Non-Linear</td><td>0.9</td><td>4</td><td>43</td></tr>
<tr><td>Barker</td><td>0.9</td><td></td><td>43</td></tr>
<tr><td>Average Q_sust (L/s)</td><td>1.0</td><td></td><td></td></tr>
<tr><th colspan="4">Recommended Abstraction</th></tr>
<tr><th>Abstraction Rate (L/s)</th><th colspan="2">Abstraction Duration (hours)</th><th>Recovery Duration (hours)</th></tr>
<tr><td>1.0</td><td colspan="2">24</td><td>0</td></tr>
</table>

**AD- Available Drawdown*

** T – Transmissivity*

3. WATER QUALITY ANALYSIS

A groundwater sample was collected from the borehole at the end of the yield test and submitted for inorganic and microbiological chemical analysis to a SANAS accredited laboratory (Vinlab) in the Western Cape. The certificate of analysis for the sample is presented in **Appendix B**. The chemistry results obtained have been classified according to the SANS241-1: 2015 standards for domestic water **(Table 3). Table 5** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 3: Classification table for specific limits

Acute Health	Chronic Health	Aesthetic	Operational	Acceptable

The chemistry results obtained have been classified according to the DWAF (1998) standards for domestic water. **Table 4** enables an evaluation of the water quality with regard to the various parameters measured (DWAF, 1998). **Table 6** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 4: Classification table for the groundwater results (DWAF, 1998)

Blue	**(Class 0)**	**Ideal water quality** - suitable for lifetime use.
Green	**(Class I)**	**Good water quality** - suitable for use, rare instances of negative effects.
Yellow	**(Class II)**	**Marginal water quality** - conditionally acceptable. Negative effects may occur.
Red	**(Class III)**	**Poor water quality** - unsuitable for use without treatment. Chronic effects may occur.
Purple	**(Class IV)**	**Dangerous water quality** - totally unsuitable for use. Acute effects may occur.

Table 5: Production borehole results classified according to the SANS241-1:2015

Analyses	CWA_EastBH	SANS 241-1:2015
Date and Time Sampled	07/04/2022 07:30	
pH (at 25 ºC)	7.3	5.0 ≤ Operational ≤ 9.7
Conductivity (mS/m) (at 25 ºC)	89.0	Aesthetic ≤170
Total Dissolved Solids (mg/L)	603.42	Aesthetic ≤1200
Turbidity (NTU)	18.70	Operational≤1 Aesthetic ≤5
Colour (mg/L as Pt)	<15	Aesthetic ≤15
Sodium (mg/L as Na)	130	Aesthetic ≤200
Potassium (mg/L as K)	4	N/A
Magnesium (mg/L as Mg)	16	N/A
Calcium (mg/L as Ca)	17	N/A
Chloride (mg/L as Cl)	207.57	Aesthetic ≤300
Sulphate (mg/L as SO4)	13.89	Aesthetic ≤250 Acute ≤500
Nitrate & Nitrite Nitrogen (mg/L as N)	<1.05	≤12 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	Acute Health ≤11
Nitrite Nitrogen (mg/L as N)	<0.05	Acute Health ≤0.9
Ammonia Nitrogen (mg/L as N)	<0.15	Aesthetic ≤1.5
Total Alkalinity (mg/L as $CaCO_3$)	102.1	N/A
Total Hardness (mg/L as $CaCO_3$)	108.1	N/A
Fluoride (mg/L as F)	0.17	Chronic Health ≤1.5
Aluminium (mg/L as Al)	<0.008	Operational ≤0.3
Total Chromium (mg/L as Cr)	<0.004	Chronic Health ≤0.05
Manganese (mg/L as Mn)	0.329	Aesthetic ≤0.1 Chronic ≤0.4
Iron (mg/L as Fe)	1.881	Aesthetic ≤0.3 Chronic ≤2
Nickel (mg/L as Ni)	<0.008	Chronic Health ≤0.07
Copper (mg/L as Cu)	0.010	Chronic Health ≤2
Zinc (mg/L as Zn)	<0.008	Aesthetic ≤5
Arsenic (mg/L as As)	<0.010	Chronic Health ≤0.01
Selenium (mg/L as Se)	<0.008	Chronic Health ≤0.04
Cadmium (mg/L as Cd)	0.002	Chronic Health ≤0.003
Antimony (mg/L as Sb)	<0.013	Chronic Health ≤0.02
Mercury (mg/L as Hg)	<0.001	Chronic Health ≤0.006
Lead (mg/L as Pb)	<0.008	Chronic Health ≤0.01
Uranium (mg/L as U)	<0.028	Chronic Health ≤0.03
Cyanide (mg/L as CN-)	<0.01	Acute Health ≤0.2
Total Organic Carbon (mg/L as C)	2.46	N/A
E.coli (count per 100 ml)	nd	Not Det. Acute Health-1
Total Coliform Bacteria (count per 100 ml)	nd	Not Det.≤10 Operational
Heterotrophic Plate Count (count per ml)	69	Operational ≤1000
Charge Balance Error %	-1.1	-5≤ Acceptable ≤5

Table 6: Classified production borehole results according to DWAF 1998.

	CWA_EastBH	DWA (1998) Drinking Water Assessment Guide				
		Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
		Ideal	**Good**	**Marginal**	**Poor**	**Dangerous**
Date and Time Sampled	07/04/2022 07:30					
pH	7.3	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)	89.0	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	18.70	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L					
Total Dissolved Solids	603.42	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	130	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	4	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	16	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	17	<80	80-150	150-300	>300	
Chloride (as Cl)	207.57	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	13.89	<200	200-400	400-600	600-1000	>1000
Nitrate & Nitrite (as N)	<1.05	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	0.17	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.329	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	1.881	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	0.010	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	<0.008	<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 $CaCO_3$)	108.100	<200	200-300	300-600	>600	
	counts/100 mL					
Faecal coliforms	nd	0	0-1	1.0-10	10-100	>100
Total coliforms	nd	0	0-10	10-100	100-1000	>1000
Charge Balance Error %	-1.1	-5≤ Acceptable ≤5				

From the chemical results presented in **Table 5** and **Table 6**, the groundwater from the borehole is of "marginal" water quality for human consumption, with elevated turbidity levels related to high concentrations of iron and manganese in the groundwater. Both these parameters may have aesthetic effects such as red staining on building walls. The iron may also precipitate, which can contribute to blocking pipes and pumps and even the borehole fractures, should the borehole be managed incorrectly. There is also an elevated concentration of chloride in the groundwater. This water is not suitable for domestic use without treatment.

The Stiff Diagram is a graphical representation of the relative concentrations of the cations (positive ions) and anions (negative ions). This diagram shows concentrations of cations and anions relative to each other and direct reference can be made to specific salts in the water. The Stiff Diagram for the sample from the borehole is shown in **Figure 5**. The groundwater sample from CWA_EastBH is dominated by Sodium & Potassium/Chloride concentrations.

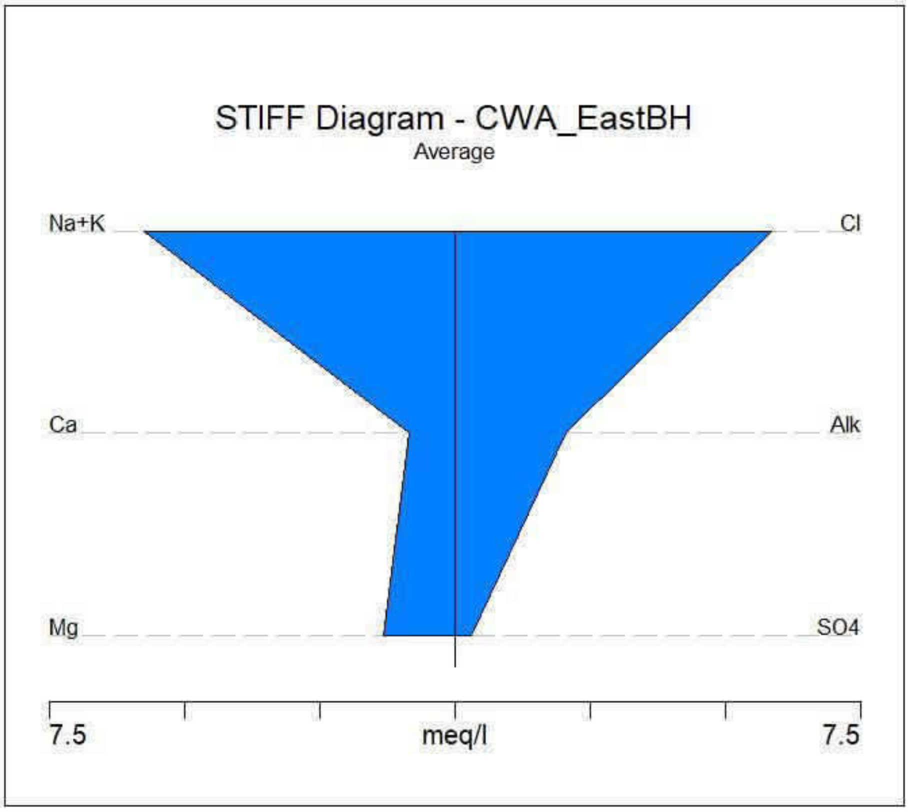


Figure 5: Stiff diagram of the borehole groundwater sample.

The Sodium Adsorption Ratio (SAR) of the groundwater samples is plotted in **Figure 6**. The groundwater for CWA_EastBH is plotted as S1/C3, thus classified as low risk in terms of sodium adsorption and high risk in terms of salinity hazard. This graph is typically applicable to irrigation, however, is dependent on soil texture and crop type.

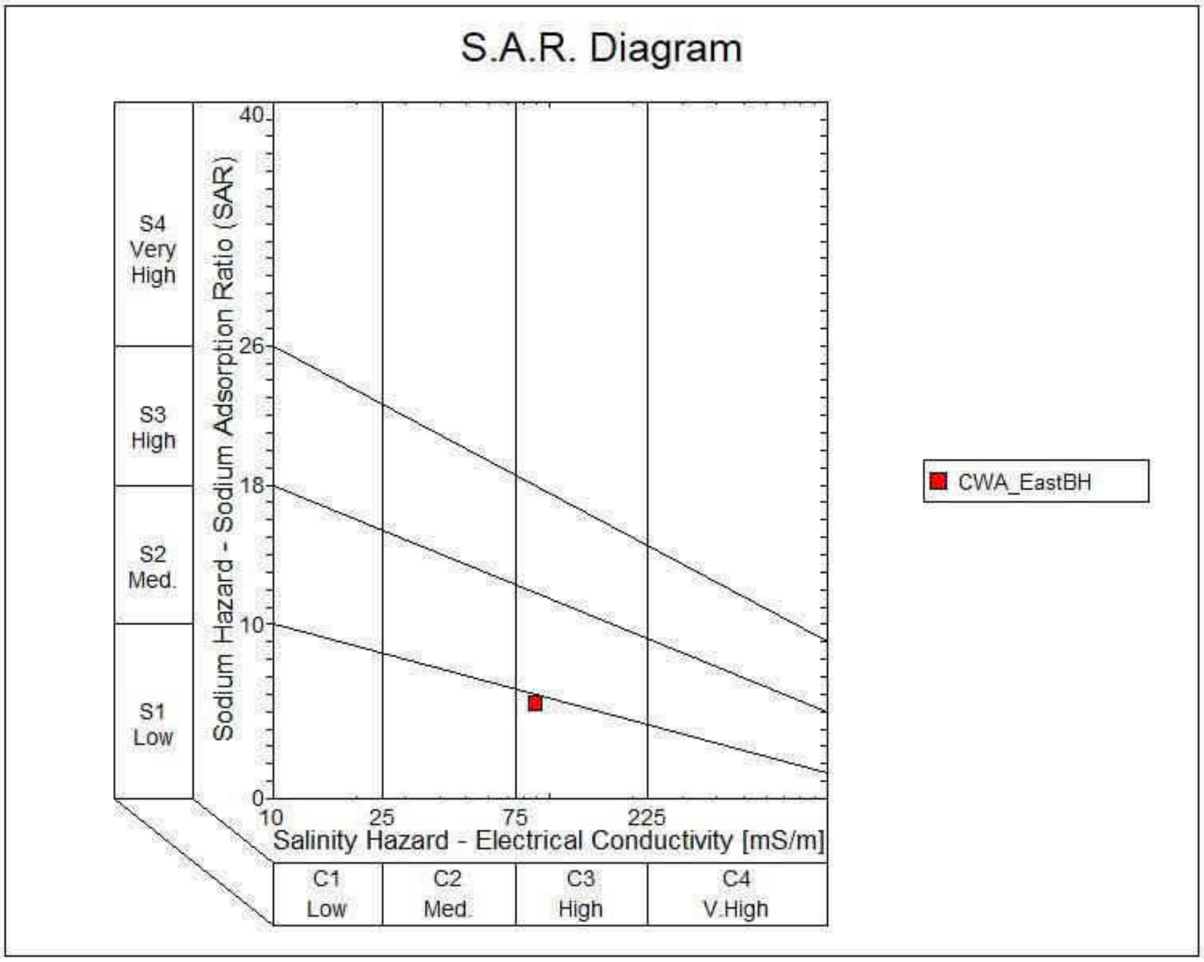


Figure 6: SAR diagram of the groundwater samples.

4. RECOMMENDATIONS

Based on the information obtained from the yield test, the abstraction recommendations for the borehole are presented in **Table 7**. The yield testing was conducted for a 24-hour period and while this data can be analysed for an estimate sustainable yield, the potential use of other boreholes in the area may induce long term cumulative impacts that cannot be predicted from these tests. This should be noted if further groundwater exploration is performed on this or neighbouring properties. Optimisation of the resource is also likely through making small changes to the abstraction rate, should the dynamic water levels be less or more than expected as per **Table 7**. Both of these points are best managed through long term regular monitoring data of water levels, flow rates and abstracted volumes.

Table 7: Borehole Abstraction Recommendations

Borehole Details				
Borehole Name	**Latitude (DD)**	**Longitude (DD)**	**Borehole Depth (m)**	**Inner Diameter at pump depth (mm)**
CWA_EastBH	-33.84071°	18.53738°	100	158
Abstraction Details				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
CWA_EastBH	1.0	24	0	86 400
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
CWA_EastBH	93	85	72	42.22

For borehole CWA_EastBH it is recommended that continuous abstraction can occur at a rate of up to 1.0 L/s. The pump can be installed at a depth of 93 mbgl. It is anticipated that abstraction at the recommended rate will cause the water level to drop to a depth of approximately 72 mbgl – this is referred to as the dynamic water level. During abstraction, a maximum level cut off switch should be installed to 85 mbgl to ensure the groundwater level does not drop too low.

From the laboratory results, the groundwater from these boreholes is of "marginal" water quality for human consumption, with elevated turbidity levels related to high concentrations of iron and manganese in the groundwater. Both these parameters may have aesthetic effects such as red staining on building walls. The iron may also precipitate, which can contribute to blocking pipes and pumps and even the borehole fractures, should the borehole be managed incorrectly. There is also an elevated concentration of chloride in the groundwater. This water is not suitable for domestic use without treatment.

To address the potential for the iron in the water to clog a borehole pump, it is recommended to maintain a constant continuous pumping schedule. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps. It is also recommended to pump the water into settling tanks to allow iron settling prior to use.

In order to maintain continuous pumping, if the demand for water is less than 86 400 L/day, it is recommended that a suitably lower flow rate pump is installed and that the water is pumped slowly and continuously to storage from where it can be used (and treated) as required. Through long term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate if required. It is therefore recommended that the borehole is equipped with a pump operating through a variable speed drive so that adjustments can be made as required if water level and flow rate monitoring data support this.

As of January 2018 the Department of Water and Sanitation released a Government Gazette stating that: "All water use sector groups and individuals taking water from any water resource (surface or groundwater) regardless of the authorization type, in the Berg, Olifants and Breede Gouritz Water Management Area, shall install electronic water recording, monitoring or measuring devices to enable monitoring of abstractions, storage and use of water by existing lawful users and establish links with any monitoring or management system as well as keep records of the water used."

Therefore, to facilitate monitoring and informed management of a borehole, it is highly recommended that boreholes be equipped with the following monitoring infrastructure and equipment (diagram included in **Appendix C**):

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m. This allows for a 'window' of access down the borehole which enables manual water level monitoring and can house an electronic water level logger
- Installation of an electronic water level logger (for automated water level monitoring)
- Installation of a sampling tap (to monitor water quality)
- Installation of a flow volume meter (to monitor abstraction rates and volumes)

This data should be analysed by a qualified Hydrogeologist to ensure long-term sustainable use from the borehole. The legal compliance with regard to the use of the groundwater also needs to be addressed with the Department of Water and Sanitation.

5. REFERENCES

Barker, J.A., (1988) A Generalised Radial Flow Model for Hydraulic Tests in Fractured Rock. Water Resources Research, Vol. 24, No. 10 Pages 1796 – 1804.

DWAF (1998). Quality of domestic water supplies, Volume 1: Assessment guide. Department of Water Affairs and Forestry, Department of Health, Water Research Commission, 1998.

Meier, P.M., Carrera, J. & Sanchez-Vila, X (1998). An evaluation of Jacob's method for the interpretation of pumping tests in heterogeneous formations. Water Resources Research, Vol. 34, No. 5. 1011 – 1025.

National Water Act (1998). The National Water Act, No 36. Department of Water Affairs and Forestry. Pretoria.

SANS (10299-4:2003). South African National Standard. Development, maintenance and management of groundwater resources. Part 4: Test-pumping of water boreholes. ISBN 0-626-14912-6.

SANS (241-1:2015). Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinants.

6. APPENDIX A: YIELD TEST DATA

Abbreviations	
EC	Electrical conductivity
mbgl	Meters below ground level
mbch	Meters below casing height
mbdl	Meters below datum level
magl	Meters above ground level
L/S	Litres per second
RPM	Rates per minute
S/W/L	Static water level
µS/cm	Microsiemens per centimetre

BOREHOLE TEST RECORD

PR0JECT #	P2647
BBR	ERNST
PRODUCTION BONUS:	THABANG TINASHE MARTIN
EC meter number	#151

CONSULTANT: GEOSS

DISTRICT: COCT

PROVINCE: WESTERN CAOE

FARM / VILLAGE NAME : FISANTEKRAAL

DATE TESTED: 05/04/2022

MAP REFERENCE:

CO-ORDINATES:

FORMAT ON GPS: hddd ° mm ' ss.s " hddd ° mm.mmm ' hddd.ddddd

LATITUDE: ° ' " OR ° ' OR S 33.76452

LONGITUDE: ° ' " ° ' E 018.73271

BOREHOLE NO: CWA-EAST BOREHOLE

TRANSMISSIVITY VALUE:

TYPE INSTALLATION: SUBMERSIBLE

BOREHOLE DEPTH: (mbgl) 100.44

COMMENTS: INSTALLED 94.00 O PIEZOMETER TUBE (32MM)

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	Test for:	macro	bacterio-logical	DATA CAPTURED BY:	ZOE
Date sample taken	07/04/2022		If consultant took sample, give name:			DATA CHECKED BY:	AVN
Time sample taken	07H30						

CONSULTANT GUIDELINES

BOREHOLE DEPTH:		m	STEP 1:		l/s	WATER STRIKE 1:			m
BLOW YIELD:		m	STEP 2:		l/s	WATER STRIKE 2:			m
STATIC WATER LEVEL:		m	STEP 3:		l/s	WATER STRIKE 3:			m
PUMP INSTALLATION DEPTH:		m	STEP 4:		l/s	**COMMENTS:**			
RECOVERY:			STEP 5:		l/s				
AFTER STEPS:		h	STEP 6:		l/s	TELEPHONE NUMBERS PHONE : (NAME & TEL)			
AFTER CONSTANT:		h	STEP DURATION:		min				

DESCRIPTION:	UNIT	QTY		UNIT	QTY
STRAIGHTNESS TEST:	NO	0	BOREHOLE DEPTH AFTER TEST:	M	100.81
VERTICALLY TEST:	NO	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	M	41.23
CASING DETECTION:	NO	1	SAND/GRAVEL/SILT PUMPED?	YES/NO	0
SUPPLIED NEW STEEL BOREHOLE COVER:	NO	0	DATA REPORTING AND RECORDING	NO	1
BOREHOLE MARKING	NO	1	SLUG TEST:	NO	0
SITE CLEANING & FINISHING	NO	1	LAYFLAT (M):	M	100
LOGGERS FOR WATERLEVEL MONITORING	NO	0	LOGGERS FOR pH AND EC:	NO	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ________________ **SIGNATURE:** ______________

DESIGNATION: ________________ **DATE:** ______________

BOREHOLE TEST CONTROL SHEET

Groundwater Solutions t/a AB PUMPS

Borehole number:		CWA-EAST BOREHOLE	Old / Alternative number:		
Contractor:		ATS	Supervisor:		ERNST
Operator:		THABNAG	Rig number & Type rig:		#27

EXISTING EQUIPMENT

Type pump	Depth	Condition	**Drive unit**	Condition	**Pump house**	Condition	**Remarks**
SUBMERSIBL	93.8	GOOD	ELECTRIC	GOOD			

TESTING EQUIPMENT

Pump type		**Depth installed (m)**	**Date & time (started)**	**Date & time (completed)**
WA22-2		89.80	05/04/2022 12H30	05/04/2022 18H30

MULTI-RATE OR STEPTEST DETAILS

STEP	**DURATION (MIN)**	**RECOVERY (MIN)**	**YIELD (L/S)**		**DRAWDOWN (m)**
1	60		0.53	l/s	4.36
2	60		2.01	l/s	16.33
3	60		3.02	l/s	25.26
4	60	120	4.02	l/s	36..41
5				l/s	
6				l/s	
7				l/s	
8				l/s	
Calibration:				l/s	
TOTAL:	240	120		l/s	
COMMENT:					

CONSTANT RATE DISCHARGE TEST

Pump type	**Depth installed (m)**	**Date & time (started)**		**Date & time (completed)**	
WA22-2	89.80	06/04/2022	08H00	08/04/2022	08H00
Yield l/s	**Drawdown (m)**	**Duration (min)**		**Recovery (min)**	
3.31	42.97	1440		1440	
Total: (Multi-rate and Constant Discharge rate)		1680		1560	
COMMENT:					

MAINTENANCE

Work time:	hour	Transport existing equipm.	Km	Travelling (To fix);	Km
List of parts replaced or repaired:					

	Borehole number	**Duration (min) CONSTANT**	**Drawdown (m)**	**Hand/logger**	**Distance (m)**
Observation Hole 1					0
Observation Hole 2					0
Observation Hole 3					0
Observation Hole 4					
Observation Hole 5					

GENERAL

ESTABLISHMENT	From:		To:			
Site Move	From project#		To #:	P2647	Travelling km:	17
	Village	Borehole no	Village	Borehole no		
	YARD	YARD	FISANTEKR AAL	CWA-EAST BOREHOLE		
Maintenance:	Work time hr		Parts repaired/ replaced		Travelling km	
After test measurements	Water level	41.23	Borehole depth	100.81	Casing depth m	RUST
Water level before installing test pump: (mbch)			40.62			
Depth before installing test pump:			100.44			
Testpump Installed	**Once** /Twice /More		Reason:			
Installed Testpump	**<10 l/s** / >10ls/s		Reason:	LOW YIELD		
Was existing equipment re-installed:		**Yes:**	No:	If not where was it left:		
GPS Unit number:			GARMIN			
EC Unit number:			#151			
Remarks:						
Signed Contractor:				Signed Consultant:		

FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P2647	MAP REFERENCE:		PROVINCE:	WESTERN CAOE
BOREHOLE NO:	CWA-EAST BO	LATITUDE:	S 33.76452	DISTRICT:	COCT
ALT BH NO:	0	LONGITUDE:	E 018.73271	SITE NAME:	FISANTEKRAAL
ALT BH NO:	0				

BOREHOLE DEPTH (m)	100.44	DATUM LEVEL ABOVE CASING (m):	0.30	EXISTING PUMP:	
WATER LEVEL (mbdl):	40.90	CASING HEIGHT: (magl):	0.28	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	89.80	DIAM PUMP INLET (mm):	158.00	PUMP TYPE:	WA22-2

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1			RPM	298	DISCHARGE RATE 2			RPM	670	DISCHARGE RATE 3			RPM	904
DATE:	05/04/2022	TIME:	12H30		DATE:	05/04/2022	TIME:	13H30		DATE:	05/04/202	TIME:	14H30	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.77		**1**		**1**	4.89		**1**		**1**	17.09		**1**	
2	0.81		**2**		**2**	5.52		**2**		**2**	17.54	2.88	**2**	
3	0.87		**3**		**3**	6.40	1.47	**3**		**3**	18.31	3.03	**3**	
5	0.94		**5**		**5**	7.23	1.68	**5**		**5**	19.80		**5**	
7	1.02		**7**		**7**	9.14		**7**		**7**	20.67	3.01	**7**	
10	1.05	0.38	**10**		**10**	10.59	2.03	**10**		**10**	21.11		**10**	
15	1.46	0.48	**15**		**15**	11.63		**15**		**15**	21.75	3.02	**15**	
20	1.98	0.51	**20**		**20**	12.76	2.01	**20**		**20**	22.59		**20**	
30	3.40	0.55	**30**		**30**	13.60		**30**		**30**	23.47	3.04	**30**	
40	3.75		**40**		**40**	15.00	2.03	**40**		**40**	24.19		**40**	
50	4.04	0.53	**50**		**50**	15.74		**50**		**50**	24.89	3.02	**50**	
60	4.36		**60**		**60**	16.33	2.01	**60**		**60**	25.26		**60**	
70			**70**		**70**			**70**		**70**			**70**	
80			**80**		**80**			**80**		**80**			**80**	
90			**90**		**90**			**90**		**90**			**90**	
100			**100**		**100**			**100**		**100**			**100**	
110			**110**		**110**			**110**		**110**			**110**	
120			**120**		**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC	1	µS/cm	**210**		**EC**	1	µS/cm	**210**		**EC**	1	µS/cm	**210**	
DISCHARGE RATE 4			RPM	1154	DISCHARGE RATE 5			RPM		DISCHARGE RATE 6			RPM	
DATE:	05/04/2022	TIME:	15H30		DATE:		TIME:			DATE:		TIME:		
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)	TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	23.12		**1**	32.48	**1**			**1**		**1**			**1**	
2	26.94		**2**	29.29	**2**			**2**		**2**			**2**	
3	27.38	3.77	**3**	25.27	**3**			**3**		**3**			**3**	
5	29.41	4.03	**5**	22.37	**5**			**5**		**5**			**5**	
7	30.54		**7**	19.24	**7**			**7**		**7**			**7**	
10	31.04	4.02	**10**	17.81	**10**			**10**		**10**			**10**	
15	31.67		**15**	16.21	**15**			**15**		**15**			**15**	
20	32.48	4.05	**20**	15.13	**20**			**20**		**20**			**20**	
30	33.61		**30**	13.82	**30**			**30**		**30**			**30**	
40	34.66	4.03	**40**	12.53	**40**			**40**		**40**			**40**	
50	35.27		**50**	11.16	**50**			**50**		**50**			**50**	
60	36.41	4.02	**60**	10.29	**60**			**60**		**60**			**60**	
70			**70**	10.01	**70**			**70**		**70**			**70**	
80			**80**	9.82	**80**			**80**		**80**			**80**	
90			**90**	8.37	**90**			**90**		**90**			**90**	
100			**100**	8.03	**100**			**100**		**100**			**100**	
110			**110**	7.74	**110**			**110**		**110**			**110**	
120			**120**	7.21	**120**			**120**		**120**			**120**	
pH			**150**		**pH**			**150**		**pH**			**150**	
TEMP		°C	**180**		**TEMP**		°C	**180**		**TEMP**		°C	**180**	
EC	1	µS/cm	**210**		**EC**		µS/cm	**210**		**EC**		µS/cm	**210**	
			240					**240**					**240**	
			300					**300**					**300**	
			360					**360**					**360**	

S/W/L:(mbch) 40.62

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO : P2647
BOREHOLE NO: CWA-EAST BOREHOLE
ALT BH NO: 0
ALT BH NO: 0

MAP REFERENCE: S 33.76452
E 018.73271

PROVINCE: WESTERN CAOE
DISTRICT: COCT
SITE NAME: FISANTEKRAAL

BOREHOLE DEPTH: 100.44
WATER LEVEL (mbdl): 42.80
DEPTH OF PUMP (m): 89.80

DATUM LEVEL ABOVE CASING (m): 0.30
CASING HEIGHT: (magl): 0.28
DIAM PUMP INLET(mm): 158

EXISTING PUMP: 0
CONTRACTOR: ATS
PUMP TYPE: WA22-2

CONSTANT DISCHARGE TEST & RECOVERY

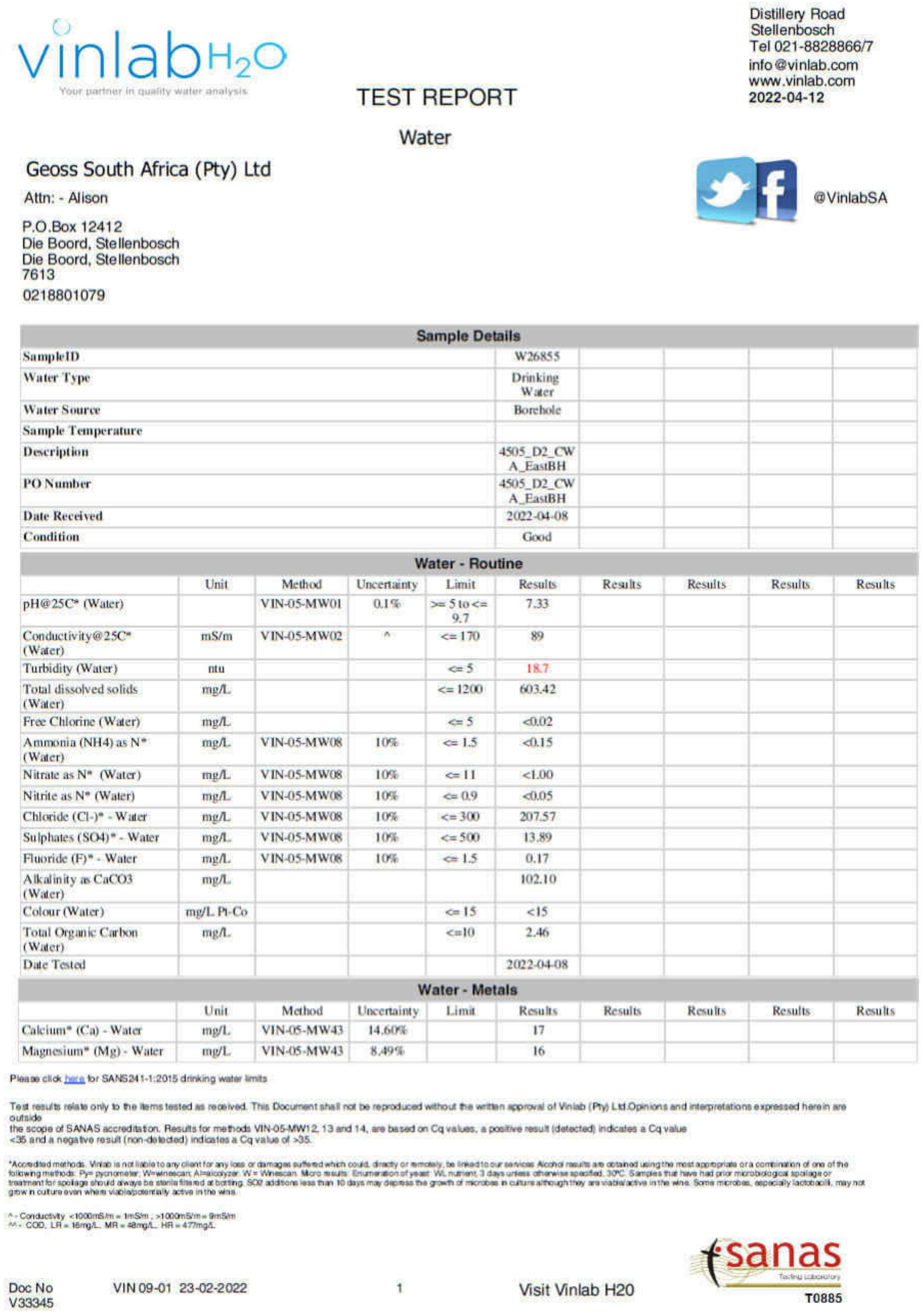
TEST STARTED
DATE: 06/04/2022 TIME: 08H00

TEST COMPLETED
DATE: TIME:

TYPE OF PUMP: WA22-2

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
DISCHARGE BOREHOLE					Distance(m);			Distance(m);			Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	1.77		**1**	37.09	**1**			**1**			**1**	
2	2.58		**2**	35.60	**2**			**2**			**2**	
3	3.10	2.82	**3**	35.21	**3**			**3**			**3**	
5	7.32	3.31	**5**	34.75	**5**			**5**			**5**	
7	9.57		**7**	33.81	**7**			**7**			**7**	
10	12.94	3.33	**10**	32.34	**10**			**10**			**10**	
15	15.58		**15**	30.91	**15**			**15**			**15**	
20	17.51	3.30	**20**	27.38	**20**			**20**			**20**	
30	19.03		**30**	25.21	**30**			**30**			**30**	
40	20.69	3.32	**40**	23.72	**40**			**40**			**40**	
60	23.23		**60**	20.34	**60**			**60**			**60**	
90	25.93	3.30	**90**	17.82	**90**			**90**			**90**	
120	27.88		**120**	15.16	**120**			**120**			**120**	
150	30.32	3.32	**150**	14.91	**150**			**150**			**150**	
180	31.52		**180**	13.38	**180**			**180**			**180**	
210	32.69	3.33	**210**	12.53	**210**			**210**			**210**	
240	33.72		**240**	11.06	**240**			**240**			**240**	
300	34.39	3.31	**300**	9.55	**300**			**300**			**300**	
360	35.61		**360**	7.86	**360**			**360**			**360**	
420	36.92	3.33	**420**	6.50	**420**			**420**			**420**	
480	38.12		**480**	6.12	**480**			**480**			**480**	
540	39.97	3.32	**540**	5.29	**540**			**540**			**540**	
600	41.33		**600**	5.01	**600**			**600**			**600**	
720	42.07	3.30	**720**	4.12	**720**			**720**			**720**	
840	42.23		**840**	3.46	**840**			**840**			**840**	
960	42.41	3.32	**960**	3.04	**960**			**960**			**960**	
1080	42.67		**1080**	2.59	**1080**			**1080**			**1080**	
1200	42.79	3.30	**1200**	1.84	**1200**			**1200**			**1200**	
1320	42.88		**1320**	1.09	**1320**			**1320**			**1320**	
1440	42.97	3.31	**1440**	0.96	**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1440		W/L			W/L			W/L
Average yield (l/s):				3.31								

7. APPENDIX B: WATER QUALITY ANALYSIS



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www.vinlab.com
2022-04-12

TEST REPORT

Water

@VinlabSA

Geoss South Africa (Pty) Ltd
Attn: - Alison

P.O.Box 12412
Die Boord, Stellenbosch
Die Boord, Stellenbosch
7613
0218801079

Sample Details					
SampleID	W26855				
Water Type	Drinking Water				
Water Source	Borehole				
Sample Temperature					
Description	4505_D2_CWA_EastBH				
PO Number	4505_D2_CWA_EastBH				
Date Received	2022-04-08				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C* (Water)		VIN-05-MW01	0.1%	>= 5 to <= 9.7	7.33				
Conductivity@25C* (Water)	mS/m	VIN-05-MW02	^	<= 170	89				
Turbidity (Water)	ntu			<= 5	18.7				
Total dissolved solids (Water)	mg/L			<= 1200	603.42				
Free Chlorine (Water)	mg/L			<= 5	<0.02				
Ammonia (NH4) as N* (Water)	mg/L	VIN-05-MW08	10%	<= 1.5	<0.15				
Nitrate as N* (Water)	mg/L	VIN-05-MW08	10%	<= 11	<1.00				
Nitrite as N* (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-)* - Water	mg/L	VIN-05-MW08	10%	<= 300	207.57				
Sulphates (SO4)* - Water	mg/L	VIN-05-MW08	10%	<= 500	13.89				
Fluoride (F)* - Water	mg/L	VIN-05-MW08	10%	<= 1.5	0.17				
Alkalinity as CaCO3 (Water)	mg/L				102.10				
Colour (Water)	mg/L Pt-Co			<= 15	<15				
Total Organic Carbon (Water)	mg/L			<=10	2.46				
Date Tested					2022-04-08				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium* (Ca) - Water	mg/L	VIN-05-MW43	14.60%		17				
Magnesium* (Mg) - Water	mg/L	VIN-05-MW43	8.49%		16				

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<35 and a negative result (non-detected) indicates a Cq value of >35.

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

Doc No
V33345

VIN 09-01 23-02-2022

1

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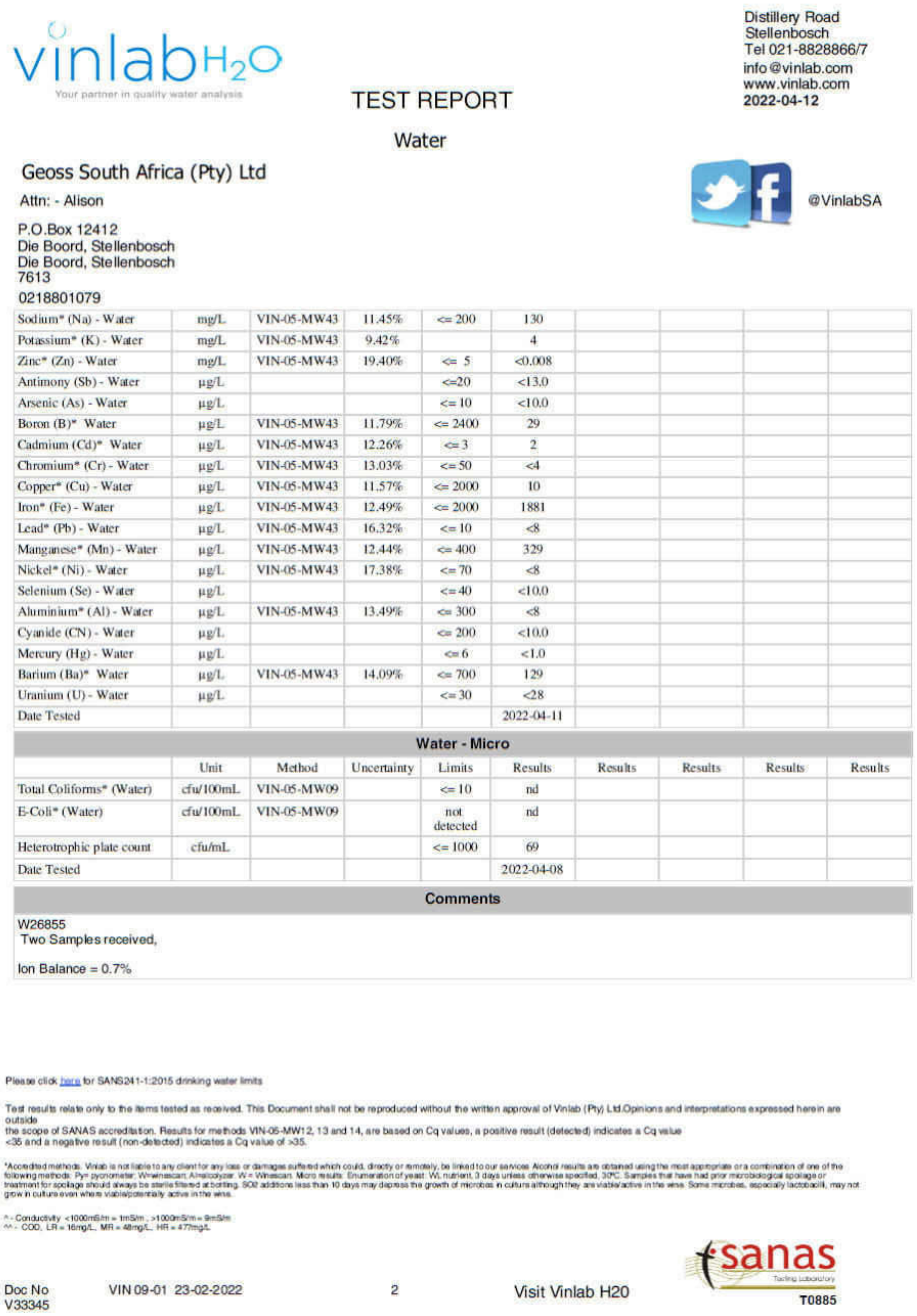

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2022-04-12

TEST REPORT

Water

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Die Boord, Stellenbosch
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Sodium* (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	130				
Potassium* (K) - Water	mg/L	VIN-05-MW43	9.42%		4				
Zinc* (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	<0.008				
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	29				
Cadmium (Cd)* Water	µg/L	VIN-05-MW43	12.26%	<=3	2				
Chromium* (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4				
Copper* (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	10				
Iron* (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	1881				
Lead* (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese* (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	329				
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	<8				
Cyanide (CN) - Water	µg/L			<= 200	<10.0				
Mercury (Hg) - Water	µg/L			<= 6	<1.0				
Barium (Ba)* Water	µg/L	VIN-05-MW43	14.09%	<= 700	129				
Uranium (U) - Water	µg/L			<= 30	<28				
Date Tested					2022-04-11				

Water - Micro

	Unit	Method	Uncertainty	Limits	Results	Results	Results	Results	Results
Total Coliforms* (Water)	cfu/100mL	VIN-05-MW09		<= 10	nd				
E-Coli* (Water)	cfu/100mL	VIN-05-MW09		not detected	nd				
Heterotrophic plate count	cfu/mL			<= 1000	69				
Date Tested					2022-04-08				

Comments

W26855
Two Samples received,

Ion Balance = 0.7%

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^^ - COD, LR = 16mg/L, MR = 48mg/L, HR = 477mg/L

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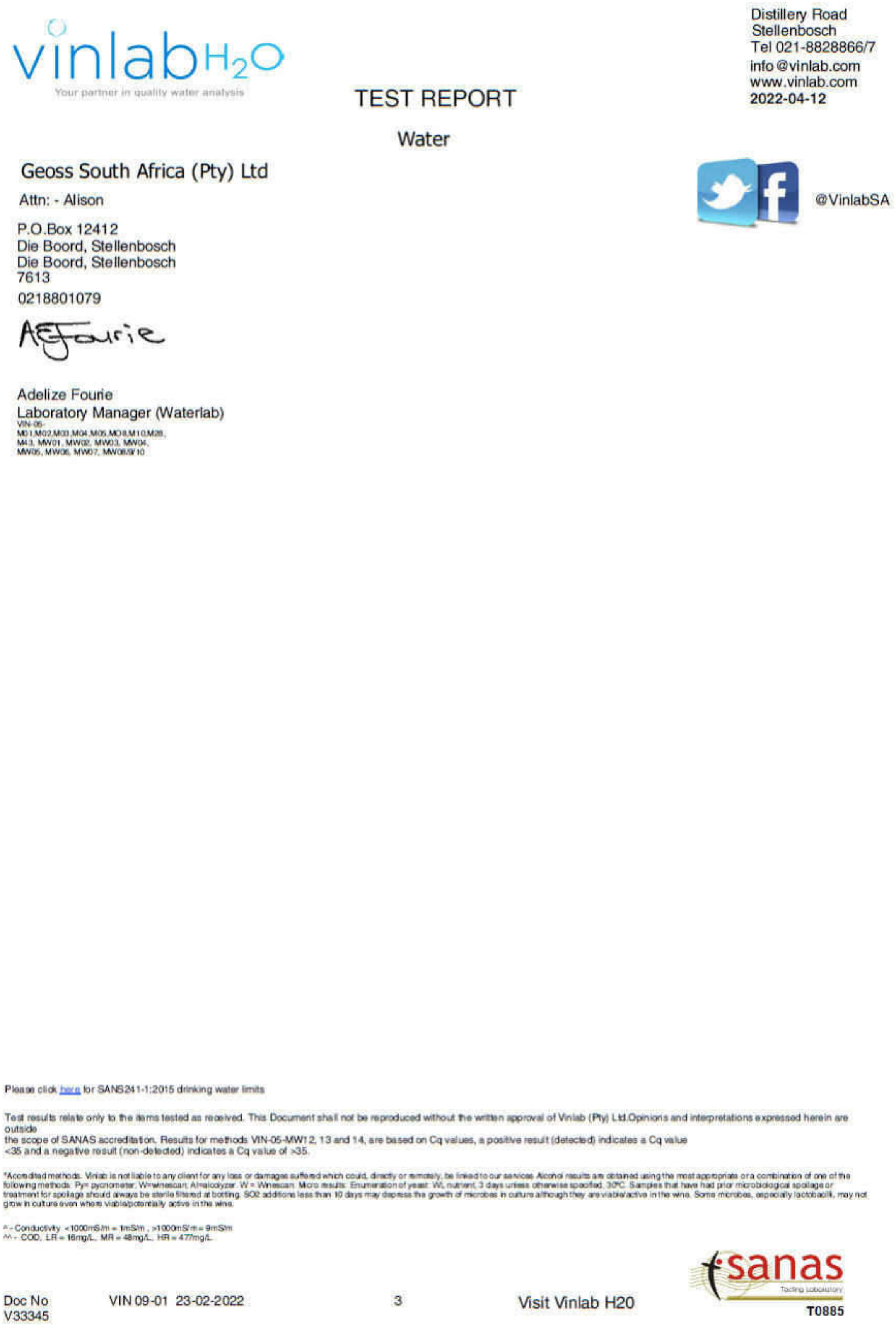

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TEST REPORT

Water

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AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)
VIN-05-
M01,M02,M03,M04,M05,M08,M10,M28,
M43, MW01, MW02, MW03, MW04,
MW05, MW06, MW07, MW08/9/10

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^^ - COD, LR = 16mg/L, MR = 48mg/L, HR = 477mg/L

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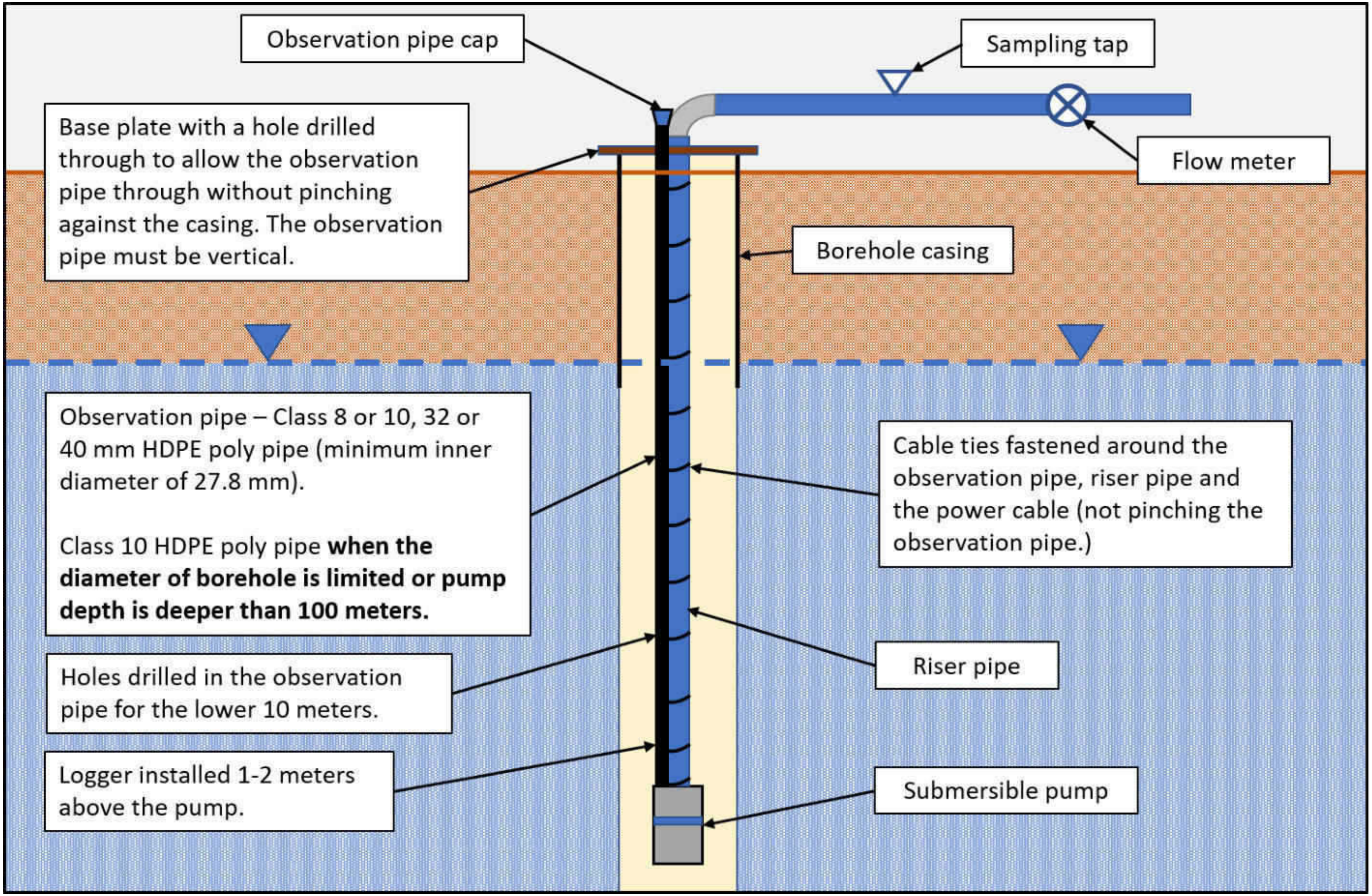
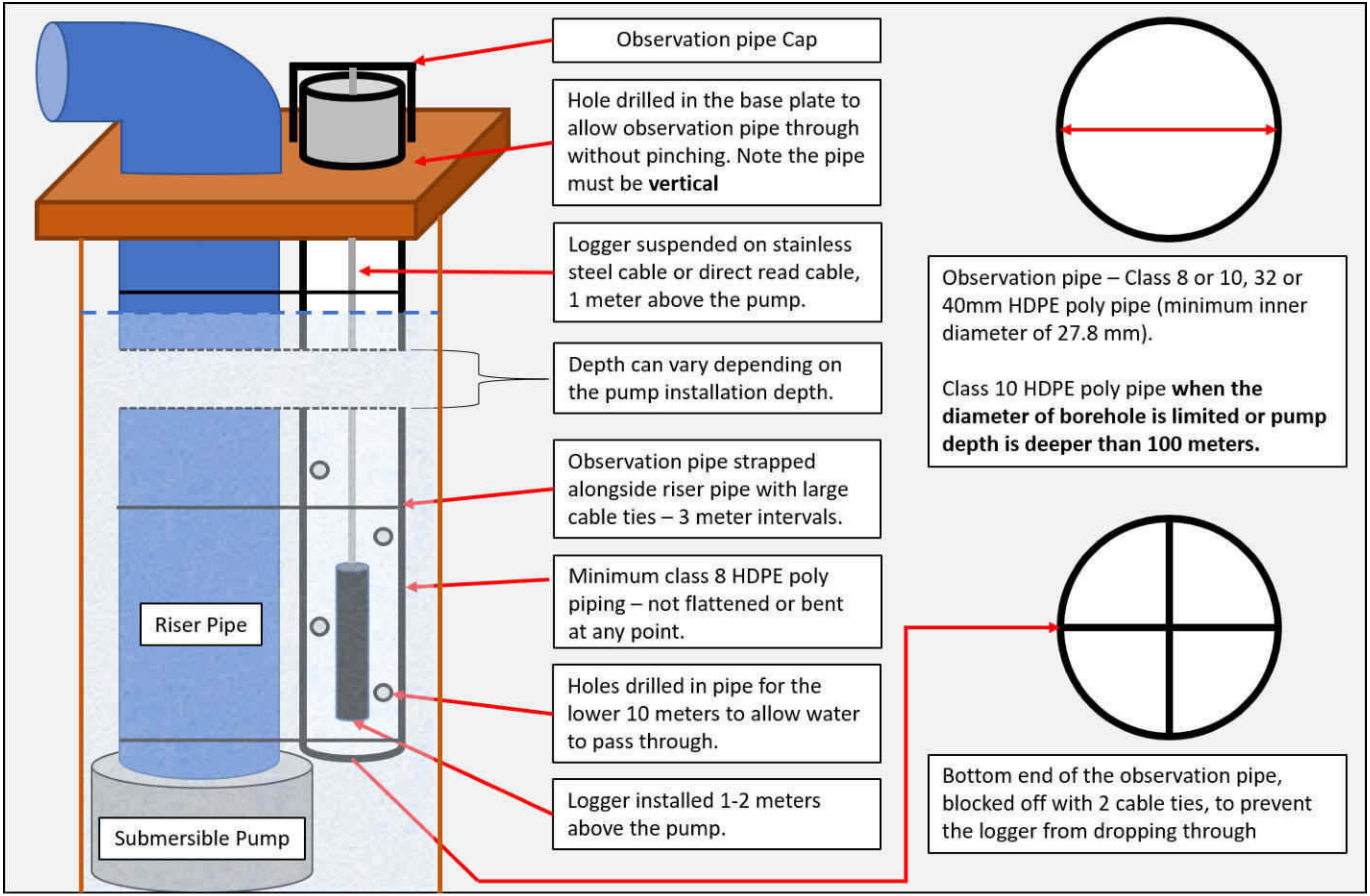
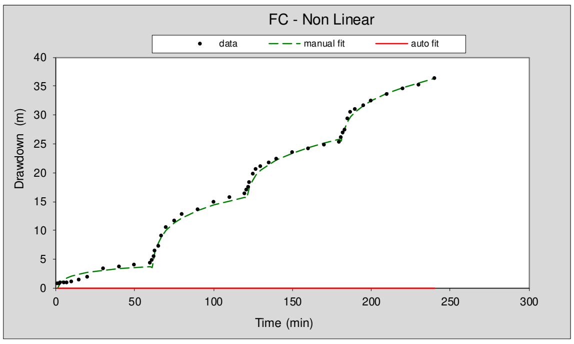
8. APPENDIX C: MONITORING INFRASTRUCTURE DIAGRAM


Observation pipe cap
Sampling tap
Base plate with a hole drilled through to allow the observation pipe through without pinching against the casing. The observation pipe must be vertical.
Flow meter
Borehole casing
Observation pipe – Class 8 or 10, 32 or 40 mm HDPE poly pipe (minimum inner diameter of 27.8 mm).
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**
Cable ties fastened around the observation pipe, riser pipe and the power cable (not pinching the observation pipe.)
Holes drilled in the observation pipe for the lower 10 meters.
Riser pipe
Logger installed 1-2 meters above the pump.
Submersible pump


Observation pipe Cap
Hole drilled in the base plate to allow observation pipe through without pinching. Note the pipe must be **vertical**
Logger suspended on stainless steel cable or direct read cable, 1 meter above the pump.
Depth can vary depending on the pump installation depth.
Observation pipe strapped alongside riser pipe with large cable ties – 3 meter intervals.
Minimum class 8 HDPE poly piping – not flattened or bent at any point.
Holes drilled in pipe for the lower 10 meters to allow water to pass through.
Logger installed 1-2 meters above the pump.
Riser Pipe
Submersible Pump
Observation pipe – Class 8 or 10, 32 or 40mm HDPE poly pipe (minimum inner diameter of 27.8 mm).
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**
Bottom end of the observation pipe, blocked off with 2 cable ties, to prevent the logger from dropping through

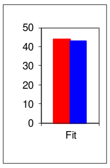
9. APPENDIX D: FC ANALYSIS

CWA_EastBH



FC - Non Linear Method to estimate Q_Sust

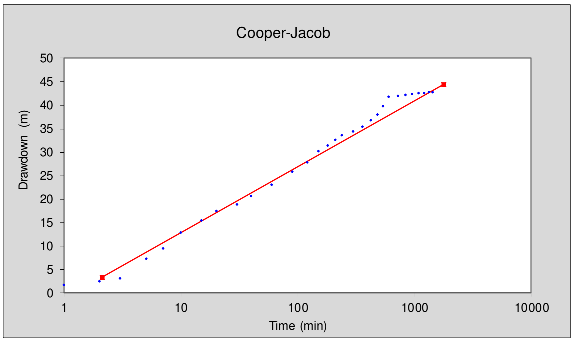
skin effect	Non-Darcian loss		Darcian loss		
A	**C**	**p**	**B**	**n**	**e**
7.00E-06	0.00E+00	2.00E+00	4.50E-02	1.82E+00	1.01E+00



Extrapolation	
Ext_pol time (min)	
1051200	
Q (L/s)	Drawdown (m)
1.6	43.88

Available drawdown (m) =	43		
No boundaries	1 no-flow	2 no-flow	Closed
1.6	0.8	0.5	0.3
Q_Sust (L/s)=	**0.88**	std.dev = 0.58	

Boundaries selected	**0 - 2**

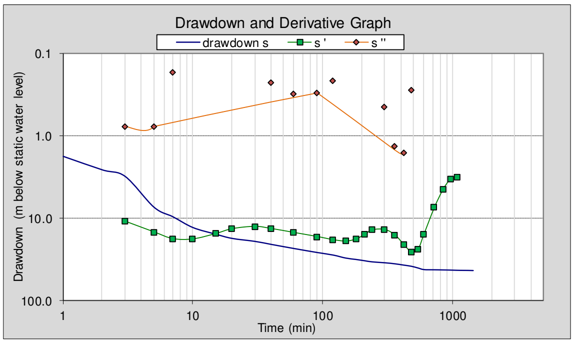


Cooper-Jacob method

T(m^2/d) =	**3.7**	**r_e (m)=**	**0.1**
S =	**######**	**Q (l/s) =**	**3.30**

	No boundaries	1 no-flow	2 no-flow	Closed
Q_sust	1.70	0.85	0.56	0.43
Avg. Q_sust =		**1.04**	std. dev =	0.57

Boundaries selected	**0 - 2**

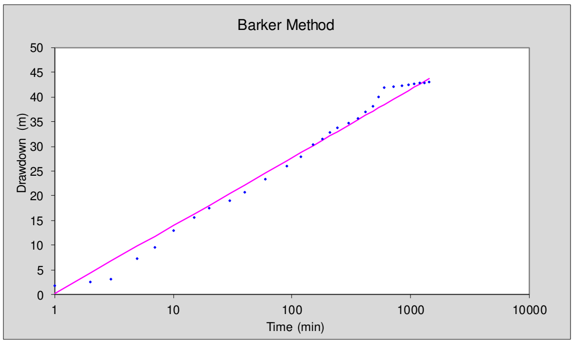


FC method

Extrapolation time in years	2	1051200	Extrapol.time in minutes	
Effective borehole radius (r_e)	40.4355694	40.4355694	Est. r_e	From r(e) sheet
Q (l/s) from pumping test	3.3	3.5229E-05	S-late	Change r_e
s_a (available drawdown), sigma_s	**43**	0	Sigma_s from risk	
Annual effective recharge (mm)	0	43	s_available working drawdown(m)	
t(end) and s(end) of pumping test	1440	42.97	End time and drawdown of test	
Average maximum derivative	**18**	25.5209276	Estimate of average of max deriv	
Average second derivative	**0**	-0.13871276	Estimate of average second deriv	
Derivative at radial flow period	14.2200721	14.2200721	Read from derivative graph	
T-early[m^2/d]		3.66924721	Aqui. thick (m)	60
T and S estimates	**T-late [m^2/d]**	**2.89872**	Est. S-late	0.0033
	S-late	0.0033		

BASIC SOLUTION

	No boundaries	1 no-flow	2 no-flow	Closed no-flow
sWell (Extrapol.time) =	94.51	146.05	197.59	352.21
Q_sust (l/s) =	1.50	0.97	0.72	0.40
Average Q_sust (l/s) =	**1.02**			
with standard deviation=	0.46			
Boundaries selected	**0 - 2**			

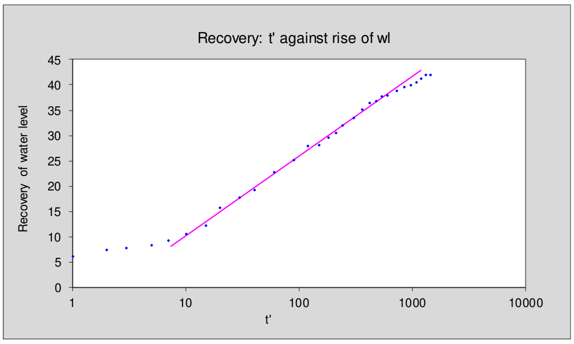


Barker method

	K_f [m/d]	S_f [1/m]	b	n	N
Fit Parameters	1.20	2.00E-02	3.17	2.00	0.0000

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	83.14	186.22	237.76	289.30
Q_sust	1.71	0.76	0.60	0.49

Fractal n = **2.00**	**Average Q-sust (l/s)=**	0.92	std. dev =	0.56
	Boundaries selected	**0 - 2**		



Recovery

T [m2/d]	3.3
CDT Duration	1440
Recovery Duration	1440
Max % Recovery	97.8

(Last page)A

Yield and Quality Testing of a Quarry at the Cape Winelands Airport, Fisantekraal, Western Cape.

REPORT: GEOSS Report No: 2022/09-23 **PREPARED FOR:** Stuart Walls Capital Expenditure Projects (Pty) Ltd Email: stuart@capex.co.za	**PREPARED BY:** Reuben Lazarus GEOSS South Africa (Pty) Ltd Unit 12, Technostell Building, 9 Quantum Street, Technopark Stellenbosch 7600 Tel: (021) 880-1079 Email: info@geoss.co.za (www.geoss.co.za)

22 September 2022

EXECUTIVE SUMMARY

GEOSS South Africa (Pty) Ltd was appointed by Stuart Walls of Capital Expenditure Projects (Pty) Ltd to conduct yield and water quality testing of a Quarry at Cape Winelands Airport. The yield testing was undertaken by ATS under the guidance of GEOSS from the 15th of August to the 1st September 2022. This included a Constant Discharge Test and Recovery Monitoring at the Quarry and sampling of the water for chemical analysis.

Based on the information obtained from the yield test, the water in CWA_Quarry is dependent on precipitation and little to no detectable groundwater in flows were observed. Should abstraction take place from CWA_Quarry, the volume that can be abstracted will be dependent on the water level in the quarry and seasonal rainfall. Abstraction should therefore be licensed as surface water abstraction.

From the laboratory results, water from the CWA_Quarry is of marginal quality for potable supply. The sodium and chloride concentrations in the quarry exceed the aesthetic limit of the SANS 241-1:2015 drinking water guidelines and result in the quarry water having a saline (salty) taste. This is most likely due to the fact that the quarry is an open body of water subject to evaporation processes. Furthermore, the clay that hosts the water body results in the elevated turbidity levels that are responsible for the murky white colour of the water. This may have been exacerbated by the pumping that took place, as well as the very windy conditions on the day of sampling. The aluminium and lead concentrations observed can be related to the clay particles in the water sample and lower concentrations can be expected should an undisturbed sample be collected, as in the sample collected in January 2022. Based on the pH and electrical conductivity from CWA_Quarry compared to the pH and electrical conductivity as well as the iron and manganese from Borehole CWA_BH001 (Geoss 2022) it is evident that the quarry is unrelated to the regional groundwater.

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ABBREVIATIONS

AD	available drawdown
bh	borehole
CDT	constant discharge test
DWA	Department of Water Affairs (pre- 1994)
DWAF	Department of Water Affairs and Forestry (1994 – 2009)
DWS	Department of Water and Sanitation (2009 – ….)
ID	inner diameter
L/s	litres per second
L/d	litres per day
m^2/d	meters squared per day
m	metres
mbgl	metres below ground level
RWL	rest water level below ground level
T	Transmissivity

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)].

Available drawdown: Available drawdown in a borehole is the difference between the rest water level or piezometric surface and the depth that the water level may drop to (typically major water baring unit, boundary inflection or pump depth).

Dynamic water level: The stabilised water level in the borehole during production over long periods of time.

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.

Rest water level: The groundwater level in a borehole not influenced by abstraction or artificial recharge.

Sustainable yield: Sustainable yield is defined as the rate of withdrawal that can be sustained by an aquifer without causing an unacceptable decline in the hydraulic head or deterioration in water quality in the aquifer.

Transmissivity: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

Suggested citation for this report:

GEOSS (2022). Borehole Yield and Quality Testing of a Quarry at the Cape Winelands Airport, Fisantekraal, Western Cape. Report Number: 2022/08-23. GEOSS South Africa (Pty) Ltd. Stellenbosch, South Africa.

Cover photo:

Testing at CWA_Quarry

GEOSS project number:

2021_09-4505 Phase H

Reviewed by:

Dale Barrow (21 September 2022)

1. INTRODUCTION

GEOSS South Africa (Pty) Ltd was appointed by Stuart Walls of Capital Expenditure Projects (Pty) Ltd to conduct yield and water quality testing of a quarry at the Cape Winelands Airport.

The Quarry (CWA_Quarry) was tested by ATS under the guidance of GEOSS from the 15th of August to the 1st September 2022, details of this are presented in this report. The quarry's details are presented in **Table 1** below and spatially in **Figure 1.** The geological setting of the area indicates that the quarry is located in ferricrete of the Bellville formation and loam and sandy loam quaternary deposits (**Figure 2**) underlain by the Tygerberg Formation (Nt), however; onsite it is evident that the quarry is located in a clay deposit of residual Tygerberg Formation.

Table 1: Borehole Details

Borehole	Latitude (DD-WGS84)	Longitude (DD-WGS84)	Depth (m)
CWA_Quarry	-33.755230°	18.731400°	N/A

Yield and Quality Testing at the CWA_Quarry

2. YIELD TESTING

2.1 *Methodology*

The pumping test was undertaken by ATS under the guidance of GEOSS from the 15th of August to the 1st September 2022. The purpose of the test pumping was to determine if the quarry is recharged by groundwater or if there is any groundwater interaction with the quarry. Should the quarry be groundwater recharged, the sustainable yield for the quarry could be determined based on the rate of groundwater inflows during and after pumping. The testing included a Constant Discharge Test and recovery monitoring of the quarry. For the Constant Discharge Test (CDT) the quarry is pumped at a constant rate for an extended period of time, followed by recovery monitoring. The water level drawdown is monitored at pre-determined intervals during these tests (drawdown refers to the difference in water level from the rest water level (RWL) measured before the commencement of the yield test). Raw data and measurements taken during the yield tests are presented in **Appendix A.** Water samples were collected at the end of the yield test and submitted for inorganic chemical analyses.

Figure 1: Locality Map of CWA_Quarry.

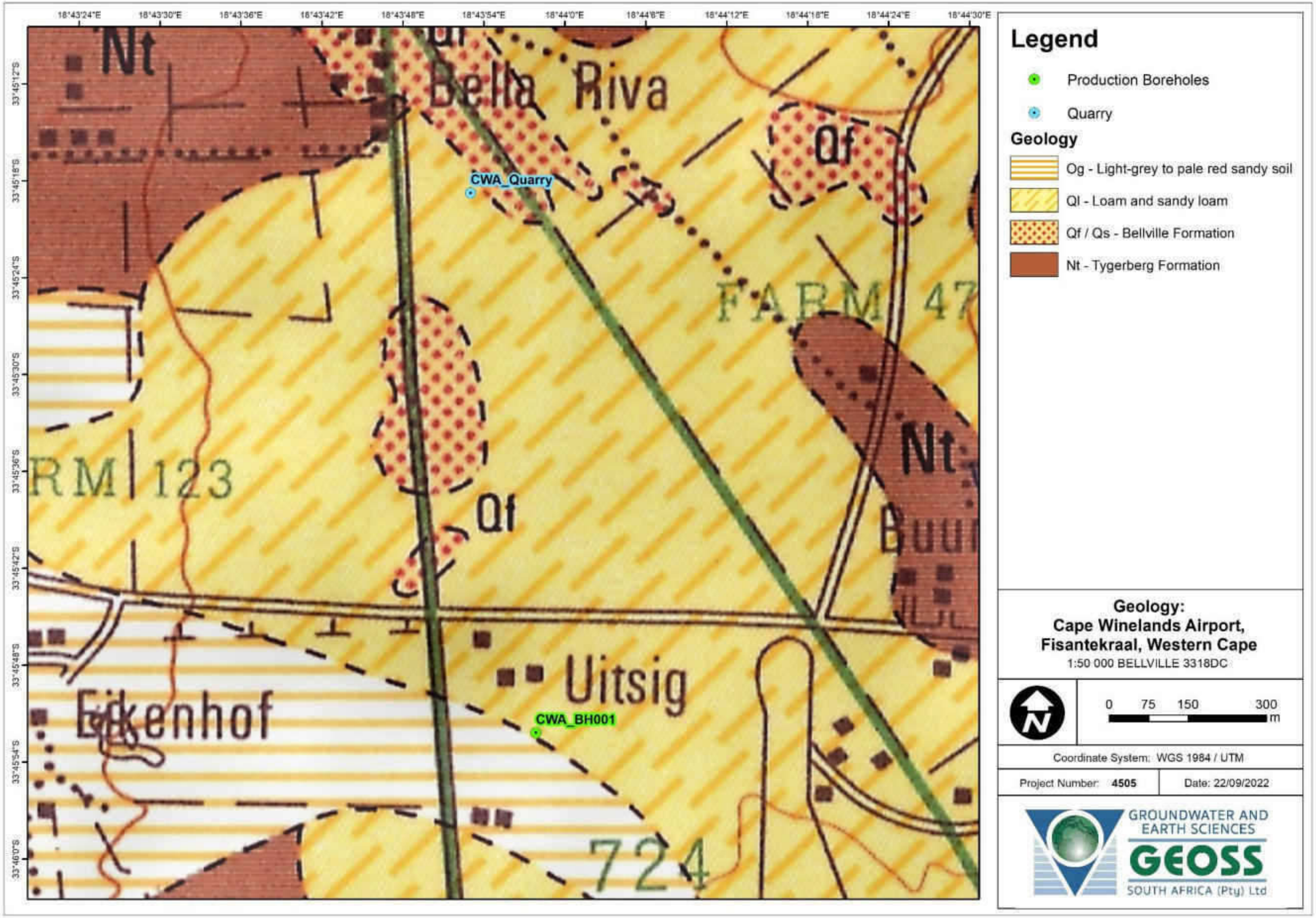

Figure 2: Geological Map with Quarry Position (1: 50 000 Geological Map Series, 3318DC, Belville).

2.2 Yield Testing at CWA_Quarry

The yield testing was conducted between the 15th of August and the 1st of September 2022. A surface mounted centrifugal pump was used to conduct the test. The discharge was pumped 350 m away from the quarry.

The CDT was conducted at the pump maximum of 30.6 L/s. After 360 minutes the test was put on hold as it started to rain. During the initial 360 minutes of discharge the water level was drawn down by 0.098 meters (**Figure 3**). A volume of 660.96 m^3 was abstracted during this time. This relates to the surface area of the quarry filled with water being 6 744.489 m^2. The quarry was left to recover for 2303 minutes. Initially no recovery was observed, however; after 26 mm of precipitation, 12 hours after the CDT was ended the water level in the quarry recovered by 0.04 meters (**Figure 4**). This suggests that the recharge occurred over an area of 9 969.2 m^2 which is smaller than the quarry walls (catchment area).

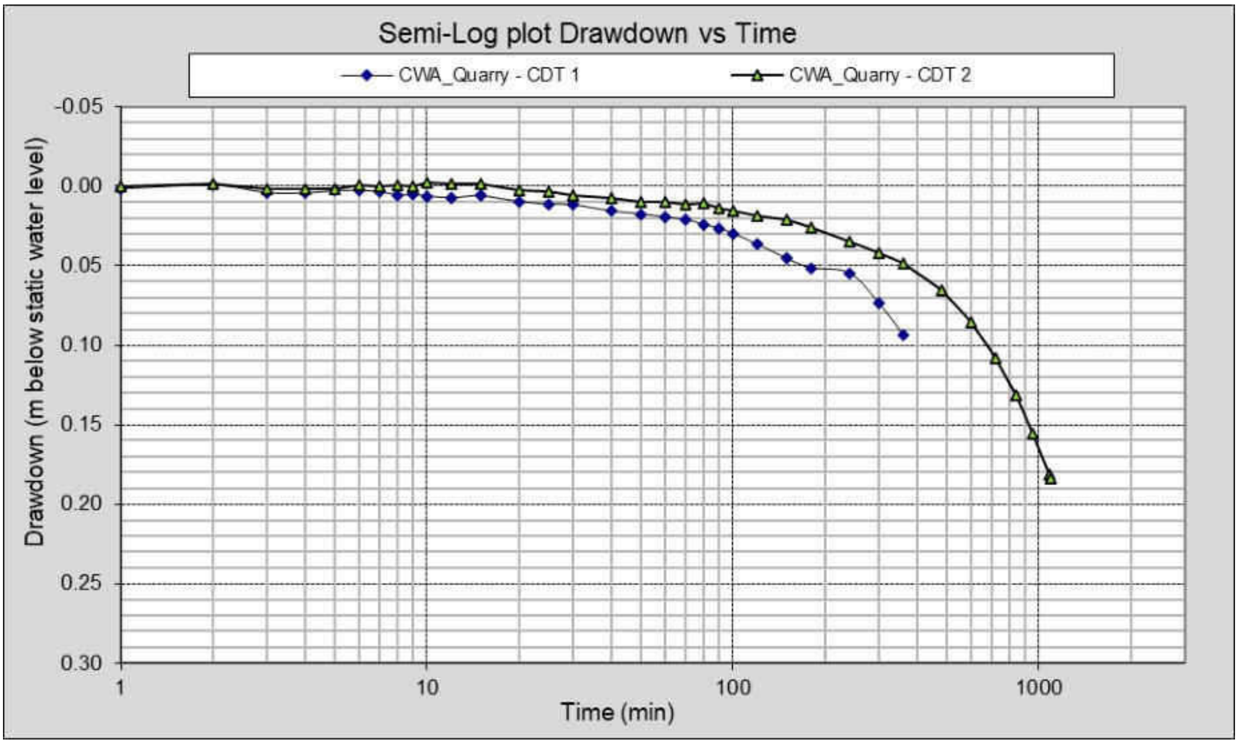

Figure 3: Semi-Log Plot of drawdown during the CDT's of CWA_Quarry (CDT 1: 30.6 L/s, CDT 2: 30.8 L/s).

A second constant discharge test was started for the remaining 1089 minutes of the planned 24-hour CDT. After 1089 minutes, the water level was drawn down by 0.183 meters. The Semi-Log plot of the drawdown is similar to that of a closed boundary system in groundwater systems (**Figure 3**). This is indicative of little to no groundwater interaction with the quarry. The borehole was left to recover after the second CDT for ~2 weeks. No significant recovery was observed and a decreasing trend in the water level was observed suggesting evaporation from the quarry. A total of 9.5 mm of precipitation took place for the duration of the recovery event with minimal effect on the water level in the quarry.

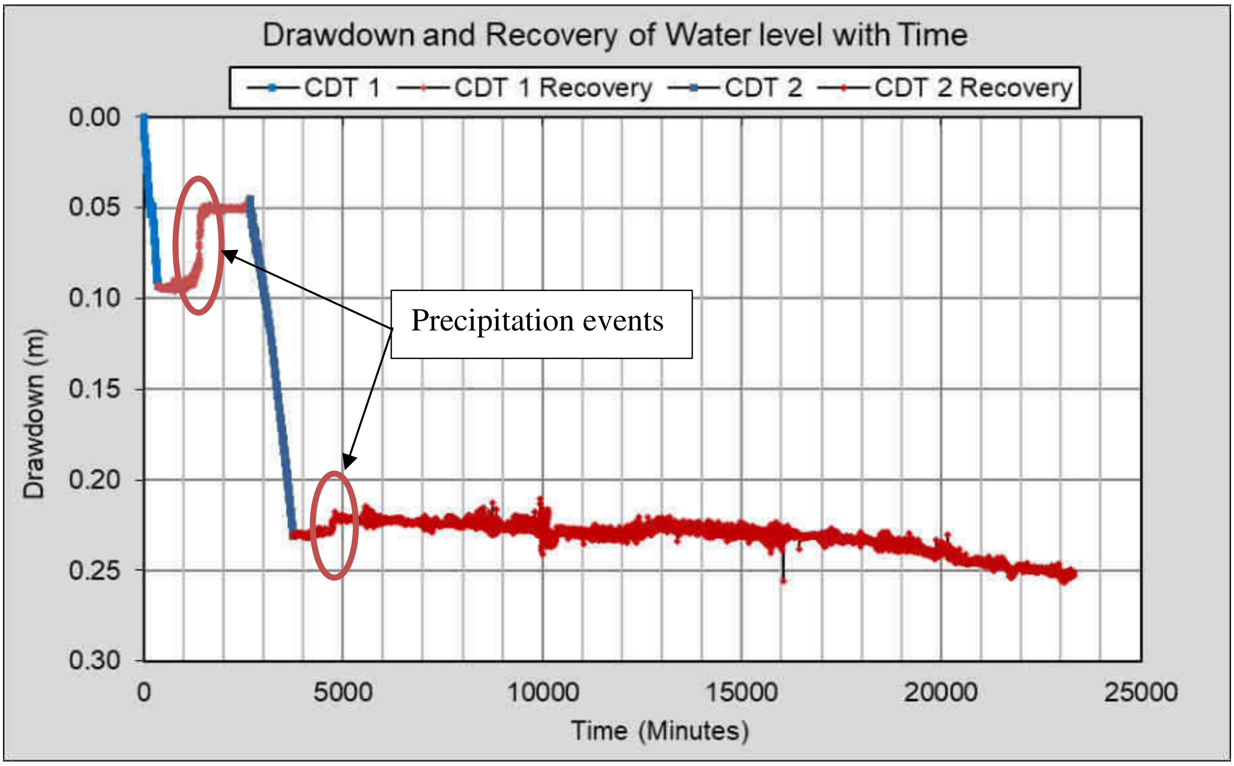

Figure 4: Time-series drawdown and recovery for CWA_Quarry (CDT 1: 30.6 L/s, CDT 2: 30.8 L/s).

Based on the dewatering trends observed during the tests and the lack of recovery in the quarry, there is no groundwater inflow into the quarry. Abstraction from the quarry will solely depend on the inflow of surface water during precipitation events and thus the volume of water that can be abstracted will be based on the water level in the quarry.

3. WATER QUALITY ANALYSIS

Water samples were collected from the CWA_Quarry at the end of the yield test and submitted for inorganic chemical analyses to a SANAS accredited laboratory (Vinlab) in the Western Cape. The certificate of analysis for the sample is presented in **Appendix B**. The chemistry results obtained for the quarry have been classified according to the SANS241-1: 2015 standards for drinking water **(Table 2). Table 4** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 2: Classification table for specific limits

Acute Health	Chronic Health	Aesthetic	Operational	Acceptable

The chemistry results obtained have been classified according to the DWAF (1998) standards for drinking water. **Table 3** enables an evaluation of the water quality with regard to the various parameters measured (DWAF, 1998). **Table 5** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 3: Classification table for the water quality analysis results (DWAF, 1998)

Blue	**(Class 0)**	**Ideal water quality** - suitable for lifetime use.
Green	**(Class I)**	**Good water quality** - suitable for use, rare instances of negative effects.
Yellow	**(Class II)**	**Marginal water quality** - conditionally acceptable. Negative effects may occur.
Red	**(Class III)**	**Poor water quality** - unsuitable for use without treatment. Chronic effects may occur.
Purple	**(Class IV)**	**Dangerous water quality** - totally unsuitable for use. Acute effects may occur.

Table 4: Water quality analysis results classified according to the SANS 241-1:2015

Analyses	**CWA_ Quarry**	**CWA_ Quarry**	**CWA_ BH001**	**SANS 241-1:2015**
Date Sampled	05/09/2022	06/01/2022	19/08/2022	
pH (at 25 °C)	9.4	10.2	7.3	5.0 ≤ Operational ≤ 9.7
Conductivity (mS/m) (at 25 °C)	167.4	165.9	89.0	Aesthetic ≤170
Total Dissolved Solids (mg/L)	1134.97	1124.80	603.42	Aesthetic ≤1200
Turbidity (NTU)	70.90	9.91	18.70	Operational≤1 Aesthetic ≤5
Colour (mg/L as Pt)	20.00	24.00	<15	Aesthetic ≤15
Sodium (mg/L as Na)	250	268	130	Aesthetic ≤200
Potassium (mg/L as K)	1	2	4	N/A
Magnesium (mg/L as Mg)	36	33	16	N/A
Calcium (mg/L as Ca)	21	18	17	N/A
Chloride (mg/L as Cl)	464.07	459.58	207.57	Aesthetic ≤300
Sulphate (mg/L as SO_4)	19.75	29.92	13.89	Aesthetic ≤250 Acute ≤500
Nitrate & Nitrite Nitrogen (mg/L as N)	<1.05	<1.05	<1.05	≤12 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	<1.00	<1.00	Acute Health ≤11
Nitrite Nitrogen (mg/L as N)	<0.05	<0.05	<0.05	Acute Health ≤0.9
Ammonia Nitrogen (mg/L as N)	<0.15	<0.15	<0.15	Aesthetic ≤1.5
Total Alkalinity (mg/L as $CaCO_3$)	82.4	67.9	102.1	N/A
Total Hardness (mg/L as $CaCO_3$)	200.1	180.3	108.1	N/A
Fluoride (mg/L as F)	0.62	0.76	0.17	Chronic Health ≤1.5
Aluminium (mg/L as Al)	1.067	0.199	<0.008	Operational ≤0.3
Total Chromium (mg/L as Cr)	<0.004	<0.004	<0.004	Chronic Health ≤0.05
Manganese (mg/L as Mn)	0.035	0.015	0.329	Aesthetic ≤0.1 Chronic ≤0.4
Iron (mg/L as Fe)	0.269	0.059	1.881	Aesthetic ≤0.3 Chronic ≤2
Nickel (mg/L as Ni)	<0.008	<0.008	<0.008	Chronic Health ≤0.07
Copper (mg/L as Cu)	0.011	0.008	0.010	Chronic Health ≤2
Zinc (mg/L as Zn)	0.011	<0.008	<0.008	Aesthetic ≤5
Arsenic (mg/L as As)	<0.010	<0.010	<0.010	Chronic Health ≤0.01
Selenium (mg/L as Se)	<0.008	<0.008	<0.008	Chronic Health ≤0.04
Cadmium (mg/L as Cd)	0.001	0.001	0.002	Chronic Health ≤0.003
Antimony (mg/L as Sb)	<0.013	<0.013	<0.013	Chronic Health ≤0.02
Mercury (mg/L as Hg)	<0.001	<0.001	<0.001	Chronic Health ≤0.006
Lead (mg/L as Pb)	0.010	<0.008	<0.008	Chronic Health ≤0.01
Uranium (mg/L as U)	<0.028	<0.028	<0.028	Chronic Health ≤0.03
Cyanide (mg/L as CN^-)	0.010	<0.01	<0.01	Acute Health ≤0.2
Total Organic Carbon (mg/L as C)	10.40	11.40	2.46	N/A
Charge Balance Error %	-0.7	1.3	-1.1	-5≤ Acceptable ≤5

Table 5: Water quality analysis results according to the DWAF 1998.

	CWA_ Quarry	**CWA_ Quarry**	**CWA_ BH001**	**DWA (1998) Drinking Water Assessment Guide**				
				Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
				Ideal	**Good**	**Marginal**	**Poor**	**Dangerous**
Date Sampled	05/09/2022	06/01/2022	19/08/2022					
pH	9.4	10.2	7.3	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)	167.4	165.9	89.0	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	70.90	9.91	18.70	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L							
Total Dissolved Solids	1134.97	1124.80	603.42	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	250	268	130	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	1	2	4	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	36	33	16	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	21	18	17	<80	80-150	150-300	>300	
Chloride (as Cl)	464.07	459.58	207.57	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	19.75	29.92	13.89	<200	200-400	400-600	600-1000	>1000
Nitrate & Nitrite (as N)	<1.05	<1.05	<1.05	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	0.62	0.76	0.17	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.035	0.015	0.329	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	0.269	0.059	1.881	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	0.011	0.008	0.010	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	0.011	<0.008	<0.008	<20	>20			
Arsenic (as As)	<0.010	<0.010	<0.010	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Cadmium (as Cd)	0.001	0.001	0.002	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	200.10	180.30	108.10	<200	200-300	300-600	>600	
Charge Balance Error %	-0.7	1.3	-1.1	-5≤ Acceptable ≤5				

From the chemical results presented in **Table 4** and **Table 5**, water from the CWA_Quarry is of marginal quality for potable supply. The sodium and chloride concentrations in the quarry exceed the aesthetic limit of the SANS 241-1:2015 drinking water guidelines and result in the quarry water having a saline (salty) taste. This is most likely due to the fact that the quarry is an open body of water subject to evaporation processes. Furthermore, the clay that hosts the water body results in the elevated turbidity levels that are responsible for the murky white colour of the water. This may have been exacerbated by the pumping that took place, as well as the very windy conditions on the day of sampling. The aluminium and lead concentrations observed can be related to the clay particles in the water sample and lower concentrations can be expected should an undisturbed sample be collected, as in the sample collected in January 2022. Based on the pH and electrical conductivity from CWA_Quarry compared to the pH and electrical conductivity as well as the iron and manganese from Borehole CWA_BH001 (Geoss 2022) it is evident that the quarry is unrelated to the regional groundwater.

A number of chemical diagrams have been plotted for the samples and these are useful for the chemical characterisation of the water and illustrate the similarities and differences in the water types. The Stiff Diagram is a graphical representation of the equivalent concentrations of the cations (positive ions) and anions (negative ions). This diagram shows concentrations of cations and anions relative to each other and direct reference can be made to specific salts in the water. From **Figure 5**, the CWA_Quarry is classified as a Sodium & Potassium/Chloride hydrofacies. The chemical characteristics of CWA_Quarry is similar to that of CWA_BH001, however; the concentrations of the dominant cations and anions in CWA_BH001 are lower than that of CWA_Quarry.

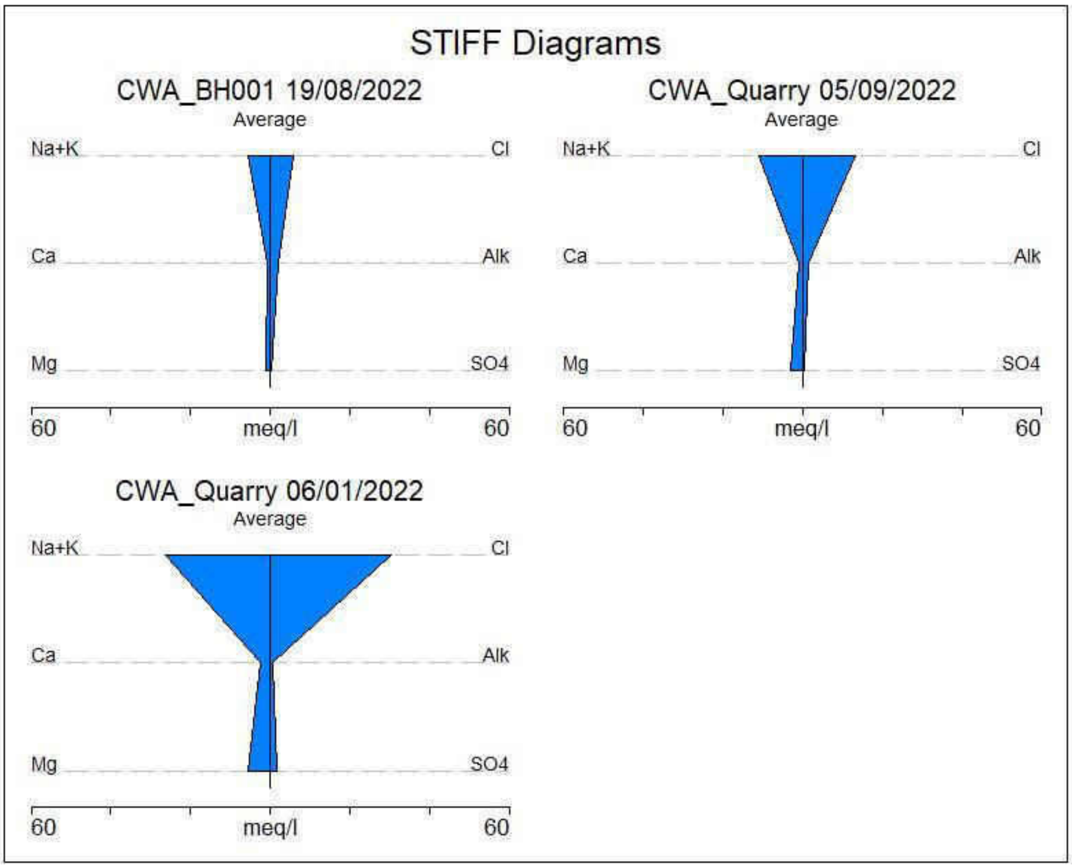

Figure 5: Stiff diagram of the water samples.

The chemistry of the samples has been plotted on a tri-linear diagram known as a Piper diagram. This diagram indicates the distribution of cations and anions in separate triangles and then a combination of the chemistry in the central diamond. From **Figure 6** (central diamond) the water samples from CWA_Quarry is distinct from the groundwater sample of CWA_BH001 although they are classified as a Sodium & Potassium/Chloride hydrofacies.

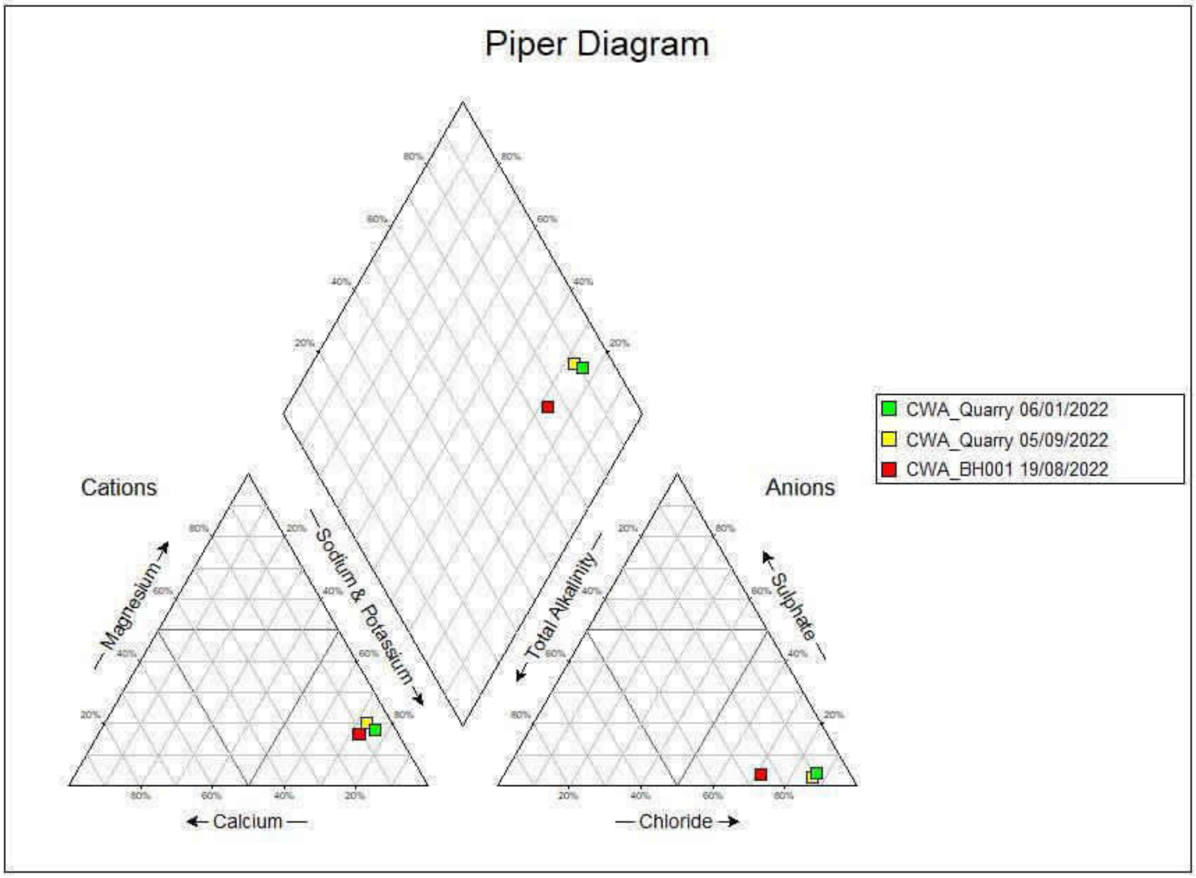

Figure 6: SAR diagram of the water samples.

In additions to the inorganic chemical analyses, a sample was collected from the CWA_Quarry and a rain water sample was collected from a rain gauge on site and was submitted for isotope analyses to a SANAS accredited laboratory (iThemba) in the Western Cape. The certificate of analysis for the sample is presented in **Appendix C**.

Isotope analysis applications are based on the isotopic variation in water as a result of the ratio change between the heavier and lighter isotopes. This ratio is affected by the energy difference between the chemical bonds during phase changes between water vapour, liquid water and ice. Heavier and lighter isotopes naturally fractionate and their signatures can be used to identify altitude, temperature and evaporation trends. Any water vapour that evaporates is depleted in heavier isotopes (Clark and Fritz, 1997; Gat, 2010).

Each catchment is characterized by its own local meteoric water line (LMWL) and can be determined through long-term isotope measurements of rainfall. During the duration of this study, long-term isotope data for rainfall could not be collected and therefore the global meteoric water line (GMWL) and Cape Meteoric Water Line (CMWL) were used for analysis purposes.

Comparisons of the quarry water to the CMWL, GMWL and rainfall in the area are presented in **Figure 7**.

Isotopic data shows that the rain water sample plots close to the CMWL. Water with an isotopic composition that falls on the meteoric water line is assumed to have originated from the atmosphere and has been unaffected by other isotopic fractionation processes. It is evident from the isotopic composition that there has been some degree of evaporation at CWA_Quarry (indicated by the deviation from the both the GMWL and the CMWL).

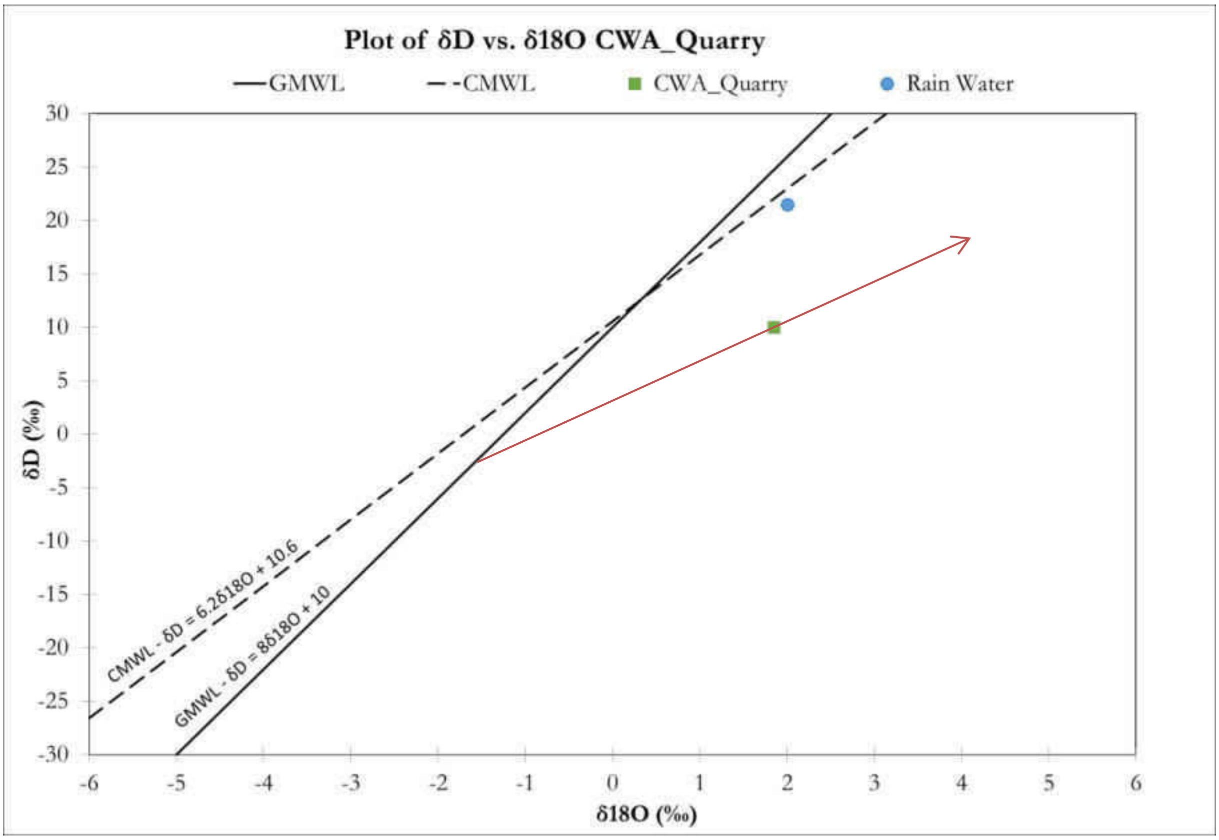

Figure 7: Delta ^{18}O vs Delta D for CWA_Quarry.

4. CONCLUSION AND RECOMMENDATIONS

Based on the information obtained from the yield test, the water in CWA_Quarry is dependent on precipitation and no groundwater influence was observed. Should abstraction take place from CWA_Quarry, the volume that can be abstracted will be dependent on the water level in the quarry. Abstraction should be licensed as surface water abstraction.

From the laboratory results, water from the CWA_Quarry is of marginal quality for potable supply. The sodium and chloride concentrations in the quarry exceed the aesthetic limit of the SANS 241-1:2015 drinking water guidelines and result in the quarry water having a saline (salty) taste. This is most likely due to the fact that the quarry is an open body of water subject to evaporation processes. Furthermore, the clay that hosts the water body results in the elevated turbidity levels that are responsible for the murky white colour of the water. This may have been exacerbated by the pumping that took place, as well as the very windy conditions on the day of sampling. The aluminium and lead concentrations observed can be related to the clay particles in the water sample and lower concentrations can be expected should an undisturbed sample be collected, as in the sample collected in January 2022. Based on the pH and electrical conductivity from CWA_Quarry compared to the pH and electrical conductivity as well as the iron and manganese from Borehole CWA_BH001 (Geoss 2022) it is evident that the quarry is unrelated to the regional groundwater.

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SANS (241-1:2015). Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinants.

6. APPENDIX A: YIELD TEST DATA

Abbreviations	
EC	Electrical conductivity
mbgl	Meters below ground level
mbch	Meters below casing height
mbdl	Meters below datum level
magl	Meters above ground level
L/S	Litres per second
RPM	Rates per minute
S/W/L	Static water level
µS/cm	Microsiemens per centimeter

BOREHOLE TEST RECORD

CONSULTANT: Geoss

DISTRICT: Fisantekraal

PROVINCE: Western Cape

FARM / VILLAGE NAME : Fisantekraal Airport Quarry

DATE TESTED: 18-08-2022

PR0JECT #	P0114
TEAM MEMBERS	

BOREHOLE LOCATION & ACCESS INFORMATION:

BOREHOLE COORDINATES

LATITUDE (SOUTH): S33.75523

LONGITUDE (EAST): E18.73140

COMMENTS ON ACCESS IF ANY:

BOREHOLE NO:	**QUARRY**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	**OPEN WATER BODY**
BOREHOLE DEPTH: (mbg	**NA**

MAINTENANCE RECORD:		**REHABILITATION RECORD:**		**DIGITAL CAMERA LOGGING:**		**EQUIPMENT FISHING RECORD**	
Labour hours:		**Jetting hours:**		**Camera logged once:**		**Hours spent:**	
Cost of material:		**Brushing hours:**		**Camera logged twice:**			
Travelling (km):		**Airlifting hours:**		**Camera logged three times:**		**OTHER COSTS ON PROJECT:**	
		Sulphamic Acid KG's		**Camera work sent to client:**		**Courier of samples:**	
		Boresaver KG's				**Km's for delivery:**	
		Soda Ash KG's				**Cost of packaging:**	

COMMENTS:	**RECOMMENDATIONS / CORRECTIVE ACTIONS:**

SAMPLE INSTRUCTIONS :

Water sample taken	Yes	No	If consultant took sample, give name:		**DATA CAPTURED BY**	AVN
Date sample taken			If sample courier, to where:		**DATA CHECKED BY:**	AVN
Time sample taken						

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	0.00
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	**M**	0
CASING DETECTION:	**NO**	0	SAND/GRAVEL/SILT PUMPED?	**YES/NO**	**1**
SUPPLIED NEW STEEL BOREHOLE COVER:	**NO**	0	DATA REPORTING AND RECORDING	**NO**	0
BOREHOLE MARKING	**NO**	0	SLUG TEST:	**NO**	0
SITE CLEANING & FINISHING	**NO**	1	LAYFLAT (M):	**M**	350
LOGGERS FOR WATERLEVEL MONITORING	**NO**	0	LOGGERS FOR pH AND EC:	**NO**	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ____________________ **SIGNATURE:** ____________________

DESIGNATION: ____________________ **DATE:** ____________________

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P0114	Coordinates: SOUTH:	S33.75523	PROVINCE:	Western Cape
BOREHOLE NO:	QUARRY	EAST:	E18.73140	DISTRICT:	Fisantekraal
ALT BH NO:	0			SITE NAME:	Fisantekraal Airport Quarry
ALT BH NO:	0				
BOREHOLE DEPTH:	NA	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbdl):		CASING HEIGHT: (magl):	0.00	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	0.00	DIAM PUMP INLET(mm):	0	PUMP TYPE:	0

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**			
DATE:	16-08-2022	TIME:	13H45	DATE:	TIME:	TYPE OF PUMP:	0

					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
DISCHARGE BOREHOLE					Distance(m);			Distance(m);			Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	0.00		**1**	0.10	**1**			**1**			**1**	
2	0.00		**2**	0.10	**2**			**2**			**2**	
3	0.00		**3**	0.10	**3**			**3**			**3**	
5	0.00		**5**	0.10	**5**			**5**			**5**	
7	0.00		**7**	0.10	**7**			**7**			**7**	
10	0.00	30.62	**10**	0.10	**10**			**10**			**10**	
15	0.01		**15**	0.10	**15**			**15**			**15**	
20	0.01	30.64	**20**	0.10	**20**			**20**			**20**	
30	0.02		**30**	0.10	**30**			**30**			**30**	
40	0.02	30.64	**40**	0.10	**40**			**40**			**40**	
60	0.03		**60**	0.10	**60**			**60**			**60**	
90	0.05	30.60	**90**	0.10	**90**			**90**			**90**	
120	0.05		**120**	0.10	**120**			**120**			**120**	
150	0.06	30.72	**150**	0.10	**150**			**150**			**150**	
180	0.06		**180**	0.10	**180**			**180**			**180**	
210	0.07	30.67	**210**	0.10	**210**			**210**			**210**	
240	0.08		**240**	0.10	**240**			**240**			**240**	
300	0.08	30.53	**300**	0.10	**300**			**300**			**300**	
360	0.10		**360**	0.10	**360**			**360**			**360**	
420			**420**	0.10	**420**			**420**			**420**	
480			**480**	0.10	**480**			**480**			**480**	
540			**540**	0.10	**540**			**540**			**540**	
600			**600**	0.10	**600**			**600**			**600**	
720			**720**		**720**			**720**			**720**	
840			**840**		**840**			**840**			**840**	
960			**960**		**960**			**960**			**960**	
1080			**1080**		**1080**			**1080**			**1080**	
1200			**1200**		**1200**			**1200**			**1200**	
1320			**1320**		**1320**			**1320**			**1320**	
1440			**1440**		**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				360		W/L			W/L			W/L
Average yield (l/s):				30.60								

FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P0114	Coordinates: SOUTH:	S33.75523	PROVINCE:	Western Cape
BOREHOLE NO:	QUARRY	EAST:	E18.73140	DISTRICT:	Fisantekraal
ALT BH NO:	0			SITE NAME:	Fisantekraal Airport Quarry
ALT BH NO:	0				
BOREHOLE DEPTH:	NA	DATUM LEVEL ABOVE CASING (m):	0.00	EXISTING PUMP:	0
WATER LEVEL (mbdl):		CASING HEIGHT: (magl):	0.00	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	0.00	DIAM PUMP INLET(mm):	0	PUMP TYPE:	0

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED DATE: 18-08-2022 TIME: 10H00

TEST COMPLETED DATE: TIME:

TYPE OF PUMP: 0

DISCHARGE BOREHOLE					OBSERVATION HOLE 1 NR: Distance(m);			OBSERVATION HOLE 2 NR: Distance(m);			OBSERVATION HOLE 3 NR: Distance(m);	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	0.00		**1**	0.19	**1**			**1**			**1**	
2	0.00		**2**	0.19	**2**			**2**			**2**	
3	0.00		**3**	0.19	**3**			**3**			**3**	
5	0.00	30.91	**5**	0.19	**5**			**5**			**5**	
7	0.00	30.86	**7**	0.19	**7**			**7**			**7**	
10	0.00		**10**	0.19	**10**			**10**			**10**	
15	0.00	30.86	**15**	0.19	**15**			**15**			**15**	
20	0.00		**20**	0.19	**20**			**20**			**20**	
30	0.01	30.88	**30**	0.19	**30**			**30**			**30**	
40	0.01		**40**	0.19	**40**			**40**			**40**	
60	0.02	30.89	**60**	0.19	**60**			**60**			**60**	
90	0.02		**90**	0.19	**90**			**90**			**90**	
120	0.03	30.87	**120**	0.19	**120**			**120**			**120**	
150	0.03		**150**	0.19	**150**			**150**			**150**	
180	0.04	30.86	**180**	0.19	**180**			**180**			**180**	
210	0.04		**210**	0.19	**210**			**210**			**210**	
240	0.05	30.87	**240**	0.19	**240**			**240**			**240**	
300	0.05		**300**	0.19	**300**			**300**			**300**	
360	0.06	30.85	**360**	0.19	**360**			**360**			**360**	
420	0.06		**420**	0.18	**420**			**420**			**420**	
480	0.07	30.86	**480**	0.18	**480**			**480**			**480**	
540	0.08		**540**	0.18	**540**			**540**			**540**	
600	0.09	30.88	**600**	0.18	**600**			**600**			**600**	
720	0.11		**720**	0.18	**720**			**720**			**720**	
840	0.14	30.85	**840**		**840**			**840**			**840**	
960	0.17		**960**		**960**			**960**			**960**	
1080	0.19	30.80	**1080**		**1080**			**1080**			**1080**	
1200			**1200**		**1200**			**1200**			**1200**	
1320			**1320**		**1320**			**1320**			**1320**	
1440			**1440**		**1440**			**1440**			**1440**	
1560			**1560**		**1560**			**1560**			**1560**	
1680			**1680**		**1680**			**1680**			**1680**	
1800			**1800**		**1800**			**1800**			**1800**	
1920			**1920**		**1920**			**1920**			**1920**	
2040			**2040**		**2040**			**2040**			**2040**	
2160			**2160**		**2160**			**2160**			**2160**	
2280			**2280**		**2280**			**2280**			**2280**	
2400			**2400**		**2400**			**2400**			**2400**	
2520			**2520**		**2520**			**2520**			**2520**	
2640			**2640**		**2640**			**2640**			**2640**	
2760			**2760**		**2760**			**2760**			**2760**	
2880			**2880**		**2880**			**2880**			**2880**	
3000			**3000**		**3000**			**3000**			**3000**	
3120			**3120**		**3120**			**3120**			**3120**	
3240			**3240**		**3240**			**3240**			**3240**	
3360			**3360**		**3360**			**3360**			**3360**	
3480			**3480**		**3480**			**3480**			**3480**	
3600			**3600**		**3600**			**3600**			**3600**	
3720			**3720**		**3720**			**3720**			**3720**	
3840			**3840**		**3840**			**3840**			**3840**	
3960			**3960**		**3960**			**3960**			**3960**	
4080			**4080**		**4080**			**4080**			**4080**	
4200			**4200**		**4200**			**4200**			**4200**	
4320			**4320**		**4320**			**4320**			**4320**	
Total time pumped(min):				1080		**W/L**			**W/L**			**W/L**
Average yield (l/s):				30.80								

7. APPENDIX B: WATER QUALITY ANALYSIS

Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2022-09-06

TEST REPORT

Water

Geoss South Africa (Pty) Ltd
Attn: - Alison

P.O.Box 12412
Die Boord, Stellenbosch
Die Boord, Stellenbosch
7613
0218801079

@VinlabSA

Sample Details					
SampleID	W30896				
Water Type	Drinking Water				
Water Source					
Sample Temperature					
Description	4305PhH_FK _Quarry				
Batch Number					
PO Number	4305PhH_FK _Quarry				
Date Received	2022-09-05				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C* (Water)		VIN-05-MW01	***	>= 5 to <= 9.7	9.44				
Conductivity@25C* (Water)	mS/m	VIN-05-MW02	*	<= 170	167.4				
Turbidity (Water)	ntu			<= 5	70.9				
Total dissolved solids (Water)	mg/L			<= 1200	1134.97				
Free Chlorine (Water)	mg/L			<= 5	<0.02				
Ammonia (NH4) as N* (Water)	mg/L	VIN-05-MW08	10%	<= 1.5	<0.15				
Nitrate as N* (Water)	mg/L	VIN-05-MW08	10%	<= 11	<1.00				
Nitrite as N* (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-)* - Water	mg/L	VIN-05-MW08	10%	<= 300	404.07				
Sulphates (SO4)* - Water	mg/L	VIN-05-MW08	10%	<= 500	19.75				
Fluoride (F)* - Water	mg/L	VIN-05-MW08	10%	<= 1.5	0.82				
Alkalinity as CaCO3 (Water)	mg/L				82.40				
Colour (Water)	mg/L Pt-Co			<= 15	20				
Total Organic Carbon (Water)	mg/L			<=10	10.4				
Date Tested					2022-09-05				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		21				

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

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the scope of SANAS accreditation. Results for methods VIN-05-MW12, 13 and 14, are based on Cq values, a positive result (detected) indicates ≤ Cq value
≤38 and a negative result (non-detected) indicates a Cq value of >38.

Doc No
V36771

VIN 09-01 10-06-2022

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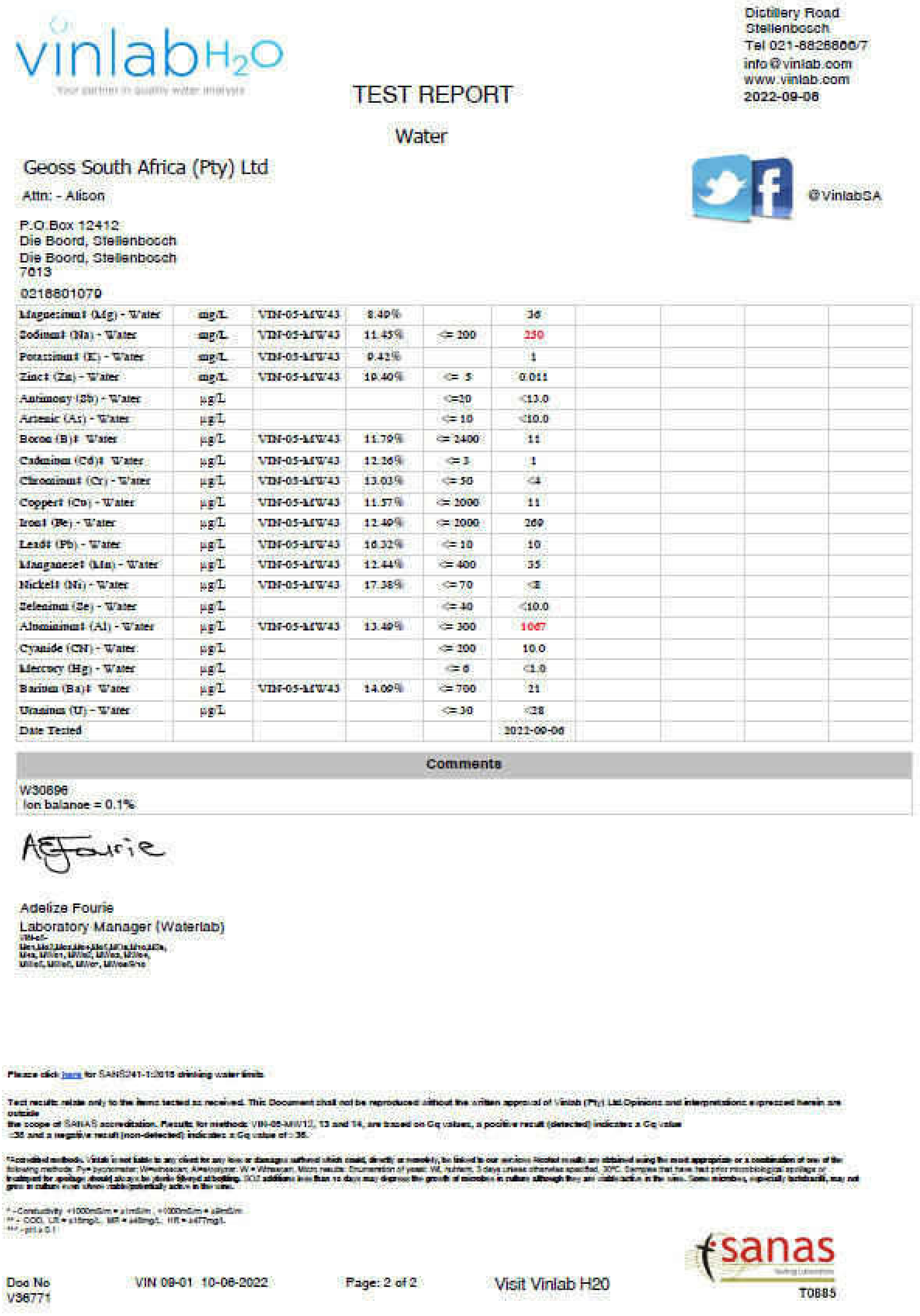

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Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2022-09-08

TEST REPORT

Water

Geoss South Africa (Pty) Ltd
Attn: - Alison

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

0218801079

@VinlabSA

Magnesium‡ (Mg) - Water	mg/L	VIN-05-MW43	8.40%		36				
Sodium‡ (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	250				
Potassium‡ (K) - Water	mg/L	VIN-05-MW43	9.42%		1				
Zinc‡ (Zn) - Water	mg/L	VIN-05-MW43	10.40%	<= 5	0.011				
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	11				
Cadmium (Cd)‡ Water	µg/L	VIN-05-MW43	12.26%	<= 3	1				
Chromium‡ (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4				
Copper‡ (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	11				
Iron‡ (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	269				
Lead‡ (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	10				
Manganese‡ (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	35				
Nickel‡ (Ni) - Water	µg/L	VIN-05-MW43	17.38%	<= 70	<2				
Selenium (Se) - Water	µg/L			<= 40	<10.0				
Aluminium‡ (Al) - Water	µg/L	VIN-05-MW43	13.49%	<= 300	1067				
Cyanide (CN) - Water	µg/L			<= 200	10.0				
Mercury (Hg) - Water	µg/L			<= 6	<1.0				
Barium (Ba)‡ Water	µg/L	VIN-05-MW43	14.09%	<= 700	21				
Uranium (U) - Water	µg/L			<= 30	<28				
Date Tested					2022-09-06				

Comments

W30896
Ion balance = 0.1%

AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)
[illegible]

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
<38 and a negative result (non-detected) indicates a Cq value of >38.

*Accredited methods. Vinlab is not liable to any client for any loss or damages suffered which could, directly or remotely, be linked to our services. [illegible]

* - Conductivity <1000mS/m = ±1mS/m , >1000mS/m = ±8mS/m
** - COD, LR = ±15mg/L, MR = ±48mg/L, HR = ±477mg/L
*** - pH ± 0.1

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T0885

Doc No
V36771

VIN 09-01 10-06-2022

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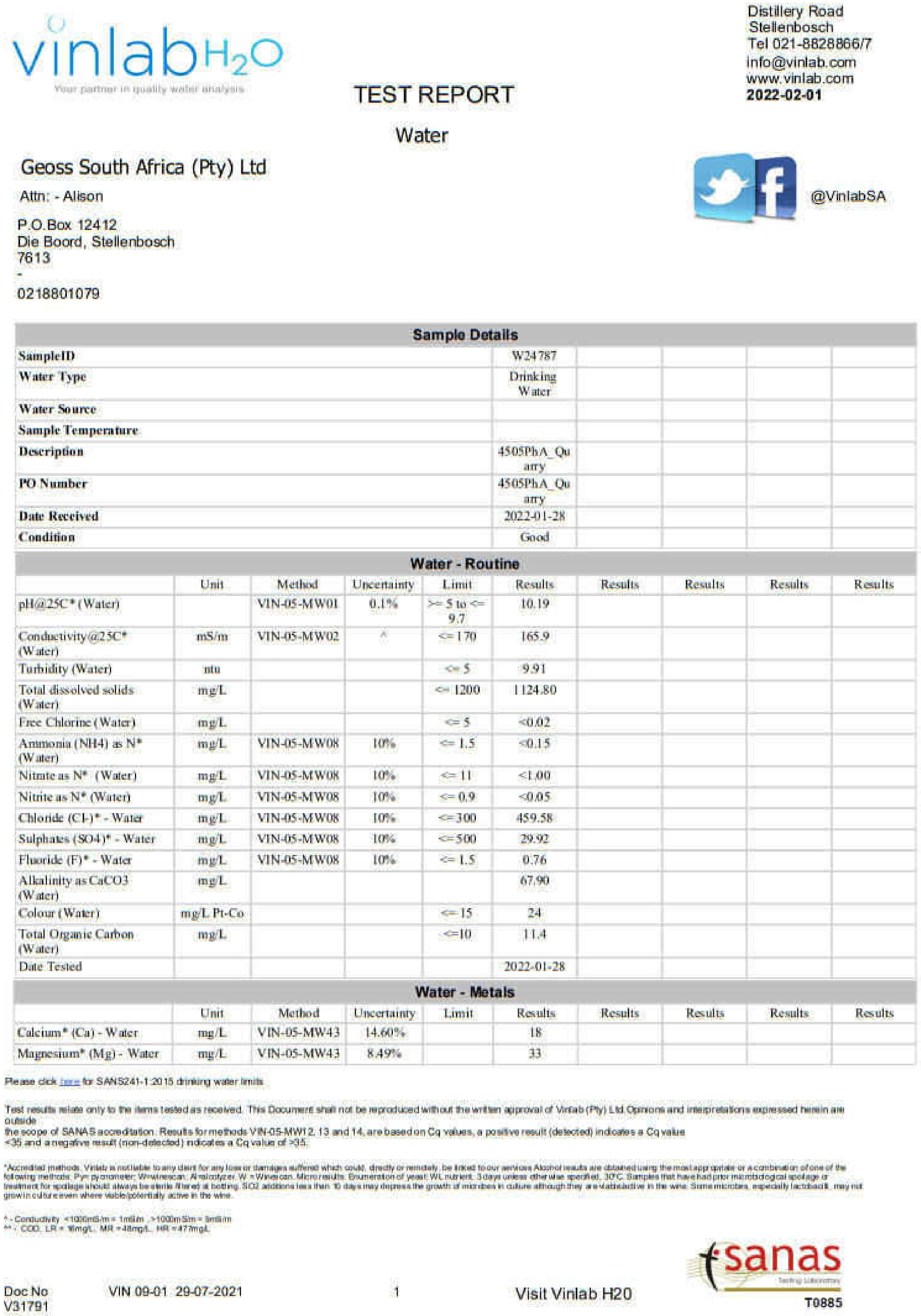

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Distillery Road
Stellenbosch
Tel 021-8828866/7
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www.vinlab.com
2022-02-01

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: - Alison

P.O.Box 12412
Die Boord, Stellenbosch
7613
-
0218801079

@VinlabSA

Sample Details

SampleID	W24787				
Water Type	Drinking Water				
Water Source					
Sample Temperature					
Description	4505PhA_Quarry				
PO Number	4505PhA_Quarry				
Date Received	2022-01-28				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C* (Water)		VIN-05-MW01	0.1%	>= 5 to <= 9.7	10.19				
Conductivity@25C* (Water)	mS/m	VIN-05-MW02	^	<= 170	165.9				
Turbidity (Water)	ntu			<= 5	9.91				
Total dissolved solids (Water)	mg/L			<= 1200	1124.80				
Free Chlorine (Water)	mg/L			<= 5	<0.02				
Ammonia (NH4) as N* (Water)	mg/L	VIN-05-MW08	10%	<= 1.5	<0.15				
Nitrate as N* (Water)	mg/L	VIN-05-MW08	10%	<= 11	<1.00				
Nitrite as N* (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-)* - Water	mg/L	VIN-05-MW08	10%	<=300	459.58				
Sulphates (SO4)* - Water	mg/L	VIN-05-MW08	10%	<=500	29.92				
Fluoride (F)* - Water	mg/L	VIN-05-MW08	10%	<= 1.5	0.76				
Alkalinity as CaCO3 (Water)	mg/L				67.90				
Colour (Water)	mg/L Pt-Co			<= 15	24				
Total Organic Carbon (Water)	mg/L			<=10	11.4				
Date Tested					2022-01-28				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium* (Ca) - Water	mg/L	VIN-05-MW43	14.60%		18				
Magnesium* (Mg) - Water	mg/L	VIN-05-MW43	8.49%		33				

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

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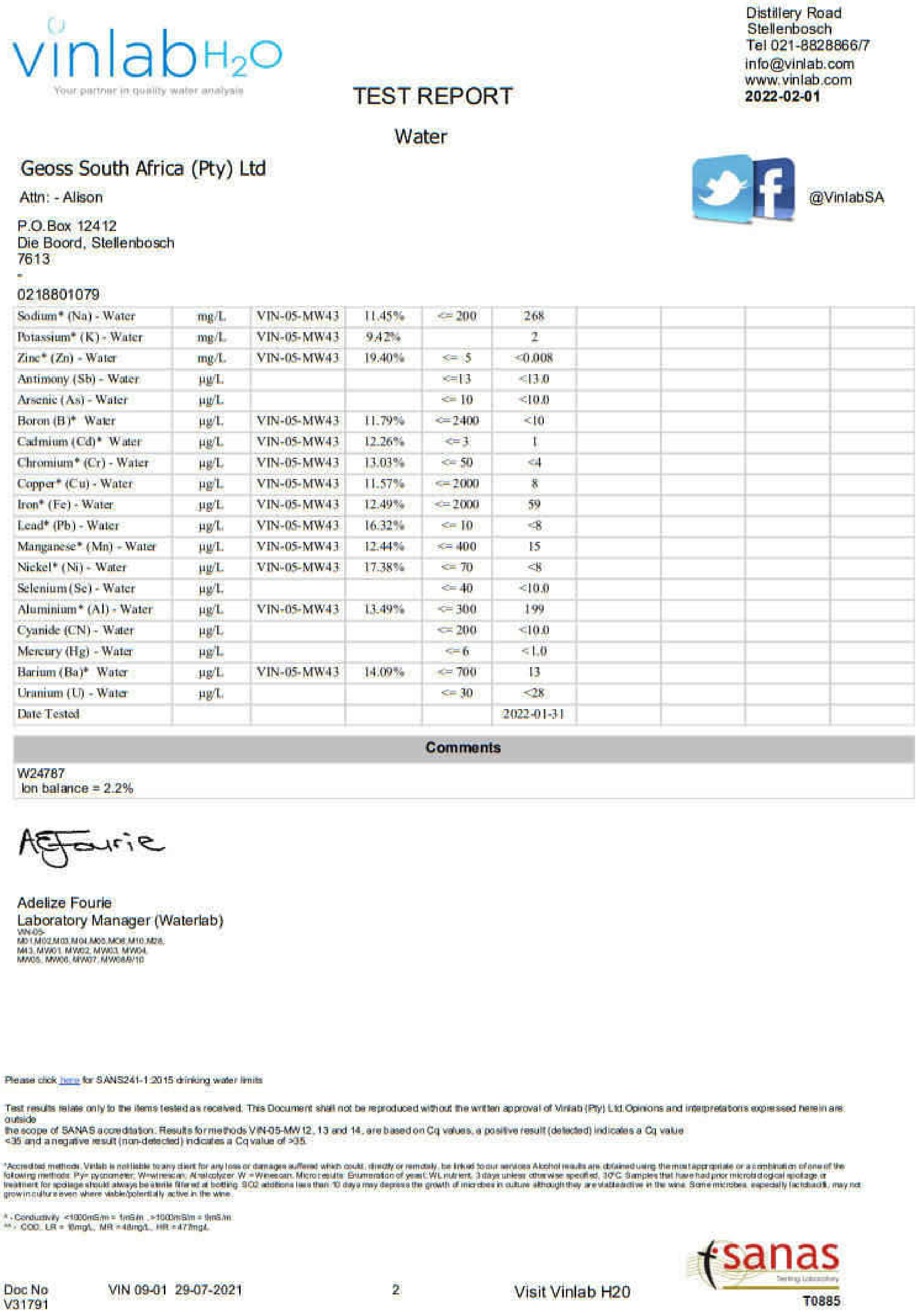
the scope of SANAS accreditation. Results for methods VIN-05-MW12, 13 and 14, are based on Cq values, a positive result (detected) indicates a Cq value
<35 and a negative result (non-detected) indicates a Cq value of >35.

*Accredited methods. 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: Pyc pycnometer; Ww=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 = 5mS/m
^^ - COD: LR = 16mg/L; MR = 48mg/L; HR = 477mg/L

Doc No V31791 VIN 09-01 29-07-2021 1 Visit Vinlab H20

sanas Testing Laboratory
T0885



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Distillery Road
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www.vinlab.com
2022-02-01

TEST REPORT

Water

Geoss South Africa (Pty) Ltd
Attn: - Alison

P.O.Box 12412
Die Boord, Stellenbosch
7613
-
0218801079

@VinlabSA

Sodium* (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	268				
Potassium* (K) - Water	mg/L	VIN-05-MW43	9.42%		2				
Zinc* (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	<0.008				
Antimony (Sb) - Water	µg/L			<=13	<13.0				
Arsenic (As) - Water	µg/L			<= 10	<10.0				
Boron (B)* Water	µg/L	VIN-05-MW43	11.79%	<=2400	<10				
Cadmium (Cd)* Water	µg/L	VIN-05-MW43	12.26%	<=3	1				
Chromium* (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4				
Copper* (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	8				
Iron* (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	59				
Lead* (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese* (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	15				
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	199				
Cyanide (CN) - Water	µg/L			<= 200	<10.0				
Mercury (Hg) - Water	µg/L			<=6	<1.0				
Barium (Ba)* Water	µg/L	VIN-05-MW43	14.09%	<= 700	13				
Uranium (U) - Water	µg/L			<= 30	<28				
Date Tested					2022-01-31				

Comments

W24787
Ion balance = 2.2%

AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)
VIN-05-
M01,M02,M03,M04,M05,M08,M10,M28,
M43, MW01, MW02, MW03, MW04,
MW05, MW06, MW07, MW08/9/10

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

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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.

*Accredited methods. 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; 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

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V31791

VIN 09-01 29-07-2021

2

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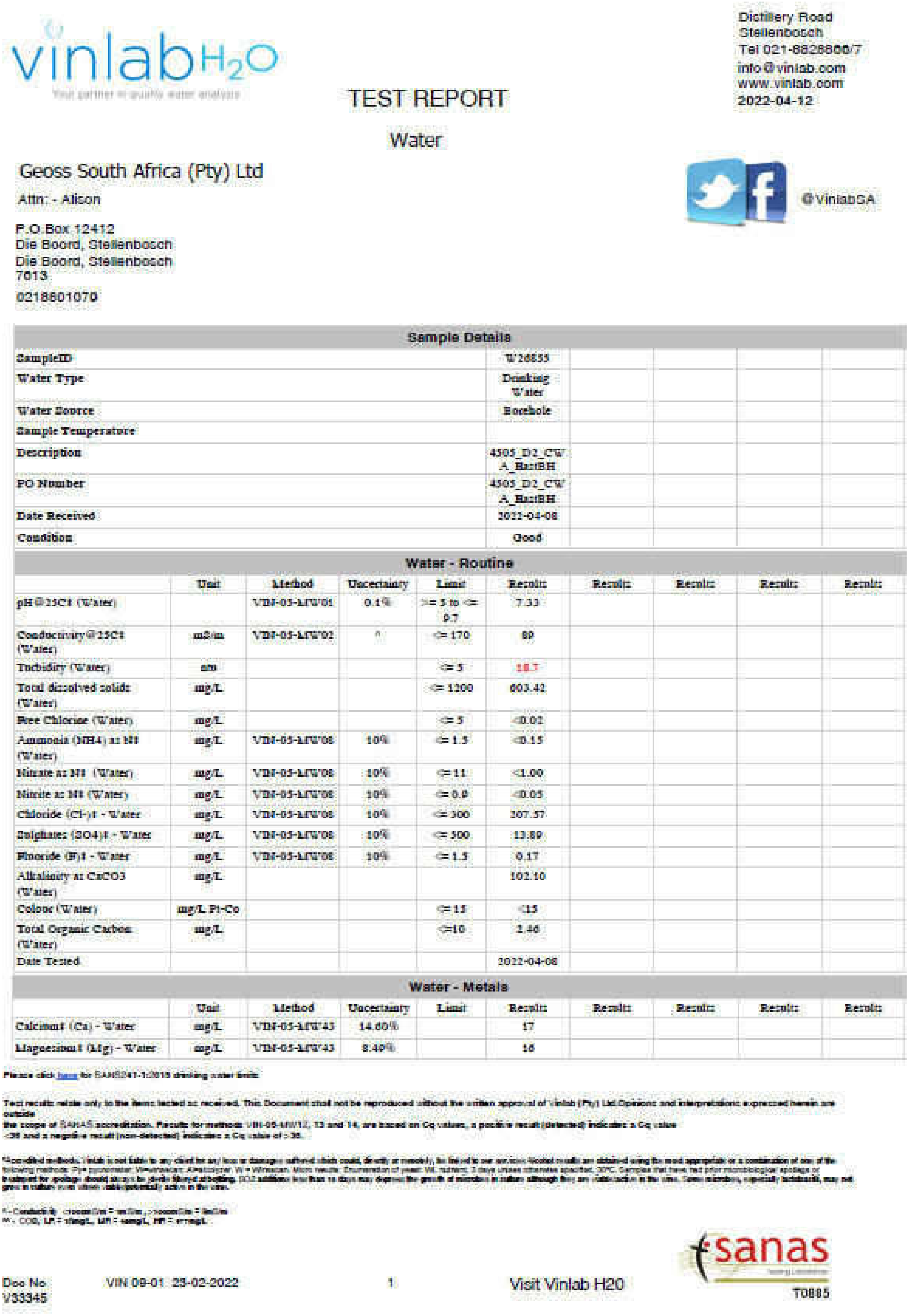

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2022-04-12

TEST REPORT

Water

Geoss South Africa (Pty) Ltd
Attn: - Alison

P.O.Box 12412
Die Boord, Stellenbosch
Die Boord, Stellenbosch
7613
0218801079

@VinlabSA

Sample Details

SampleID	W26855				
Water Type	Drinking Water				
Water Source	Borehole				
Sample Temperature					
Description	4505_D2_CWA_EastBH				
PO Number	4505_D2_CWA_EastBH				
Date Received	2022-04-08				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C# (Water)		VIN-05-MW01	0.1%	>= 5 to <= 9.7	7.33				
Conductivity@25C# (Water)	mS/m	VIN-05-MW02	^	<= 170	89				
Turbidity (Water)	ntu			<= 5	18.7				
Total dissolved solids (Water)	mg/L			<= 1200	603.42				
Free Chlorine (Water)	mg/L			<= 5	<0.02				
Ammonia (NH4) as N# (Water)	mg/L	VIN-05-MW08	10%	<= 1.5	<0.15				
Nitrate as N# (Water)	mg/L	VIN-05-MW08	10%	<= 11	<1.00				
Nitrite as N# (Water)	mg/L	VIN-05-MW08	10%	<= 0.9	<0.05				
Chloride (Cl-)# - Water	mg/L	VIN-05-MW08	10%	<= 300	207.57				
Sulphates (SO4)# - Water	mg/L	VIN-05-MW08	10%	<= 500	13.89				
Fluoride (F)# - Water	mg/L	VIN-05-MW08	10%	<= 1.5	0.17				
Alkalinity as CaCO3 (Water)	mg/L				102.10				
Colour (Water)	mg/L Pt-Co			<= 15	<15				
Total Organic Carbon (Water)	mg/L			<=10	2.46				
Date Tested					2022-04-08				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium# (Ca) - Water	mg/L	VIN-05-MW43	14.60%		17				
Magnesium# (Mg) - Water	mg/L	VIN-05-MW43	8.49%		16				

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<38 and a negative result (non-detected) indicates a Cq value of >38.

*Accredited methods. Vinlab is not liable to any client for any loss or damages suffered which could, directly or remotely, be linked to our services. [illegible]

^ - Conductivity [illegible]
^^ - COD, LR = [illegible], MR = [illegible], HR = [illegible]

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V33345

VIN 09-01 23-02-2022

1

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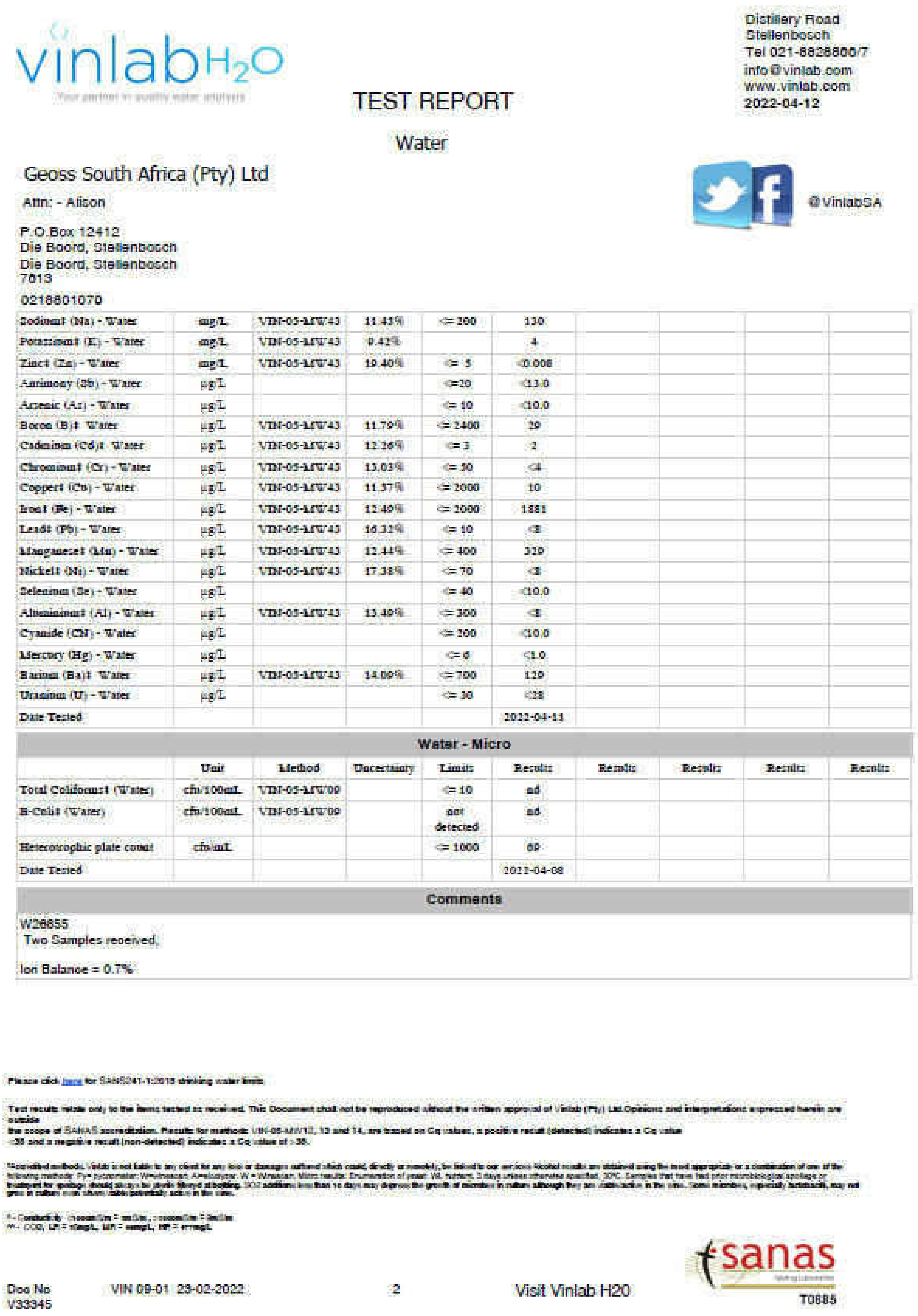

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2022-04-12

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: - Alison

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7613

0218801070

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Sodium‡ (Na) - Water	mg/L	VIN-05-MW43	11.43%	<= 200	130				
Potassium‡ (K) - Water	mg/L	VIN-05-MW43	9.42%		4				
Zinc‡ (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	<0.008				
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	29				
Cadmium (Cd)‡ Water	µg/L	VIN-05-MW43	12.26%	<= 3	2				
Chromium‡ (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4				
Copper‡ (Cu) - Water	µg/L	VIN-05-MW43	11.37%	<= 2000	10				
Iron‡ (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	1881				
Lead‡ (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese‡ (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	329				
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	<8				
Cyanide (CN) - Water	µg/L			<= 200	<10.0				
Mercury (Hg) - Water	µg/L			<= 6	<1.0				
Barium (Ba)‡ Water	µg/L	VIN-05-MW43	14.09%	<= 700	129				
Uranium (U) - Water	µg/L			<= 30	<28				
Date Tested					2022-04-11				

Water - Micro

	Unit	Method	Uncertainty	Limits	Results	Results	Results	Results	Results
Total Coliforms‡ (Water)	cfu/100mL	VIN-05-MW09		<= 10	nd				
E-Coli‡ (Water)	cfu/100mL	VIN-05-MW09		not detected	nd				
Heterotrophic plate count	cfu/mL			<= 1000	69				
Date Tested					2022-04-08				

Comments

W26855
Two Samples received.

Ion Balance = 0.7%

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

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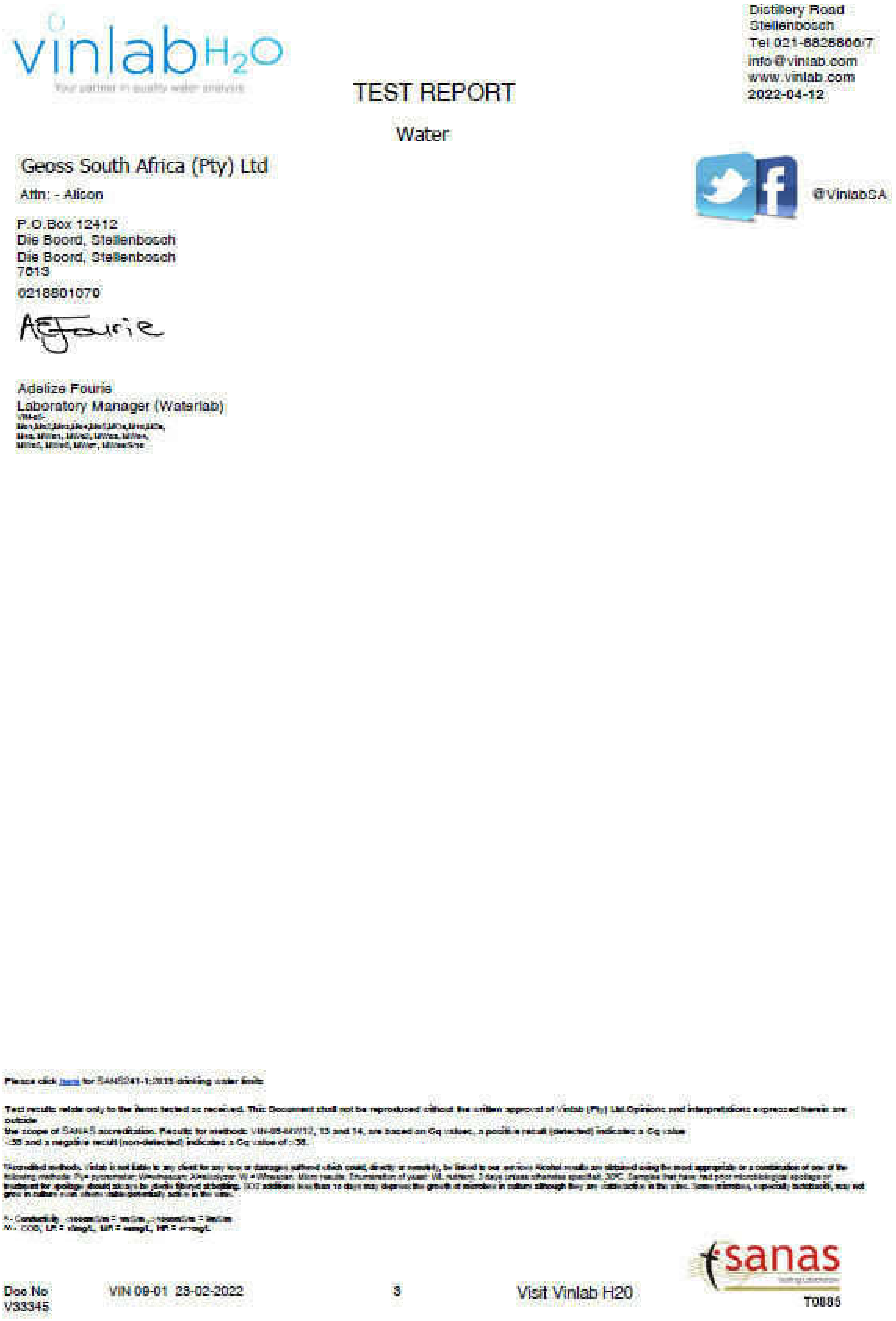

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TEST REPORT

Water

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AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)

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<38 and a negative result (non-detected) indicates a Cq value of >38.

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8. APPENDIX C: ISOTOPE ANALYSIS

National Research Foundation
iThemba LABS
Laboratory for Accelerator Based Sciences

Environmental Isotope Laboratory

Postal address: Private Bag 11, Wits, 2050, South Africa.
Physical Address: Empire Road (between Jan Smuts Avenue and Yale Road)
Tel ++27 11 351 7000/1 (switchboard/secretary), Fax ++27 11 351 7053

Report

Reference: GEOS026

Date: 15th September 2022

Environmental isotope analysis on two (2) water samples

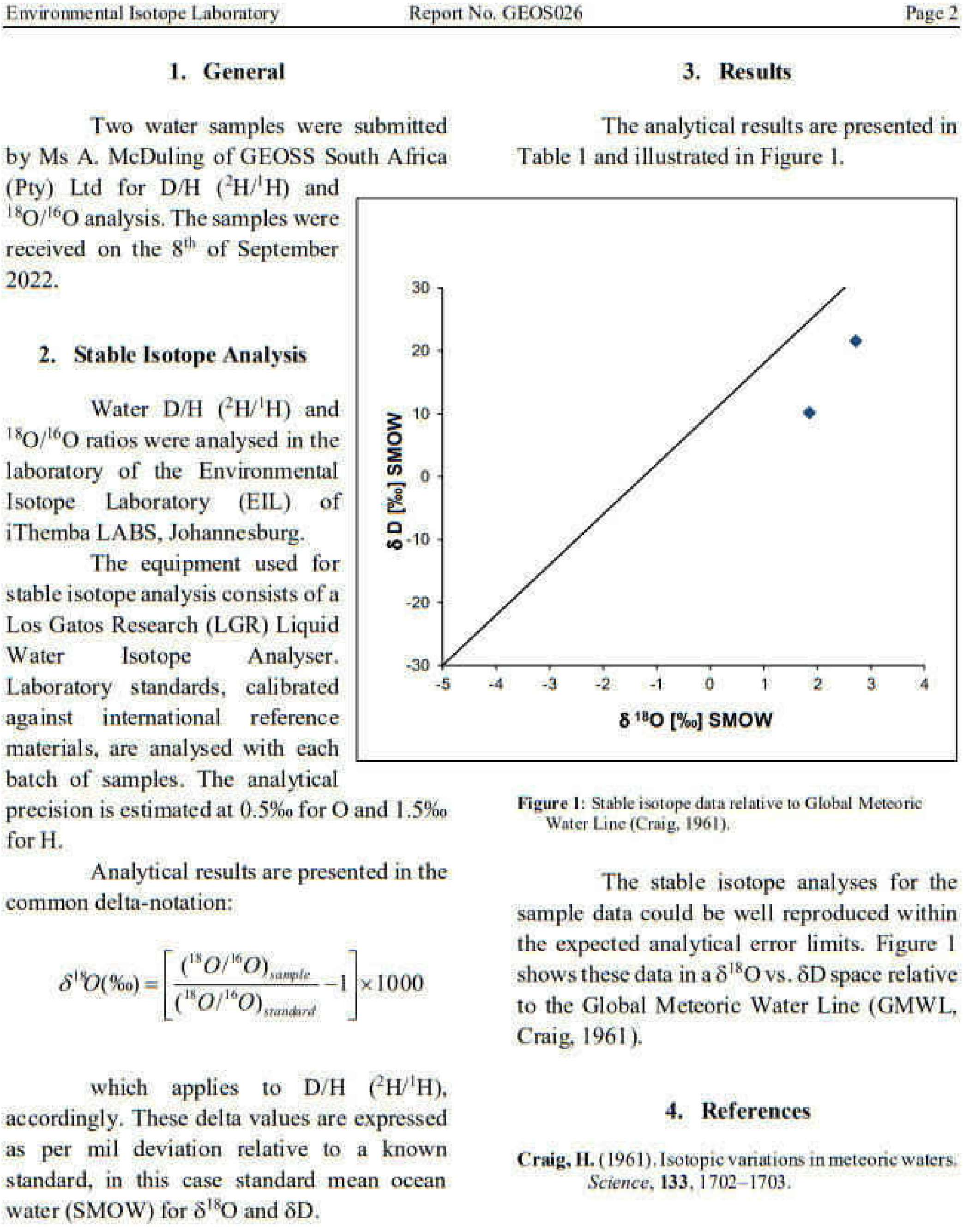
submitted by Ms Alison McDuling

GEOSS South Africa (Pty) Ltd

Ref: 2021_09-4505PhH

M.J. Butler, M. Mabitsela

confidential



Environmental Isotope Laboratory Report No. GEOS026 Page 2

1. General

Two water samples were submitted by Ms A. McDuling of GEOSS South Africa (Pty) Ltd for D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ analysis. The samples were received on the 8th of September 2022.

2. Stable Isotope Analysis

Water D/H ($^{2}H/^{1}H$) and $^{18}O/^{16}O$ ratios were analysed in the laboratory of the Environmental Isotope Laboratory (EIL) of iThemba LABS, Johannesburg.

The equipment used for stable isotope analysis consists of a Los Gatos Research (LGR) Liquid Water Isotope Analyser. Laboratory standards, calibrated against international reference materials, are analysed with each batch of samples. The analytical precision is estimated at 0.5‰ for O and 1.5‰ for H.

Analytical results are presented in the common delta-notation:

$$\delta^{18}O(‰) = \left[\frac{(^{18}O/^{16}O)_{sample}}{(^{18}O/^{16}O)_{standard}} - 1\right] \times 1000$$

which applies to D/H ($^{2}H/^{1}H$), accordingly. These delta values are expressed as per mil deviation relative to a known standard, in this case standard mean ocean water (SMOW) for $\delta^{18}O$ and δD.

3. Results

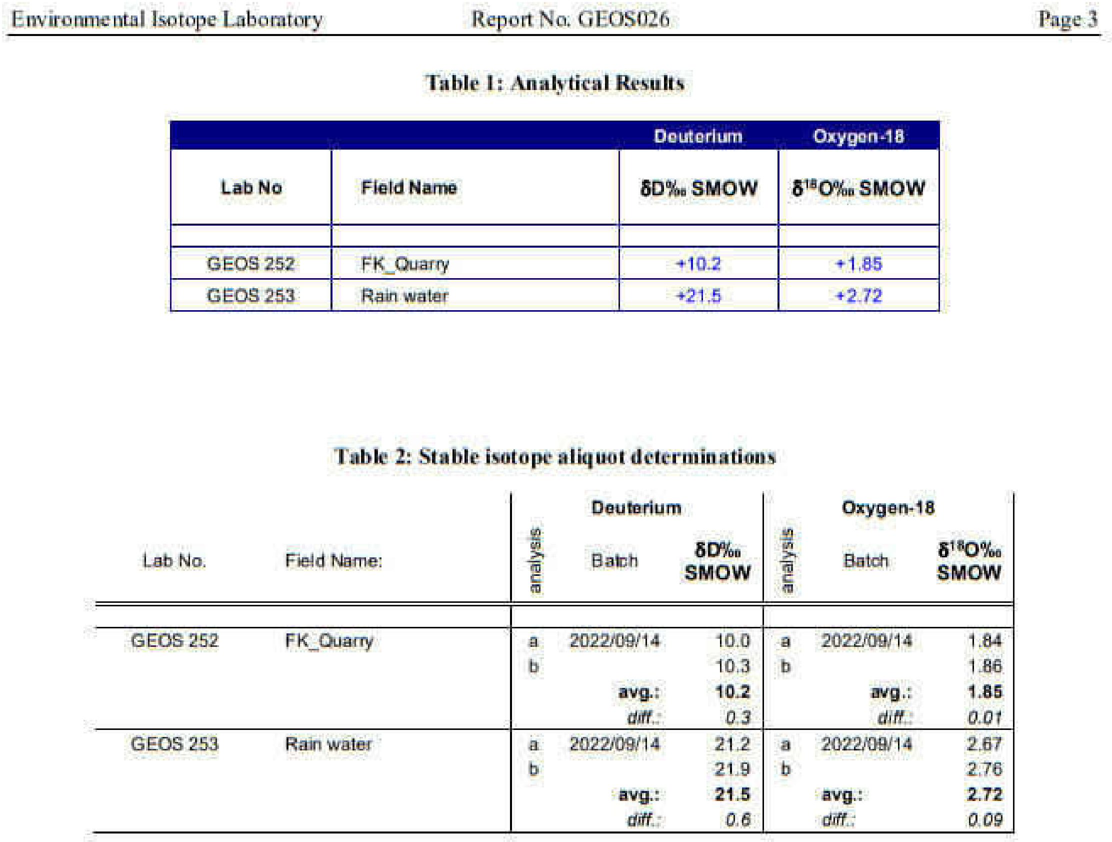
The analytical results are presented in Table 1 and illustrated in Figure 1.

Figure 1: Stable isotope data relative to Global Meteoric Water Line (Craig, 1961).

The stable isotope analyses for the sample data could be well reproduced within the expected analytical error limits. Figure 1 shows these data in a $\delta^{18}O$ vs. δD space relative to the Global Meteoric Water Line (GMWL, Craig, 1961).

4. References

Craig, H. (1961). Isotopic variations in meteoric waters. *Science*, **133**, 1702–1703.



Environmental Isotope Laboratory Report No. GEOS026 Page 3

Table 1: Analytical Results

		Deuterium	**Oxygen-18**
Lab No	**Field Name**	**δD‰ SMOW**	**δ^{18}O‰ SMOW**
GEOS 252	FK_Quarry	+10.2	+1.85
GEOS 253	Rain water	+21.5	+2.72

Table 2: Stable isotope aliquot determinations

			Deuterium			**Oxygen-18**	
Lab No.	Field Name:	analysis	Batch	**δD‰ SMOW**	analysis	Batch	**δ^{18}O‰ SMOW**
GEOS 252	FK_Quarry	a	2022/09/14	10.0	a	2022/09/14	1.84
		b		10.3	b		1.86
			avg.:	**10.2**		**avg.:**	**1.85**
			diff.:	*0.3*		*diff.:*	*0.01*
GEOS 253	Rain water	a	2022/09/14	21.2	a	2022/09/14	2.67
		b		21.9	b		2.76
			avg.:	**21.5**		**avg.:**	**2.72**
			diff.:	*0.6*		*diff.:*	*0.09*

(LAST PAGE)

Borehole Yield and Quality Testing of CWA_BH003 at Cape Winelands Airport, Fisantekraal, Western Cape.

Prepared by
GEOSS
11 December 2024

GROUNDWATER AND EARTH SCIENCES
GEOSS
SOUTH AFRICA (Pty) Ltd

Executive Summary

GEOSS South Africa (Pty) Ltd was appointed by Stuart Walls from Capital Expenditure Projects (Pty) Ltd to conduct yield and groundwater quality testing of one borehole at Cape Winelands Airport, Fisantekraal. The yield testing was undertaken by ATS under the management and supervision of GEOSS SA from 25 November to 4 December 2024. This included a Step Test, CDT and Recovery Test at the borehole and sampling of the groundwater for chemical analysis. It is recommended that groundwater abstraction occur within the below-mentioned parameters from the tested borehole. Aquifer over-abstraction is unlikely to occur if these rates are adhered to and if the borehole is managed through long-term monitoring data.

Borehole Details				
Borehole Name	**Latitude (DD, WGS84)**	**Longitude (DD, WGS84)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
CWA_BH003	-33.774037°	18.747742°	149.9	170
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
CWA_BH003	1.69	24	0	146 016
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
CWA_BH003	107	101	61	18.89

* Typical water level expected during long-term production

Through long term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate if required. It is recommended that the borehole is equipped with a variable frequency drive. This enables adjustments to the flow rate to be made if required, as determined by the hydrogeological analysis of water level and flow rate monitoring data.

Based on the laboratory results, the groundwater from borehole CWA_BH003 is of poor quality for potable use. The primary parameters of concern are elevated concentrations of iron and manganese. According to SANS 241-1:2015 standards, the measured levels of iron (3.944 mg/L) and manganese (0.466 mg/L) exceed the chronic health threshold and may pose chronic health risks if consumed as drinking water. Furthermore, these elevated concentrations can adversely affect the water's aesthetic quality, leading to issues such as poor taste, discoloration, and staining.

If abstraction is not managed optimally, the borehole is also at risk of iron biofouling, which can result in clogging of both the borehole and associated abstraction infrastructure. Additionally, the water's turbidity (64.1 NTU) exceeds the aesthetic guideline limits of SANS 241-1:2015, likely due to the high iron and manganese levels.

Currently, the groundwater from CWA_BH003 is unsuitable for human consumption without treatment. If considered for irrigation purposes, crop selection should account for the water's chloride concentration to prevent potential adverse effects on plant health.

To address the potential for iron to clog the borehole and abstraction infrastructure, it is recommended to maintain a constant and continuous pumping schedule as much as possible.

Thus, should a daily volume of less than 146 016 L/d be required, it is recommended to decrease the pumping rate and not the pumping duration. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps.

To facilitate monitoring and informed management of the borehole, it is recommended to equip borehole with the following monitoring infrastructure and equipment:

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m.
- Installation of an electronic water level logger (for automated water level monitoring)
- Installation of a sampling tap (to monitor water quality)
- Installation of a flow volume meter (to monitor abstraction rates and volumes)

This report is an important document for obtaining the legal authorisation with regard to the use of the groundwater with the Department of Water and Sanitation. However, it does not serve as a Geohydrological Assessment Report in support of a Water Use Licence Application. Such a report would need to incorporate and expand upon the information provided here. GEOSS SA cannot guarantee that there is sufficient water in the aquifer to support the intended usage, or that the Department of Water and Sanitation will authorise the desired abstraction from this aquifer.

Client Information:

Prepared for	Capital Expenditure Projects (Pty) Ltd
Contact Person	Stuart Walls
Contact Email	stuart@capex.co.za
Contact Number	083 449 6082

Author Information:

Prepared by	GEOSS South Africa (Pty) Ltd Unit 12, Technostell Building 9 Quantum Street TechnoPark Stellenbosch 7600
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Contact Number	(021) 880 1079

Document Information and History:

Report Name	**Borehole Yield and Quality Testing of CWA_BH003 at Cape Winelands Airport, Fisantekraal, Western Cape.**		
Report No	2024/12-13		
Suggested Citation	GEOSS (2024). Borehole Yield and Quality Testing of CWA_BH003 at Cape Winelands Airport, Fisantekraal, Western Cape. GEOSS Report Number: 2024/12-13. GEOSS – South Africa (Pty) Ltd. Stellenbosch, South Africa.		
GEOSS Project Number	2021_09-4505_P1		
Cover Photo	Cover photo taken during site visit		
Issue	Version	Date	Reviewed by
1 (Draft)	1.0	11 December 2024	Reuben Lazarus
2 (Final)	1.1	11 December 2024	Julian Conrad

Principal Author(s) and Reviewer(s):

	Author	Principal Reviewer	Final Reviewer
Name	Shane Teek	Reuben Lazarus	Julian Conrad
Qualification	MEng (Civil Engineering)	MSc (Geology – Environmental Geochemistry)	MSc (Hydrogeology)
SACNASP No.	126397	120711	*400159/05*
Registration	Earth Science (Pr.Sci.Nat)	Earth Science (Pr.Sci.Nat)	Earth Science (Pr.Sci.Nat)

Table of Contents

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Abbreviations

AD	Available Drawdown
bh	Borehole
CDT	Constant Discharge Test
CGS	Council for Geoscience
DD	Decimal degree
DWAF	Department of Water Affairs and Forestry (1994 – 2009)
DWS	Department of Water and Sanitation (2009 – ....)
EC	Electrical Conductivity
FC	Flow Characteristic
GRF	Generalised Radial Flow
IARF	Infinite Acting Radial Flow
ID	inner diameter
L/d	litres per day
L/s	litres per second
m	metres
m^2/d	meters squared per day
mamsl	metres above mean sea level
mbch	metres below collar height
mbgl	metres below ground level
mg	milligram
mg/L	milligram per litre
mm	millimetres
nd	not detected
OD	outer diameter
RWL	rest water level below ground level
SANS	South African National Standard
T	Transmissivity
TDS	total dissolved solids
WGS84	Since the 1st January 1999, the official co-ordinate system for South
Africa	is based on the World Geodetic System 1984 ellipsoid, commonly known
as	WGS84
WL	water level
WULA	Water Use Licence Assessment

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)].
available drawdown	available drawdown in a borehole is the difference between the rest water level or piezometric surface and the depth that the water level may drop to (typically major water baring unit, boundary inflection or pump depth).
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)].
confined aquifer	an aquifer confined between two impermeable beds
dynamic water level	the stabilised water level in the borehole during production over long periods of time.
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.
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.
intergranular aquifer	an aquifer in which groundwater is stored in and flows through open pore spaces in the unconsolidated Quaternary deposits.
rest water level	the groundwater level in a borehole not influenced by abstraction or artificial recharge.
sustainable yield	sustainable yield is defined as the rate of withdrawal that can be sustained by an aquifer without causing an unacceptable decline in the hydraulic head or deterioration in water quality in the aquifer.
transmissivity	the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.
unconfined aquifer	an aquifer which has free water surface - which means the water table exists for this type of aquifer; primarily recharged by the infiltration of precipitation from the ground surface

SPECIALIST EXPERTISE

CURRICULUM VITAE – Reuben Lazarus

GENERAL

Nationality:	South African
Profession:	Hydrogeologist
Specialization:	Groundwater development, yield testing, geochemistry and camera logging
Position in firm:	Hydrogeologist, Business Unit Leader: Yield and Water Quality Testing at GEOSS South Africa (Pty) Ltd
Date commenced:	October 2017
Year of birth & ID #:	1992 – 9207075195083
Language skills:	Afrikaans (mother tongue) English (excellent)

KEY SKILLS

- Groundwater component of Catchment Management Strategies and other Groundwater Resource Directed Measures.
- Groundwater development – borehole drilling and test pumping supervision and analysis.
- Groundwater monitoring – development and analysis of groundwater level and quality data.
- Groundwater management – sustainable aquifer development and management.
- Groundwater contamination assessments – geochemical analysis.
- Writing of hydrogeological reports
- ArcMap / Geochemist's Workbench / WISH and typical software skills.

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2018	MSc (Geology – Environmental Geochemistry)	University of Stellenbosch, South Africa
2016	BSc (Hons) (Earth Science)	University of Stellenbosch, South Africa
2015	BSc (Earth Science)	University of Stellenbosch, South Africa

Courses and symposiums

2023	VFD Level 1 and Level 2 (ElectroMechanica)
2023	PLC Level 1 and Level 2 AS 200 (ElectroMechanica)
2023	Basic hydraulics & Pumps (Dudley Willer)
2022	Environmental Sampling Workshop (Van Walt)
2019	SA remediation workshop (Enviro Workshops)

Memberships/Organisations

- South African Council for National Scientific Professions (SACNASP)- Mem. No. Pr.Sci.Nat: 120711
- Groundwater Division of the Geological Society of South Africa UID 9661/21
- Geological Society of South Africa Mem. No. 970021

EMPLOYMENT RECORD

June 2021 – present:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist: Yield and Water Quality Testing Business Unit Leader*
October 2018 – June 2021:	GEOSS South Africa (Pty) Ltd, Stellenbosch *Project Hydrogeologist*
October 2017 – October 2018:	GEOSS - Geohydrological and Spatial Solutions International (Pty) Ltd *Student Hydrogeologist*

SPECIALIST EXPERTISE

CURRICULUM VITAE – Shane Teek

GENERAL

Nationality:	South African
Profession:	Hydrogeologist | Geotechnical Geologist
Specialization:	Soil classification and characterization for determination of engineering properties. Geotechnical data analysis and interpretation; factual reporting. Groundwater exploration, development, sampling, and monitoring. Groundwater impact and contamination assessments.
Position in firm:	Geotechnical Geologist | Hydrogeologist at GEOSS South Africa (Pty) Ltd
Date commenced:	June 2021
Language skills:	English (mother tongue), Afrikaans (fluent)

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.
- Major chemistry-, including stable isotope analysis.
- Writing of hydrogeological reports.
- Compilation of geotechnical investigation reports.
- Conducting hydrocensus studies.
- Logging of trial pit and auger hole data.
- Drill chip logging.
- QGIS / Geochemist's Workbench / WISH and typical software skills.

EDUCATIONAL AND PROFESSIONAL STATUS

Qualifications

2021	M.Eng. (Geotechnical/Civil Engineering)	University of Stellenbosch, South Africa
2016	B.Sc. (Hons) Earth Science	University of Stellenbosch, South Africa
2015	B.Sc. Earth Science	University of Stellenbosch, South Africa

Courses and symposiums

2022	Introduction to Earth Observation (Centre for Geographical Analysis).
2021	Geotechnical Workshop (GSSA; course presenters: various including Prof Peter Day).
2018	Advanced Foundation Design (Course presenter: Prof Peter Day, Dr Marius de Wet).
2018	Advanced Geotechnics (Course presenters: Prof Peter Day, Prof Nico de Koker, Dr Richard Walls).
2018	Advanced Soil Behaviour (Course presenter: Dr Marius de Wet).
2018	GEO254 (Course presenter: Dr Nanine Fouché).
2018	GEO354 (Course presenter: Dr Marius de Wet).

Memberships/Organisations

- South African Council for National Scientific Professions (SACNASP) – Mem. No. 126397 (Pr. Sci. Nat).
- Affiliate member of the South African Institution of Engineering and Environmental Geologists (SAIEG).

EMPLOYMENT RECORD

July 2021 to present	GEOSS South Africa (Pty) Ltd, South Africa.
Jan 2020 to June 2021	Geotechnics Africa Western Cape, South Africa.
Feb 2019 to July 2019	Polytechnique Montréal, Canada.
Jan 2019 to Dec 2021	Geocroukamp, South Africa.
Jan 2017 to Dec 2017	Remote Exploration Services, South Africa.

SPECIALIST DECLARATION

We, Reuben Lazarus 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 South African National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes);
- have and will not have no vested interest in the proposed activity proceeding;
- 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

Reuben Lazarus
GEOSS South Africa (Pty) Ltd
SACNASP – Pr.Sci.Nat: 120711
11 December 2024

Julian Conrad
GEOSS South Africa (Pty) Ltd
SACNASP – Pr.Sci.Nat
11 December 2024

1 Introduction

GEOSS South Africa (Pty) Ltd was appointed by Stuart Walls from Capital Expenditure Projects (Pty) Ltd to conduct yield and water quality testing of one borehole at Cape Winelands Airport, Fisantekraal.

The borehole was tested by ATS under the management and supervision of GEOSS SA from 25 November to 4 December 2024, details of this are presented in this report. The borehole's details are presented **in Table 1** below and spatially **in Map 1.** A borehole drill log is presented in **Appendix A.** Based on the drill log the borehole is drilled through the sandy loam of the Springfontyn formation into the underlying greywacke and phyllites of the Tygerberg formation (GEOSS, 2024; **Map 2**).

Table 1: Borehole Details.

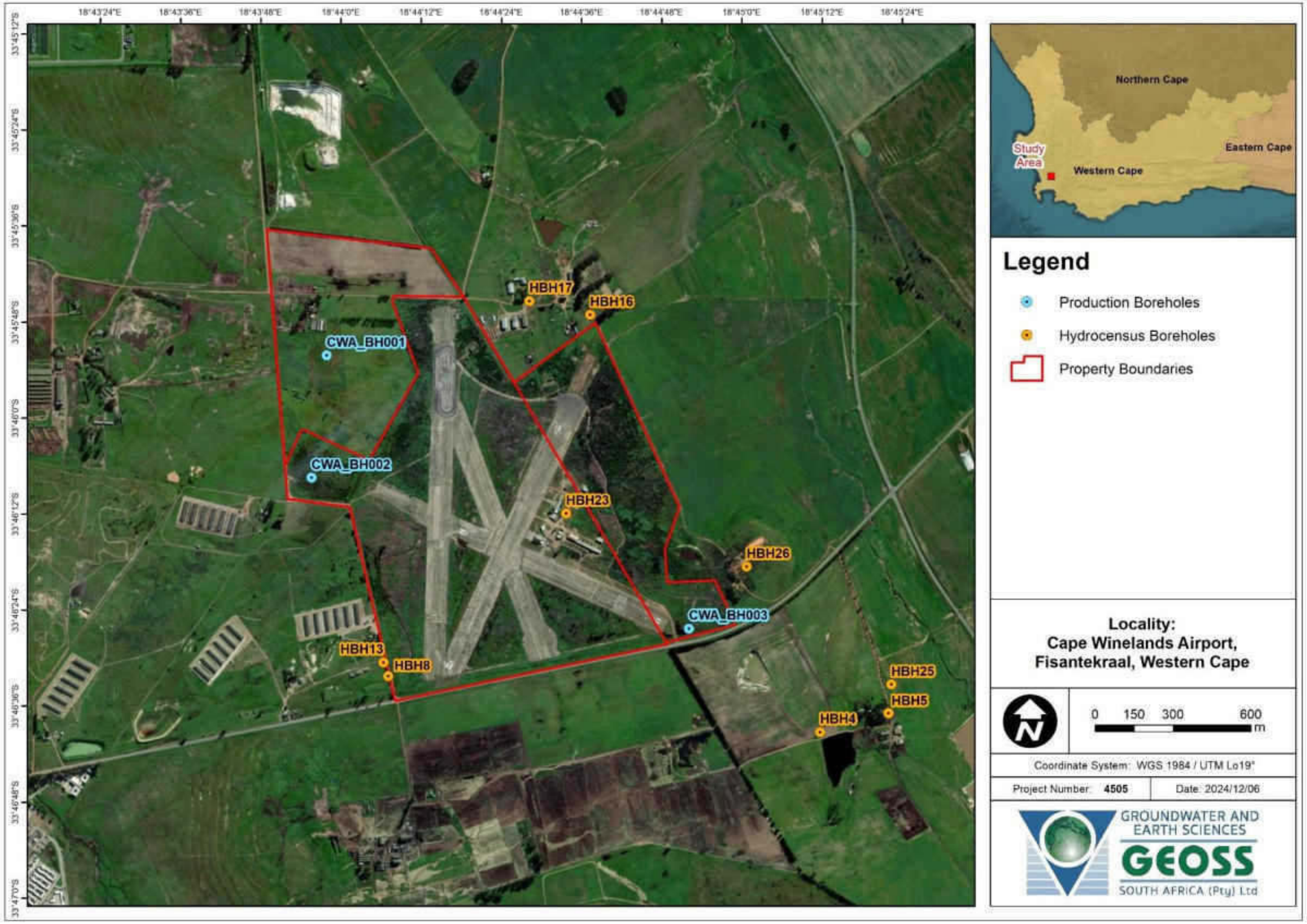
Borehole	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Depth (m)
CWA_BH003	-33.774037°	18.747742°	149.9

Figure 1: CWA_BH003 before (left) and after (right) testing.

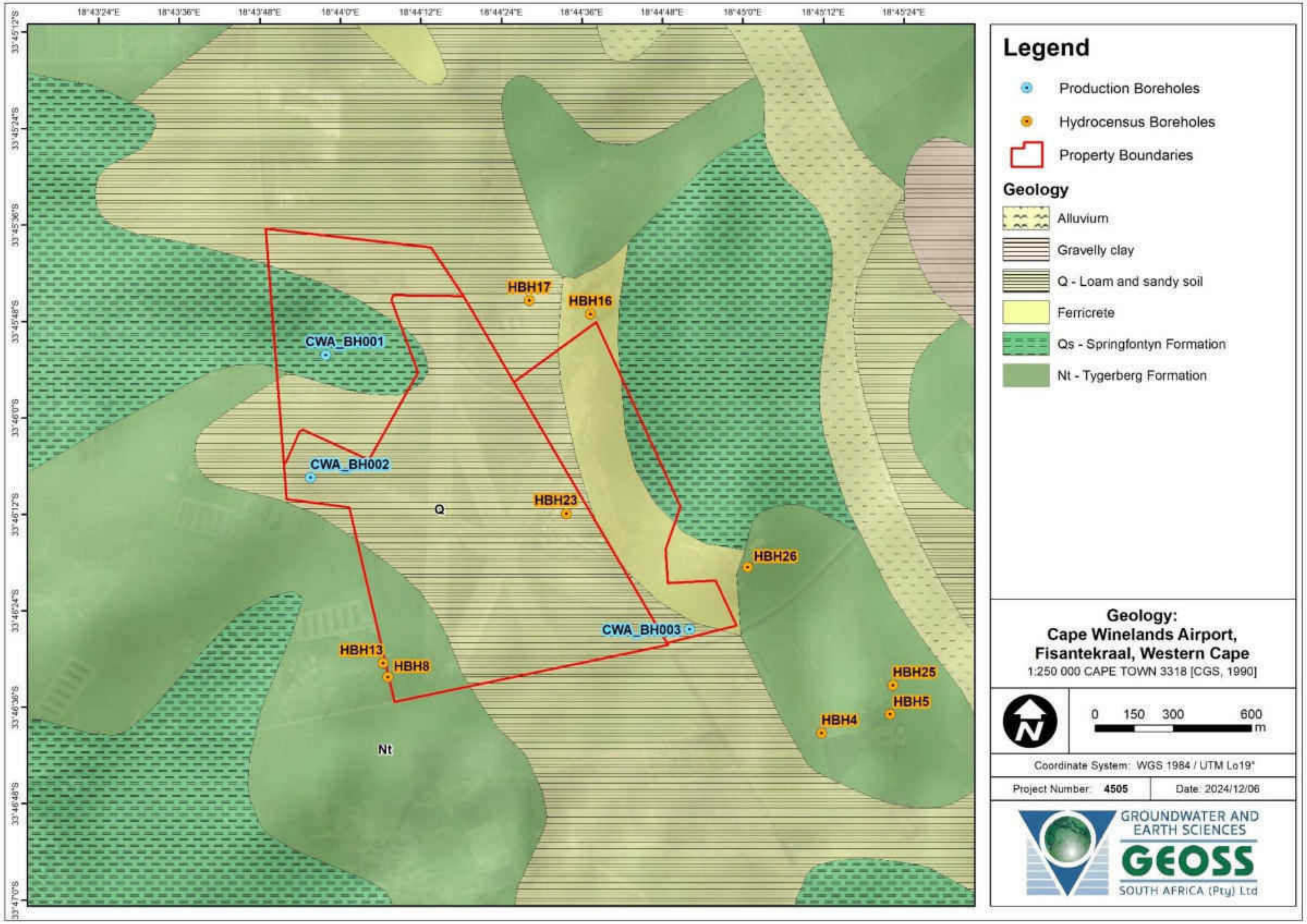
2 Yield Testing

2.1 Methodology

The yield testing was undertaken by ATS under the management and supervision of GEOSS SA from 25 November to 4 December 2024 and carried out according to the National Standard (SANS 10299-4:2003, Part 4 – Test pumping of water boreholes). This included a Step Test, Constant Discharge Test (CDT) and recovery monitoring of the borehole. For the Step Test, a borehole is pumped at a constant rate for one-hour intervals and the flow rates are incrementally increased for each step. This test is followed by a Constant Discharge Test where the borehole is pumped at a constant rate for an extended period of time, followed by recovery monitoring. The water level drawdown is monitored at pre-determined intervals during these tests (drawdown refers to the difference in water level from the rest water level (RWL) measured before commencement of the yield test). Raw data and measurements taken during the yield tests are presented in **Appendix B.**



Map 1: Borehole Locality Map.



Map 2: Geological Map with Property Boundaries and relevant Borehole Positions (1: 250 000 Geological Map Series, 3318 Cape Town) (CGS, 1990).

The yield test data was analysed using the excel-based FC program, developed by the IGS (Institute for Groundwater Studies) in Bloemfontein. The sustainable yield of the borehole was calculated based upon long-term extrapolations of the CDT data according to (1) the Cooper-Jacob approximation of the Theis solution for confined aquifers, (2) the Barker Generalised Radial Flow Model (GRF) for hydraulic tests in fractured rock and (3) the Flow Characteristic (FC) method(s) using first and second derivative calculations. Boundary conditions are accounted for in multiplication factors to the rate of drawdown (derivatives), according to each of the above three methods. These three methods are briefly described below.

1. The Cooper-Jacob approximation of the Theis solution for confined aquifers was designed for porous media aquifers, where infinite acting radial flow (IARF) was observed during the pumping of a borehole. The application of this method to fractured aquifers was discussed by Meier et al (1998), concluding that T estimates using the Cooper-Jacob analysis gave an effective T for the fracture zone. The Cooper-Jacob analysis (and more accurately the Theis method) is therefore viable for analysing pumping test data for fractured aquifers where IARF is observed. The parameters are then used to predict theoretical long-term drawdowns.
2. The Barker GRF Model (Barker, 1988) uses fracture hydraulic conductivity, fracture storativity and flow domain to predict drawdown due to abstraction in a borehole in a fractured medium. By changing these values, a curve of drawdown predictions can be made to fit real-world data and therefore predict theoretical long-term drawdowns.
3. The FC methods are the Basic FC, the FC Inflection Point and the FC Non-Linear. The Basic FC and the FC Inflection Point methods make use of the derivatives of the drawdown data to predict theoretical long-term drawdowns and the scale-back factors are applied to selected available drawdowns. The FC Non-Linear method uses curve fitting of the Step Test data to predict theoretical long-term drawdowns. Due to the short nature of the Step Test, this method is usually not included if the other methods of analysis differ from it.

In all three methods, the available drawdown was carefully selected to ensure that the flow regime described by the analytical solution is not extrapolated beyond its applicable depth, which may easily result in an overuse of the resource. For CWA_BH003 this was 74 m (101 mbgl), based on the first fracture intersected in the borehole and the rest water level prior to the start of the second CDT. A two-year extrapolation time without recharge to the aquifer was selected as per the recommendations within the FC method program.

Water samples were collected at the end of the yield test and submitted for inorganic chemical analyses.

2.2 Yield Testing at CWA_BH003

The yield testing was conducted between the 25th of November and the 4th December 2024. The borehole was measured to a depth of 149.9 meters below ground level (mbgl). The test pump was installed at a depth of 106.44 mbgl. The rest water level (RWL) at the start of the test was 18.89 mbgl.

During the step test, the water level was drawn down 72.7 meters below the rest water level (91.59 mbgl) during the 4th step at a rate of 9.24 L/s (33 264 L/hour, pump max). **Figure 2** shows the time-series drawdown for the Step Test.

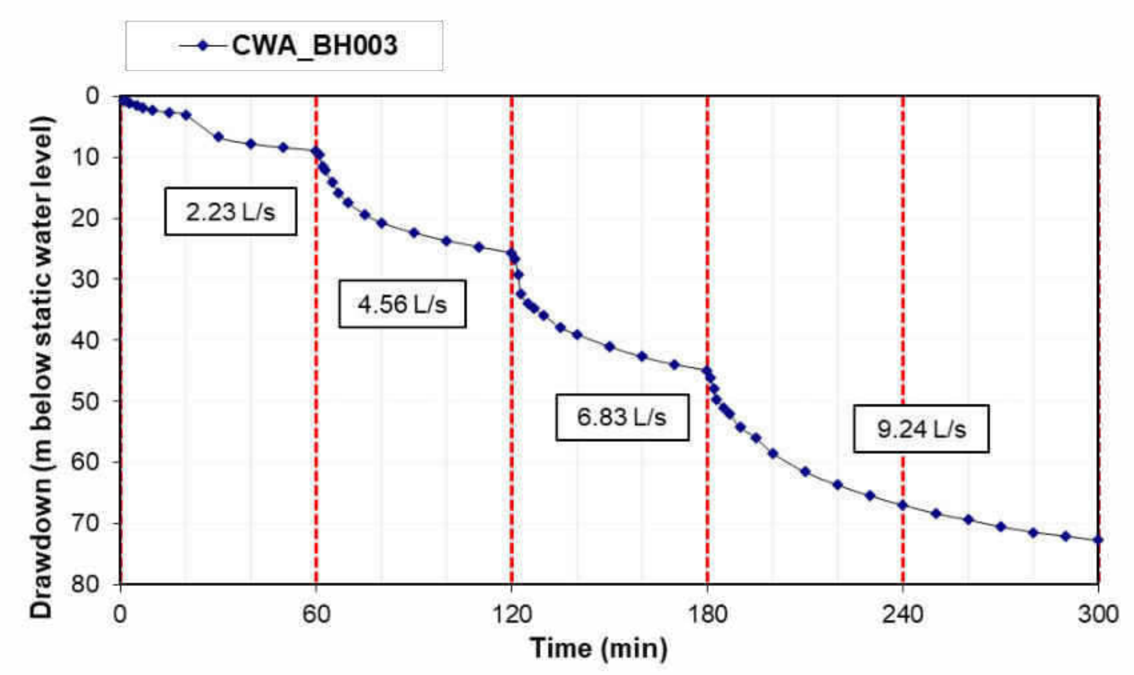


Figure 2: Step Test drawdown data for CWA_BH003.

The water level was left to recover overnight. Before starting the CDT, the water level recovered to 22.99 mbgl. Based on the results of the Step Test, the planned 48-hour CDT was conducted at a rate of 6.45 L/s (23 220 L/hour). After 38 hours the test rig experienced a breakdown. The borehole was left to recover for 38 hours (pump time) before restarting the CDT. Before restarting the CDT, the water level recovered to 26.8 mbgl. The CDT was restarted at a rate of 6.13 L/s (22 068 L/hour). At the end of the 48-hour period, the water level had drawn down 70.19 meters below the rest water level (96.99 mbgl). The semi-log plot of the drawdown from the CDT is presented **in Figure 3.** The available drawdown (AD) is indicated with the horizontal red line at 78 m below the rest water level of the first CDT (101 mbgl).

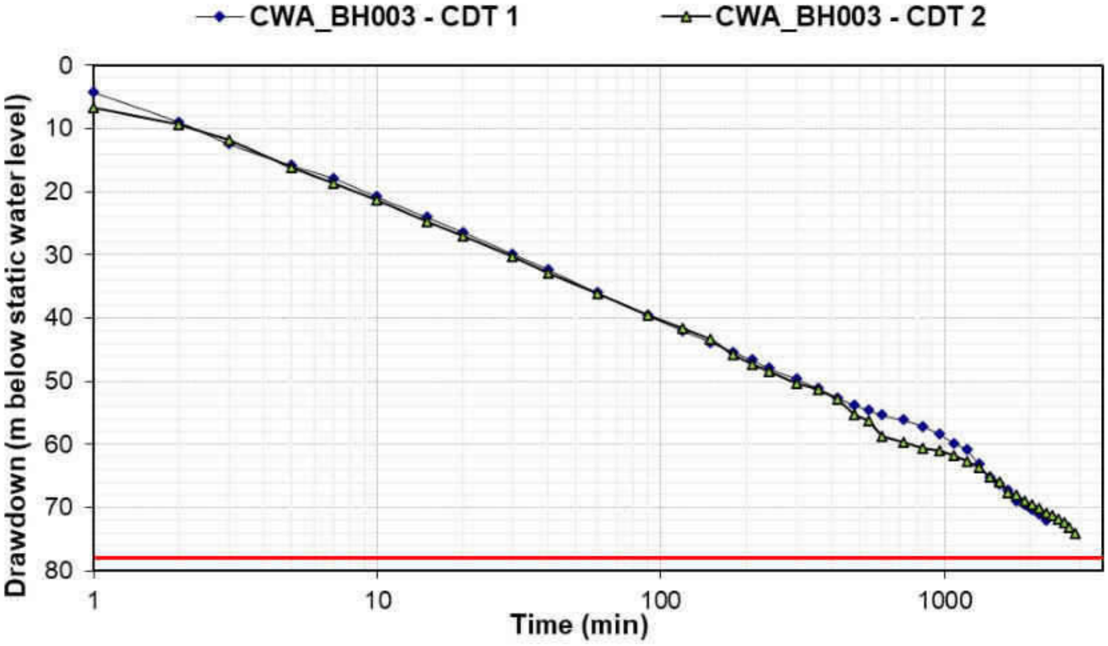


Figure 3: Semi-Log Plot of drawdown during the CDT of CWA_BH003 (CDT1: 6.45 L/s, CDT2: 6.13 L/s).

The recovery of the water level was monitored after the CDT and is presented in **Figure 4.** The recovery was good, reaching 95.6% of the drawdown during the second CDT, in 29 hours. Monitoring will be essential to determine the long-term recovery of the borehole.

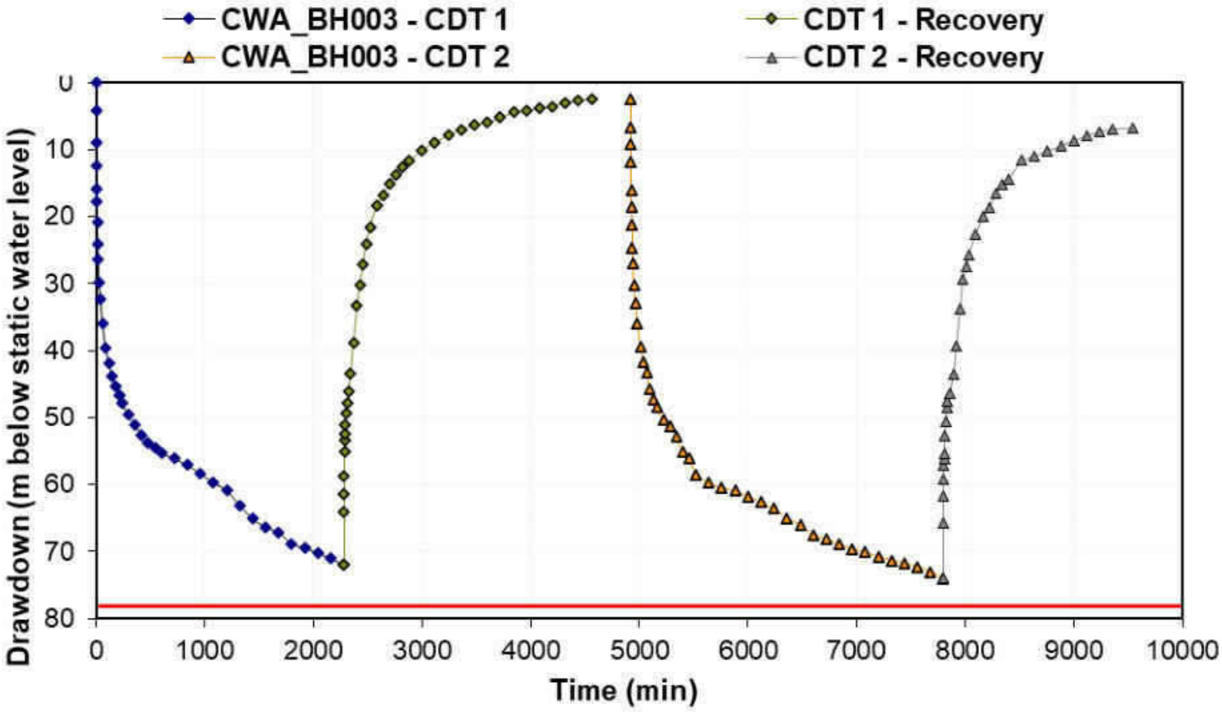


Figure 4: Time-series drawdown and recovery for CWA_BH003 (CDT1: 6.45 L/s, CDT2: 6.13 L/s).

Several methods were used to assess the yield test data as presented in **Table 2.** It is recommended that the borehole can be abstracted from at a rate of up to 1.69 **L**/s (6 084 **L**/hour) for up to 24 hours per day. The assessments were based on an available drawdown (AD) of 74 meters below the RWL of the second CDT, which equates to 101 mbgl.

Table 2: Yield Determination - CWA_BH003.

CWA_BH003			
Method	**Sustainable Yield (L/s)**	**Late *T (m^2/d)**	***AD used (m)**
Basic FC	1.82	3.8	74.0
Cooper-Jacob	1.85	4.3	74.0
FC Non-Linear	1.39	5	74.0
Barker	1.69		74.0
Average Q_sust (L/s)	**1.69**		
Recommended Abstraction			
Abstraction Rate (L/s)	**Abstraction Duration (hours)**		**Recovery Duration (hours)**
1.69	24		0

**AD- Available Drawdown

* T – Transmissivity

3 Radius of influence

Due to lack of access and monitoring infrastructure, no boreholes within a reasonable distance from CWA_BH003 were monitored during the testing of CWA_BH003. Transmissivity was calculated through the Theis method using the drawdown response in CWA_BH003. The transmissivity of the system was calculated at 4.3 m^2/d. A storativity value of $5x10^{-4}$ was used for the radius of influence calculation based on an average expected value of confined aquifers as report by (Todd, 1980). Based on the aquifer parameters the radius of influence was calculated for the recommended sustainable yield of the borehole. Observed drawdowns of up to 13.5 m, 9.5 m, and 6 m are expected at approximately 310 m (HBH6), 640 m (HBH4), and 1200 m (HBH8) from CWA_BH003, respectively, at the recommended sustainable abstraction rate (1.69 L/s, 24 hours/day) after two years without recharge (**Figure 5**).

It must be stressed that the Cooper-Jacob modelling of radius of influence is based on a homogenous, confined aquifer and therefore does not account for the heterogeneity associated with secondary aquifers (fractured rock). Thus, the radius of influence model will only provide an indication of how abstraction at CWA_BH003 will impact the water level in the fracture network. This suggests that the cone of depression will not expand equivalently in all directions surrounding the borehole, but will rather propagate along the fracture network within the secondary aquifer. It will be essential for all neighbouring boreholes to be monitored by the respective owners to ensure sustainable use and to determine the cumulative impact of regional abstraction on the groundwater resource.

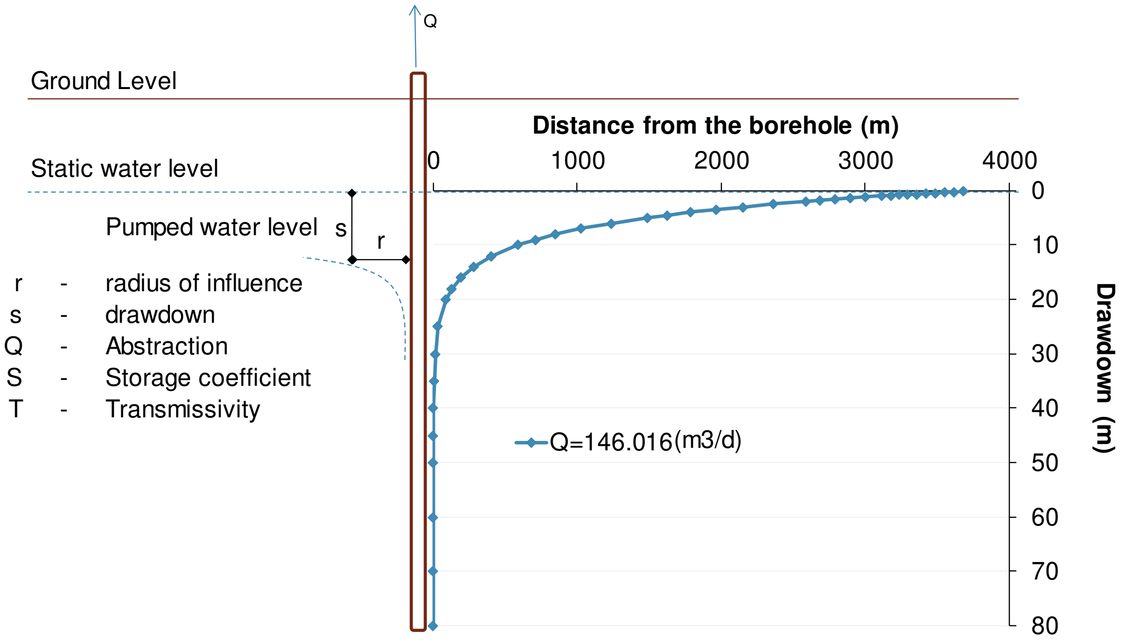


Figure 5: Radius of influence for CWA_BH003 at the recommended sustainable yield (1.69 L/s).

4 Water Quality Analysis

Groundwater samples were collected from the borehole at the end of the yield test and submitted for inorganic chemical analyses to a SANAS accredited laboratory (Vinlab) in the Western Cape. The certificate of analysis for the sample is presented in **Appendix C.** The chemistry results obtained for the borehole have been classified according to the SANS241-1: 2015 standards for domestic water (**Table 3**). **Table 5** presents the water chemistry analysis results, colour coded according to the SANS241-1: 2015 drinking water assessment standards.

Table 3: Classification table for the specific limits.

Acute Health	**Aesthetic**	**Chronic Health**	**Operational**	**Acceptable**

The limits and associated risks for domestic water as determined by the South African National Standard (SANS) 241:2015 are as follows, where:

- Health risks: parameters falling outside these limits may cause acute or chronic health problems in individuals.
- Aesthetic risks: parameters falling outside these limits indicate that water is visually, aromatically or palatably unacceptable.
- Operational risks: parameters falling outside these limits may indicate that operational procedures to ensure water quality standards are met may have failed.

The chemistry results obtained have also been classified according to the DWAF (1998) standards for domestic water. **Table 4** enables an evaluation of the water quality with regards to the various parameters measured (DWAF, 1998). **Table 6** presents the water chemistry analysis results colour coded according to the DWAF drinking water assessment standards.

Table 4: 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.

Table 5: Production borehole results classified according to SANS241-1:2015.

Analyses	CWA_BH003	SANS 241-1:2015
Date Tested	07:50 03/12/2024	
pH (at 25 °C)	7.2	5.0 ≤ Operational ≤ 9.7
Conductivity (mS/m) (at 25 °C)	80.6	Aesthetic ≤170
Total Dissolved Solids (mg/L)	546.47	Aesthetic ≤1200
Turbidity (NTU)	64.10	Operational ≤1 Aesthetic ≤5
Colour (mg/L as Pt)	<15	Aesthetic ≤15
Sodium (mg/L as Na)	149	Aesthetic ≤200
Potassium (mg/L as K)	3	N/A
Magnesium (mg/L as Mg)	19	N/A
Calcium (mg/L as Ca)	20	N/A
Chloride (mg/L as Cl)	294.37	Aesthetic ≤300
Sulphate (mg/L as SO_4)	17.39	Aesthetic ≤250 Acute ≤500
Nitrate & Nitrite Nitrogen (mg/L as N)	0.068	≤1 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	Acute Health ≤11
Nitrite Nitrogen (mg/L as N)	<0.05	Acute Health ≤0.9
Ammonia Nitrogen (mg/L as N)	<0.15	Aesthetic ≤1.5
Total Alkalinity (mg/L as $CaCO_3$)	72.0	N/A
Total Hardness (mg/L as $CaCO_3$)	127.9	N/A
Fluoride (mg/L as F)	<0.15	Chronic Health ≤1.5
Aluminium (mg/L as Al)	<0.008	Operational ≤0.3
Total Chromium (mg/L as Cr)	<0.004	Chronic Health ≤0.05
Manganese (mg/L as Mn)	0.466	Aesthetic ≤0.1 Chronic ≤0.4
Iron (mg/L as Fe)	3.944	Aesthetic ≤0.3 Chronic ≤2
Nickel (mg/L as Ni)	<0.008	Chronic Health ≤0.07
Copper (mg/L as Cu)	<0.002	Chronic Health ≤2
Zinc (mg/L as Zn)	<0.008	Aesthetic ≤5
Arsenic (mg/L as As)	<0.010	Chronic Health ≤0.01
Selenium (mg/L as Se)	<0.008	Chronic Health ≤0.04
Cadmium (mg/L as Cd)	0.001	Chronic Health ≤0.003
Antimony (mg/L as Sb)	<0.013	Chronic Health ≤0.02
Mercury (mg/L as Hg)	<0.001	Chronic Health ≤0.006
Lead (mg/L as Pb)	<0.008	Chronic Health ≤0.01
Uranium (mg/L as U)	<0.028	Chronic Health ≤0.03
Cyanide (mg/L as CN^-)	0.010	Acute Health ≤0.2
Total Organic Carbon (mg/L as C)	2.19	N/A
Charge Balance Error %	4.0	≥-5 - ≤5 Acceptable

Table 6: Classified production borehole results according to DWAF 1998.

Sample Marked:	CWA_BH003	DWAF (1998) Drinking Water Assessment Guide				
		Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
		Ideal	**Good**	**Marginal**	**Poor**	**Dangerous**
Date and Time Sampled	07:50 03/12/2024					
pH	7.2	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)	80.6	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	64.10	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L					
Total Dissolved Solids	546.47	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	149	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	3	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	19	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	20	<80	80-150	150-300	>300	
Chloride (as Cl)	294.37	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO_4)	17.39	<200	200-400	400-600	600-1000	>1000
Fluoride (as F)	<0.15	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.466	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	3.944	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	<0.002	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	<0.008	<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)	0.001	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	127.9	<200	200-300	300-600	>600	
Charge Balance Error %	4.0	≥-5 - ≤5 Acceptable				

Based on the chemical results presented in **Table 5** and **Table 6**, the groundwater from borehole CWA_BH003 is of poor quality for potable use. The primary parameters of concern are elevated concentrations of iron and manganese. According to SANS 241-1:2015 standards, the measured levels of iron (3.944 mg/L) and manganese (0.466 mg/L) exceed the chronic health threshold and may pose chronic health risks if consumed as drinking water. Furthermore, these elevated concentrations can adversely affect the water's aesthetic quality, leading to issues such as poor taste, discoloration, and staining.

If not managed optimally, the borehole is also at risk of iron biofouling, which can result in clogging of both the borehole and associated abstraction infrastructure. Additionally, the water's turbidity (64.1 NTU) exceeds the aesthetic guideline limits of SANS 241-1:2015, likely due to the high iron and manganese levels.

Currently, the groundwater from CWA_BH003 is unsuitable for human consumption without treatment. If considered for irrigation purposes, crop selection should account for the water's chloride concentration to prevent potential adverse effects on plant health.

A number of chemical diagrams have been plotted for the groundwater sample and these are useful for chemical characterisation of the water and illustrate the similarities and differences in the water types. The Stiff Diagram is a graphical representation of the equivalent concentrations of the cations (positive ions) and anions (negative ions). This diagram shows concentrations of cations and anions relative to each other and direct reference can be made to specific salts in the water. From **Figure 6**, CWA_BH003 is classified as a Sodium & Potassium/Chloride hydrofacies. This is expected of groundwater hosted in the greywacke and phyllites of the Tygerberg formation.

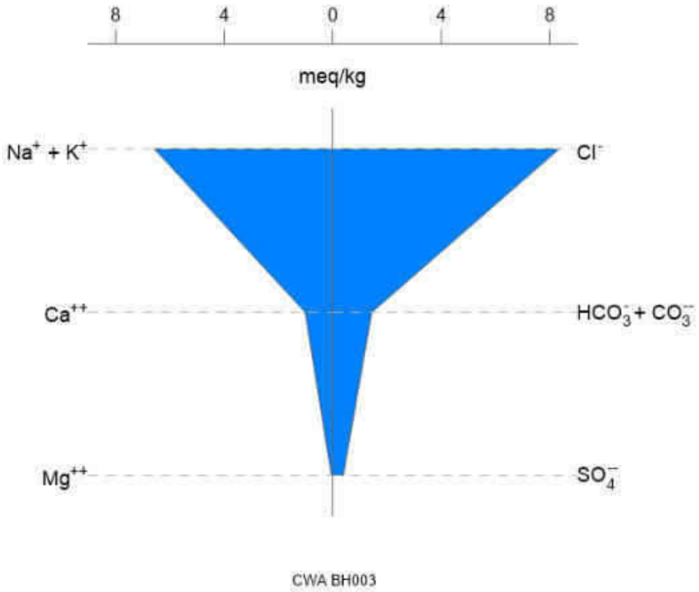


Figure 6: Stiff diagram of the groundwater sample.

The Sodium Adsorption Ratio (SAR) of the groundwater is plotted in **Figure 7.** CWA_BH003 plots as S1/C3, thus classified as low risk in terms of sodium adsorption and high risk in terms of salinity hazard. This graph is typically applicable to irrigation, however, is dependent on soil texture and crop type.

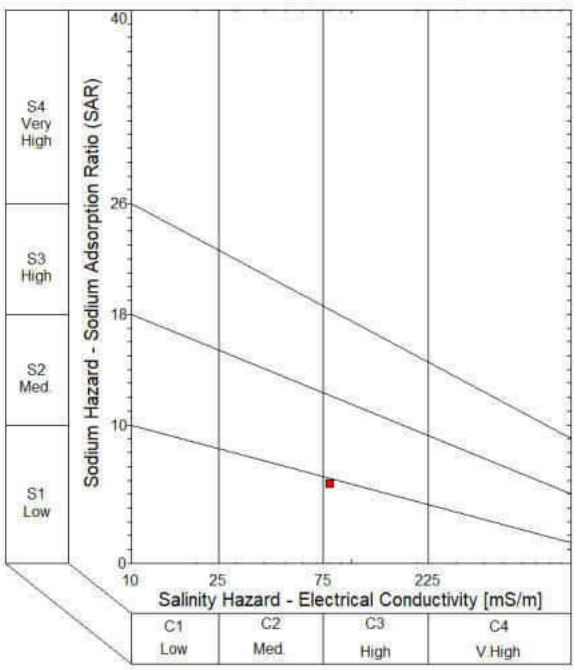


Figure 7: SAR diagram of the groundwater sample.

5 Recommendations

Based on the information obtained from the yield test, the abstraction recommendation for the borehole is presented in **Table 7.** The yield testing was conducted with a Step Test, Constant Discharge Test and Recovery Test and while this data can be analysed to estimate sustainable yields, additional drilling in the area may result in long term cumulative impacts. Optimisation of the resource is also likely through making small changes to the abstraction rate, should the dynamic water level's drawdown be less or more than expected as per **Table 7.** Both of these points are best managed through long term monitoring data.

Table 7: Borehole Abstraction Recommendations.

Borehole Details				
Borehole Name	**Latitude (DD, WGS84)**	**Longitude (DD, WGS84)**	**Borehole Depth (m)**	**Inner Diameter (mm)**
CWA_BH003	-33.774037°	18.747742°	149.9	170
Abstraction Recommendations				
Borehole Name	**Abstraction rate (L/s)**	**Abstraction Duration (hrs)**	**Recovery Duration (hrs)**	**Possible Volume Abstracted (L/d)**
CWA_BH003	1.69	24	0	146 016
Pump Installation Details				
Borehole Name	**Pump Installation Depth (mbgl)**	**Critical Water Level (mbgl)**	**Dynamic Water Level (mbgl)***	**Rest Water Level (mbgl)**
CWA_BH003	107	101	61	18.89

* Typical water level expected during long-term production

For borehole CWA_BH003 it is recommended that abstraction can occur at a rate of up to 1.69 L/s for 24 hours per day. A pump suitable to deliver the recommended rate should be installed at a depth of 107 mbgl. It is anticipated that abstraction at the recommended rate will cause the water level to drop to a depth of approximately 61 mbgl – this is referred to as the dynamic water level. During abstraction, a maximum level cut off switch should be installed to 101 mbgl to ensure the groundwater level does not drop below the fracture depth.

Based on the laboratory results, the groundwater from borehole CWA_BH003 is of poor quality for potable use. The primary parameters of concern are elevated concentrations of iron and manganese. According to SANS 241-1:2015 standards, the measured levels of iron (3.944 mg/L) and manganese (0.466 mg/L) exceed the chronic health threshold and may pose chronic health risks if consumed as drinking water. Furthermore, these elevated concentrations can adversely affect the water's aesthetic quality, leading to issues such as poor taste, discoloration, and staining.

If not managed optimally, the borehole is also at risk of iron biofouling, which can result in clogging of both the borehole and associated abstraction infrastructure. Additionally, the water's turbidity (64.1 NTU) exceeds the aesthetic guideline limits of SANS 241-1:2015, likely due to the high iron and manganese levels.

Currently, the groundwater from CWA_BH003 is unsuitable for human consumption without treatment. If considered for irrigation purposes, crop selection should account for the water's chloride concentration to prevent potential adverse effects on plant health.

To address the potential for iron to clog the borehole and abstraction infrastructure, it is recommended to maintain a constant and continuous pumping schedule as much as possible. Thus, should a daily volume of less than 146 016 L/d be required, it is recommended to decrease the pumping rate and not the pumping duration. By pumping continuously instead of on a stop-start schedule, iron oxidation in the borehole is minimized, decreasing the amount of iron precipitation inside the boreholes and pumps.

Through long term water level monitoring data, the abstraction volumes can be optimised by adjusting the abstraction rate if required. It is recommended that the borehole is equipped with a variable frequency drive. This enables adjustments to the flow rate to be made if required, as determined by the hydrogeological analysis of water level and flow rate monitoring data.

As of January 2018 the Department of Water and Sanitation released a Government Gazette stating that: “All water use sector groups and individuals taking water from any water resource (surface or groundwater) regardless of the authorization type, in the Berg, Olifants and Breede Gouritz Water Management Area, shall install electronic water recording, monitoring or measuring devices to enable monitoring of abstractions, storage and use of water by existing lawful users and establish links with any monitoring or management system as well as keep records of the water used.”

Therefore, to facilitate monitoring and informed management of the borehole, it is recommended that the borehole be equipped with the following monitoring infrastructure and equipment (diagram included **in Appendix E**):

- Installation of a 32 mm (inner diameter, class 10) observation pipe from the pump depth to the surface, closed at the bottom and slotted for the bottom 5 – 10 m.
- Installation of an electronic water level logger (for automated water level monitoring).
- Installation of a sampling tap (to monitor water quality).
- Installation of a flow volume meter (to monitor abstraction rates and volumes).

This monitoring data should be analysed by a qualified Hydrogeologist to ensure long-term sustainable use from the borehole. The legal compliance with regard to the use of the groundwater also needs to be addressed with the Department of Water and Sanitation.

6 References

Barker, J.A., (1988). A Generalised Radial Flow Model for Hydraulic Tests in Fractured Rock. Water Resources Research, Vol. 24, No. 10 Pages 1796 – 1804.

Council for Geoscience (1990). The 1: 250 000 geological map series Map number: 3318 Cape Town.

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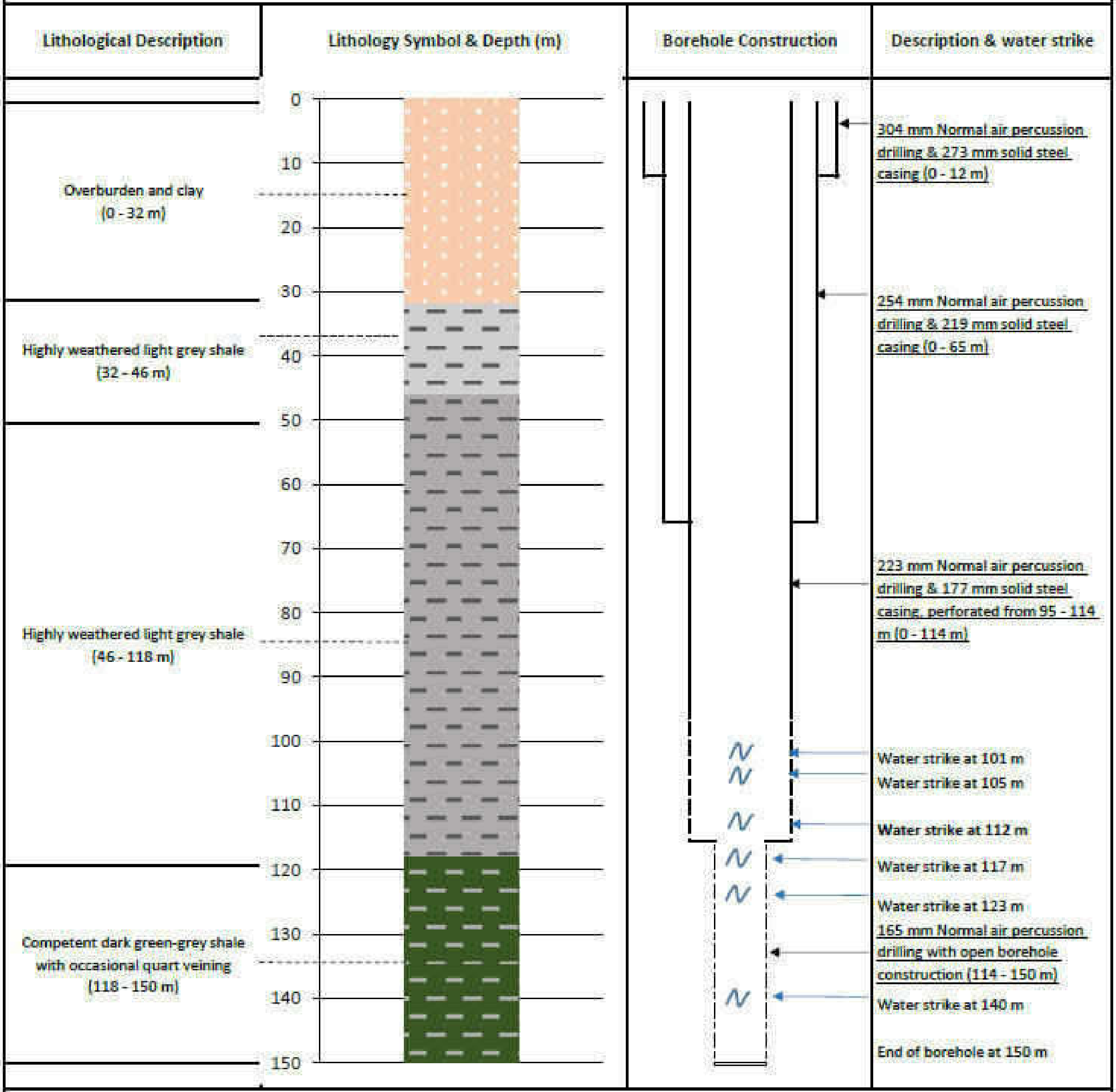
7 Appendix A: Borehole Log

Log of Borehole No.: CWA_BH003

Location:	Cape Winelands Airport	**Latitude:**	-33.774037
Date:	05-Nov-24	**Longitude:**	18.747742
Client:	Capital Expendature Projects	**Ground Elevation:**	126 mamsl



Lithological Description

Overburden and clay (0 - 32 m)

Highly weathered light grey shale (32 - 46 m)

Highly weathered light grey shale (46 - 118 m)

Competent dark green-grey shale with occasional quart veining (118 - 150 m)

Description & water strike

304 mm Normal air percussion drilling & 273 mm solid steel casing (0 - 12 m)

254 mm Normal air percussion drilling & 219 mm solid steel casing (0 - 65 m)

223 mm Normal air percussion drilling & 177 mm solid steel casing, perforated from 95 - 114 m (0 - 114 m)

Water strike at 101 m

Water strike at 105 m

Water strike at 112 m

Water strike at 117 m

Water strike at 123 m

165 mm Normal air percussion drilling with open borehole construction (114 - 150 m)

Water strike at 140 m

End of borehole at 150 m

Drilled By:	Gerritsen Drilling SA	**Remarks:**	Airlift yield = 23 000 L/h
Drill Method:	Air percussion		
Logged By:	GEOSS South Africa		

8 Appendix B: Yield Test Data

Abbreviations	
EC	Electrical conductivity
mbgl	Meters below ground level
mbch	Meters below casing height
mbdl	Meters below datum level
magl	Meters above ground level
L/S	Litres per second
RPM	Rates per minute
S/W/L	Static water level
µS/cm	Microsiemens per centimeter

BOREHOLE TEST RECORD

PR0JECT #	P3032
TEAM MEMBERS	MICHAEL PHILLIP CHINODA JOHANNES TAFARA

CONSULTANT: GEOSS

DISTRICT: FISANTEKRAAL

PROVINCE: WESTERN CAPE

FARM / VILLAGE NAME : CAPE WINELANDS AIRPORT

DATE TESTED: 25/11/2024

BOREHOLE LOCATION & ACCESS INFORMATION:

BOREHOLE COORDINATES

LATITUDE (SOUTH):	33.77404
LONGITUDE (EAST):	18.74773

COMMENTS ON ACCESS IF ANY:

BOREHOLE NO:	**CWA -003**
TRANSMISSIVITY VALUE:	
TYPE INSTALLATION:	**NEW BOREHOLE (MANHOLE)**
BOREHOLE DEPTH: (mbg	**149.9**

MAINTENANCE RECORD:

Labour hours:	
Cost of material:	
Travelling (km):	

REHABILITATION RECORD:

Jetting hours:	
Brushing hours:	
Airlifting hours:	
Sulphamic Acid KG's	
Boresaver KG's	
Soda Ash KG's	

DIGITAL CAMERA LOGGING:

Camera logged once:	
Camera logged twice:	
Camera logged three times:	
Camera work sent to client:	

EQUIPMENT FISHING RECORD

Hours spent:	

OTHER COSTS ON PROJECT:

Courier of samples:	
Km's for delivery:	
Cost of packaging:	

COMMENTS:

We started the first constant discharge test at 6.4l/s, the test stopped after 2280 minutes due to engine failure. We restarted the test at 6.1 l/s and then a top rod stripped. We had to restart the test again at 6.1l/s for 48 hours

RECOMMENDATIONS / CORRECTIVE ACTIONS:

SAMPLE INSTRUCTIONS :

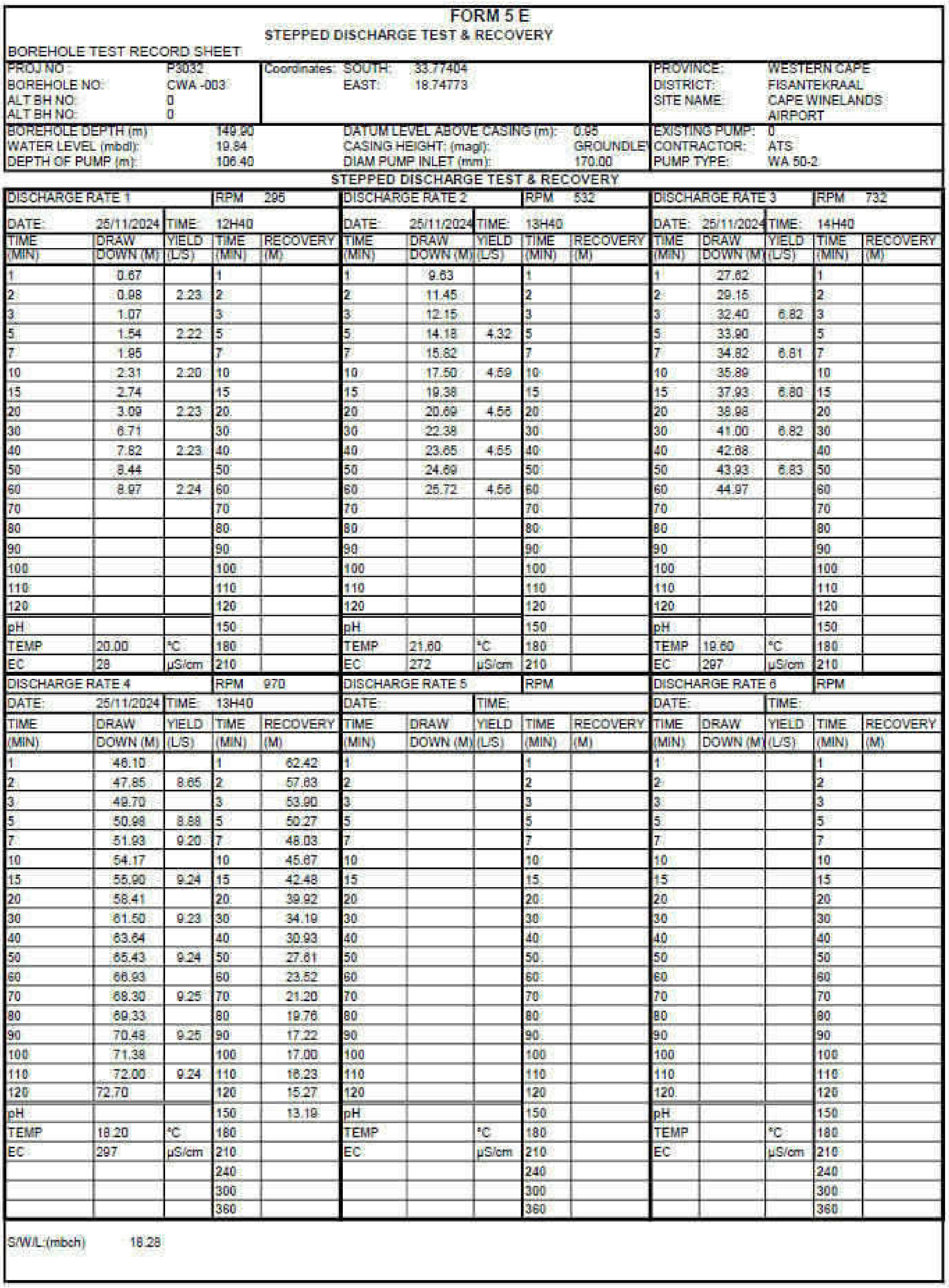
Water sample taken	**Yes**	No	If consultant took sample, give name:		**DATA CAPTURED BY**	EC
Date sample taken	03/12/2024		If sample courier, to where:		**DATA CHECKED BY:**	AH
Time sample taken	07H50					

DESCRIPTION:	**UNIT**	**QTY**		**UNIT**	**QTY**
STRAIGHTNESS TEST:	**NO**	0	BOREHOLE DEPTH AFTER TEST:	**M**	149.90
VERTICALLY TEST:	**NO**	0	BOREHOLE WATER LEVEL AFTER TEST: (mbch)	**M**	25.8
CASING DETECTION:	**NO**	1	SAND/GRAVEL/SILT PUMPED?	**YES/NO**	**0**
SUPPLIED NEW STEEL BOREHOLE COVER:	**NO**	0	DATA REPORTING AND RECORDING	**NO**	1
BOREHOLE MARKING	**NO**	0	SLUG TEST:	**NO**	0
SITE CLEANING & FINISHING	**NO**	1	LAYFLAT (M):	**M**	200
LOGGERS FOR WATERLEVEL MONITORING	**NO**	0	LOGGERS FOR pH AND EC:	**NO**	0

It is hereby acknowledged that upon leaving the site, all existing equipment is in an acceptable condition.

NAME: ______________________ **SIGNATURE:** ______________________

DESIGNATION: ______________________ **DATE:** ______________________



FORM 5 E

STEPPED DISCHARGE TEST & RECOVERY

BOREHOLE TEST RECORD SHEET

PROJ NO :	P3032	Coordinates:	SOUTH:	33.77404		PROVINCE:	WESTERN CAPE
BOREHOLE NO:	CWA -003		EAST:	18.74773		DISTRICT:	FISANTEKRAAL
ALT BH NO:	0					SITE NAME:	CAPE WINELANDS AIRPORT
ALT BH NO:	0						
BOREHOLE DEPTH (m)	149.90		DATUM LEVEL ABOVE CASING (m):		0.95	EXISTING PUMP:	0
WATER LEVEL (mbdl):	19.84		CASING HEIGHT: (magl):		GROUNDLE\	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	106.40		DIAM PUMP INLET (mm):		170.00	PUMP TYPE:	WA 50-2

STEPPED DISCHARGE TEST & RECOVERY

DISCHARGE RATE 1 RPM 295

DATE: 25/11/2024 TIME: 12H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	0.67		1	
2	0.98	2.23	2	
3	1.07		3	
5	1.54	2.22	5	
7	1.95		7	
10	2.31	2.20	10	
15	2.74		15	
20	3.09	2.23	20	
30	6.71		30	
40	7.82	2.23	40	
50	8.44		50	
60	8.97	2.24	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP	20.00	°C	180	
EC	28	µS/cm	210	

DISCHARGE RATE 2 RPM 532

DATE: 25/11/2024 TIME: 13H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	9.63		1	
2	11.45		2	
3	12.15		3	
5	14.18	4.32	5	
7	15.82		7	
10	17.50	4.59	10	
15	19.38		15	
20	20.69	4.56	20	
30	22.38		30	
40	23.65	4.65	40	
50	24.69		50	
60	25.72	4.56	60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP	21.60	°C	180	
EC	272	µS/cm	210	

DISCHARGE RATE 3 RPM 732

DATE: 25/11/2024 TIME: 14H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	27.62		1	
2	29.15		2	
3	32.40	6.82	3	
5	33.90		5	
7	34.82	6.81	7	
10	35.89		10	
15	37.93	6.80	15	
20	38.98		20	
30	41.00	6.82	30	
40	42.68		40	
50	43.93	6.83	50	
60	44.97		60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP	19.60	°C	180	
EC	297	µS/cm	210	

DISCHARGE RATE 4 RPM 970

DATE: 25/11/2024 TIME: 13H40

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1	46.10		1	62.42
2	47.85	8.65	2	57.63
3	49.70		3	53.90
5	50.98	8.88	5	50.27
7	51.93	9.20	7	48.03
10	54.17		10	45.67
15	55.90	9.24	15	42.48
20	58.41		20	39.92
30	61.50	9.23	30	34.19
40	63.64		40	30.93
50	65.43	9.24	50	27.61
60	66.93		60	23.52
70	68.30	9.25	70	21.20
80	69.33		80	19.76
90	70.48	9.25	90	17.22
100	71.38		100	17.00
110	72.00	9.24	110	16.23
120	72.70		120	15.27
pH			150	13.19
TEMP	18.20	°C	180	
EC	297	µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 5 RPM

DATE: TIME:

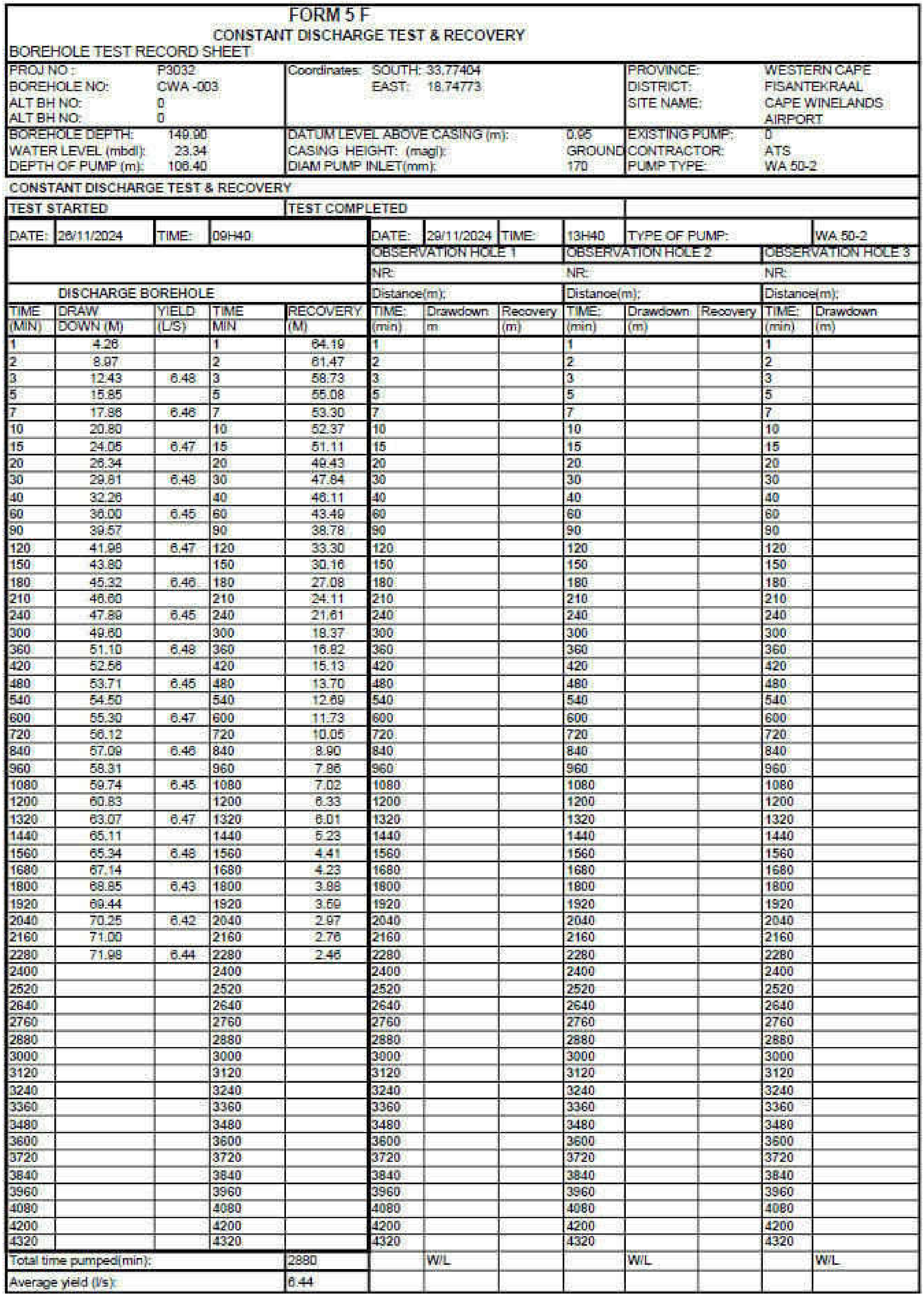
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		°C	180	
EC		µS/cm	210	
			240	
			300	
			360	

DISCHARGE RATE 6 RPM

DATE: TIME:

TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME (MIN)	RECOVERY (M)
1			1	
2			2	
3			3	
5			5	
7			7	
10			10	
15			15	
20			20	
30			30	
40			40	
50			50	
60			60	
70			70	
80			80	
90			90	
100			100	
110			110	
120			120	
pH			150	
TEMP		°C	180	
EC		µS/cm	210	
			240	
			300	
			360	

S/W/L:(mbch) 18.28



FORM 5 F

CONSTANT DISCHARGE TEST & RECOVERY

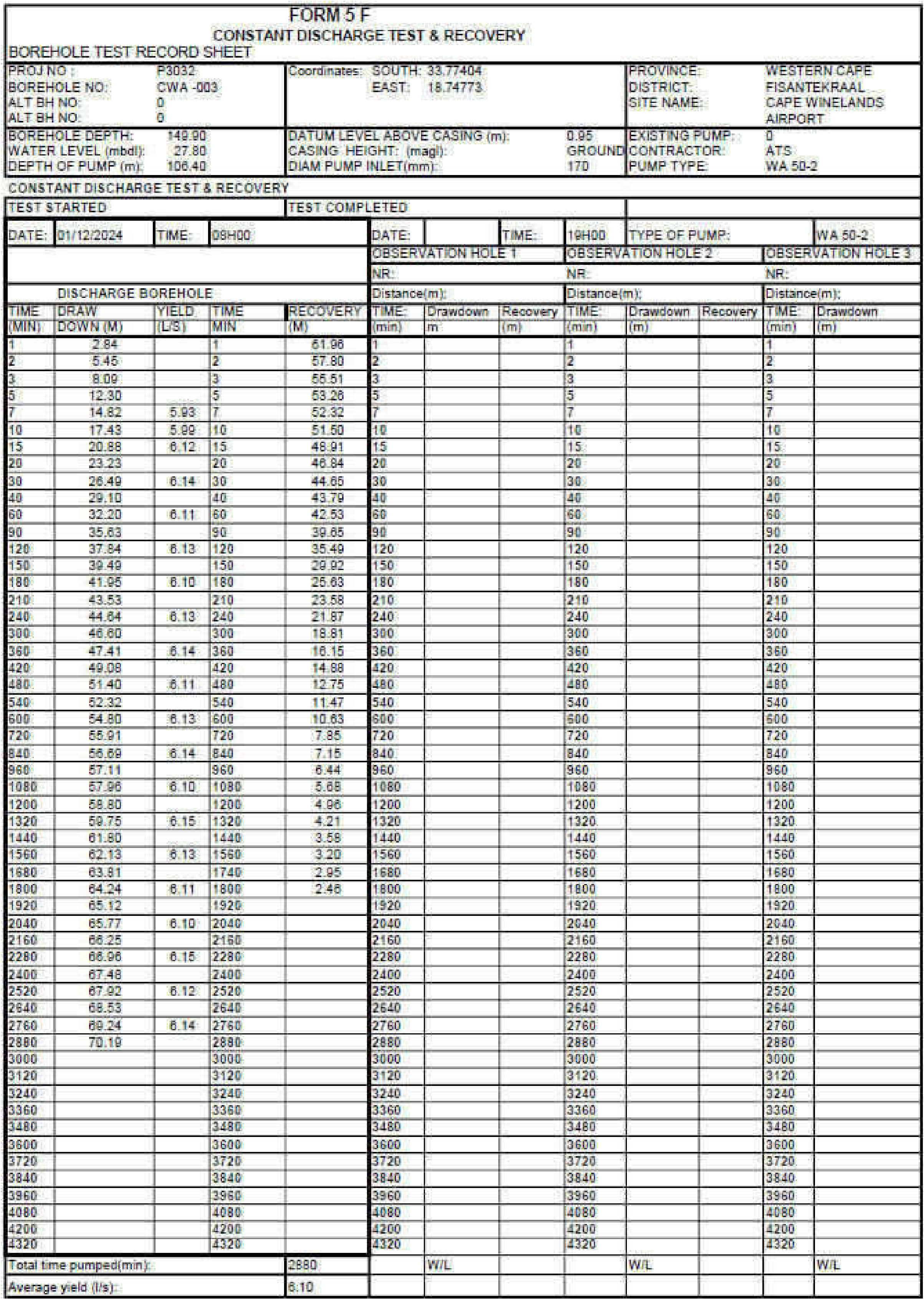
BOREHOLE TEST RECORD SHEET

PROJ NO :	P3032	Coordinates:	SOUTH: 33.77404	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	CWA -003		EAST: 18.74773	DISTRICT:	FISANTEKRAAL
ALT BH NO:	0			SITE NAME:	CAPE WINELANDS AIRPORT
ALT BH NO:	0				
BOREHOLE DEPTH:	149.90	DATUM LEVEL ABOVE CASING (m):	0.95	EXISTING PUMP:	0
WATER LEVEL (mbdl):	23.34	CASING HEIGHT: (magl):	GROUND	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	106.40	DIAM PUMP INLET(mm):	170	PUMP TYPE:	WA 50-2

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				**TEST COMPLETED**					
DATE:	26/11/2024	TIME:	09H40	DATE:	29/11/2024	TIME:	13H40	TYPE OF PUMP:	WA 50-2

DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
					Distance(m):			Distance(m):			Distance(m):	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	4.26		1	64.19	1			1			1	
2	8.97		2	61.47	2			2			2	
3	12.43	6.48	3	58.73	3			3			3	
5	15.85		5	55.08	5			5			5	
7	17.88	6.46	7	53.30	7			7			7	
10	20.80		10	52.37	10			10			10	
15	24.05	6.47	15	51.11	15			15			15	
20	26.34		20	49.43	20			20			20	
30	29.81	6.48	30	47.84	30			30			30	
40	32.26		40	46.11	40			40			40	
60	36.00	6.45	60	43.49	60			60			60	
90	39.57		90	38.78	90			90			90	
120	41.98	6.47	120	33.30	120			120			120	
150	43.80		150	30.16	150			150			150	
180	45.32	6.46	180	27.08	180			180			180	
210	46.60		210	24.11	210			210			210	
240	47.89	6.45	240	21.61	240			240			240	
300	49.60		300	18.37	300			300			300	
360	51.10	6.48	360	16.82	360			360			360	
420	52.56		420	15.13	420			420			420	
480	53.71	6.45	480	13.70	480			480			480	
540	54.50		540	12.69	540			540			540	
600	55.30	6.47	600	11.73	600			600			600	
720	56.12		720	10.05	720			720			720	
840	57.09	6.46	840	8.90	840			840			840	
960	58.31		960	7.86	960			960			960	
1080	59.74	6.45	1080	7.02	1080			1080			1080	
1200	60.83		1200	6.33	1200			1200			1200	
1320	63.07	6.47	1320	6.01	1320			1320			1320	
1440	65.11		1440	5.23	1440			1440			1440	
1560	65.34	6.48	1560	4.41	1560			1560			1560	
1680	67.14		1680	4.23	1680			1680			1680	
1800	68.85	6.43	1800	3.88	1800			1800			1800	
1920	69.44		1920	3.59	1920			1920			1920	
2040	70.25	6.42	2040	2.97	2040			2040			2040	
2160	71.00		2160	2.76	2160			2160			2160	
2280	71.98	6.44	2280	2.46	2280			2280			2280	
2400			2400		2400			2400			2400	
2520			2520		2520			2520			2520	
2640			2640		2640			2640			2640	
2760			2760		2760			2760			2760	
2880			2880		2880			2880			2880	
3000			3000		3000			3000			3000	
3120			3120		3120			3120			3120	
3240			3240		3240			3240			3240	
3360			3360		3360			3360			3360	
3480			3480		3480			3480			3480	
3600			3600		3600			3600			3600	
3720			3720		3720			3720			3720	
3840			3840		3840			3840			3840	
3960			3960		3960			3960			3960	
4080			4080		4080			4080			4080	
4200			4200		4200			4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				2880		W/L			W/L			W/L
Average yield (l/s):				6.44								



FORM 5 F
CONSTANT DISCHARGE TEST & RECOVERY
BOREHOLE TEST RECORD SHEET

PROJ NO :	P3032	Coordinates: SOUTH:	33.77404	PROVINCE:	WESTERN CAPE
BOREHOLE NO:	CWA -003	EAST:	18.74773	DISTRICT:	FISANTEKRAAL
ALT BH NO:	0			SITE NAME:	CAPE WINELANDS AIRPORT
ALT BH NO:	0				
BOREHOLE DEPTH:	149.90	DATUM LEVEL ABOVE CASING (m):	0.95	EXISTING PUMP:	0
WATER LEVEL (mbdl):	27.80	CASING HEIGHT: (magl):	GROUND	CONTRACTOR:	ATS
DEPTH OF PUMP (m):	106.40	DIAM PUMP INLET(mm):	170	PUMP TYPE:	WA 50-2

CONSTANT DISCHARGE TEST & RECOVERY

TEST STARTED				TEST COMPLETED					
DATE:	01/12/2024	TIME:	08H00	DATE:		TIME:	19H00	TYPE OF PUMP:	WA 50-2

DISCHARGE BOREHOLE					OBSERVATION HOLE 1			OBSERVATION HOLE 2			OBSERVATION HOLE 3	
					NR:			NR:			NR:	
					Distance(m):			Distance(m):			Distance(m):	
TIME (MIN)	DRAW DOWN (M)	YIELD (L/S)	TIME MIN	RECOVERY (M)	TIME: (min)	Drawdown m	Recovery (m)	TIME: (min)	Drawdown (m)	Recovery	TIME: (min)	Drawdown (m)
1	2.84		1	61.96	1			1			1	
2	5.45		2	57.80	2			2			2	
3	8.09		3	55.51	3			3			3	
5	12.30		5	53.26	5			5			5	
7	14.82	5.93	7	52.32	7			7			7	
10	17.43	5.99	10	51.50	10			10			10	
15	20.88	6.12	15	48.91	15			15			15	
20	23.23		20	46.84	20			20			20	
30	26.49	6.14	30	44.65	30			30			30	
40	29.10		40	43.79	40			40			40	
60	32.20	6.11	60	42.53	60			60			60	
90	35.63		90	39.65	90			90			90	
120	37.84	6.13	120	35.49	120			120			120	
150	39.49		150	29.92	150			150			150	
180	41.95	6.10	180	25.63	180			180			180	
210	43.53		210	23.58	210			210			210	
240	44.64	6.13	240	21.87	240			240			240	
300	46.60		300	18.81	300			300			300	
360	47.41	6.14	360	16.15	360			360			360	
420	49.08		420	14.88	420			420			420	
480	51.40	6.11	480	12.75	480			480			480	
540	52.32		540	11.47	540			540			540	
600	54.80	6.13	600	10.63	600			600			600	
720	55.91		720	7.85	720			720			720	
840	56.69	6.14	840	7.15	840			840			840	
960	57.11		960	6.44	960			960			960	
1080	57.96	6.10	1080	5.68	1080			1080			1080	
1200	58.80		1200	4.96	1200			1200			1200	
1320	59.75	6.15	1320	4.21	1320			1320			1320	
1440	61.80		1440	3.58	1440			1440			1440	
1560	62.13	6.13	1560	3.20	1560			1560			1560	
1680	63.81		1740	2.95	1680			1680			1680	
1800	64.24	6.11	1800	2.46	1800			1800			1800	
1920	65.12		1920		1920			1920			1920	
2040	65.77	6.10	2040		2040			2040			2040	
2160	66.25		2160		2160			2160			2160	
2280	66.96	6.15	2280		2280			2280			2280	
2400	67.48		2400		2400			2400			2400	
2520	67.92	6.12	2520		2520			2520			2520	
2640	68.53		2640		2640			2640			2640	
2760	69.24	6.14	2760		2760			2760			2760	
2880	70.19		2880		2880			2880			2880	
3000			3000		3000			3000			3000	
3120			3120		3120			3120			3120	
3240			3240		3240			3240			3240	
3360			3360		3360			3360			3360	
3480			3480		3480			3480			3480	
3600			3600		3600			3600			3600	
3720			3720		3720			3720			3720	
3840			3840		3840			3840			3840	
3960			3960		3960			3960			3960	
4080			4080		4080			4080			4080	
4200			4200		4200			4200			4200	
4320			4320		4320			4320			4320	
Total time pumped(min):				2880		W/L			W/L			W/L
Average yield (l/s):				6:10								

9 Appendix C: Water Quality

vinlab H₂O
Your partner in quality water analysis

Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2024-12-10

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

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

@VinlabSA

Sample Details

SampleID	W58385				
Water Type	Drinking Water				
Water Source	Borehole				
Sample Temperature					
Description	CWA_BH03				
Batch Number	CWA_BH03				
PO Number	4505_P1				
Date Received	2024-12-05				
Condition	Good				

Water - Routine

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
pH@25C (Water)		VIN-05-MW01	^^^	>= 5 to <= 9.7	7.16				
Conductivity@25C (Water)	mS/m	VIN-05-MW02	^	<= 170	80.6				
Turbidity (Water)*	ntu			<= 5	64.1				
Total dissolved solids (Water)*	mg/L			<= 1200	546.47				
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	294.37				
Sulphates (SO4) - Water	mg/L	VIN-05-MW08	7.56%	<= 500	17.39				
Fluoride (F) - Water	mg/L	VIN-05-MW08	12.30%	<= 1.5	<0.15				
Alkalinity as CaCO3 (Water)*	mg/L				72.00				
Colour (Water)*	mg/L Pt-Co			<= 15	<15				
Total Organic Carbon (Water)*	mg/L			<=10	2.19				
Date Tested					2024-12-05				

Water - Metals

	Unit	Method	Uncertainty	Limit	Results	Results	Results	Results	Results
Calcium (Ca) - Water	mg/L	VIN-05-MW43	14.60%		20				
Magnesium (Mg) - Water	mg/L	VIN-05-MW43	8.49%		19				
Sodium (Na) - Water	mg/L	VIN-05-MW43	11.45%	<= 200	149				
Potassium (K) - Water	mg/L	VIN-05-MW43	9.42%		3				

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.

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^ - 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

Doc No
V58118

VIN 09-01 07-05-2024

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Your partner in quality water analysis

Distillery Road
Stellenbosch
Tel 021-8828866/7
info@vinlab.com
www.vinlab.com
2024-12-10

TEST REPORT

Water

Geoss South Africa (Pty) Ltd

Attn: Alison McDuling

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

@VinlabSA

Zinc (Zn) - Water	mg/L	VIN-05-MW43	19.40%	<= 5	<0.008				
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	42				
Cadmium (Cd) Water	µg/L	VIN-05-MW43	12.26%	<= 3	1				
Chromium (Cr) - Water	µg/L	VIN-05-MW43	13.03%	<= 50	<4				
Copper (Cu) - Water	µg/L	VIN-05-MW43	11.57%	<= 2000	<2				
Iron (Fe) - Water	µg/L	VIN-05-MW43	12.49%	<= 2000	3944				
Lead (Pb) - Water	µg/L	VIN-05-MW43	16.32%	<= 10	<8				
Manganese (Mn) - Water	µg/L	VIN-05-MW43	12.44%	<= 400	466				
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	<8				
Cyanide (CN) - Water*	µg/L			<= 200	10.0				
Mercury (Hg) - Water*	µg/L			<= 6	<1.0				
Barium (Ba) Water	µg/L	VIN-05-MW43	14.09%	<= 700	275				
Uranium (U) - Water*	µg/L			<= 30	<28				
Date Tested					2024-12-05				

Comments

W58385
Ion balance = 4.0%

AEFourie

Adelize Fourie
Laboratory Manager (Waterlab)
VIN-05-
M01,M02,M03,M04,M05,M08,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

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^^ - COD, LR = ±16mg/L, MR = ±48mg/L, HR = ±477mg/L
^^^ - pH ± 0.1

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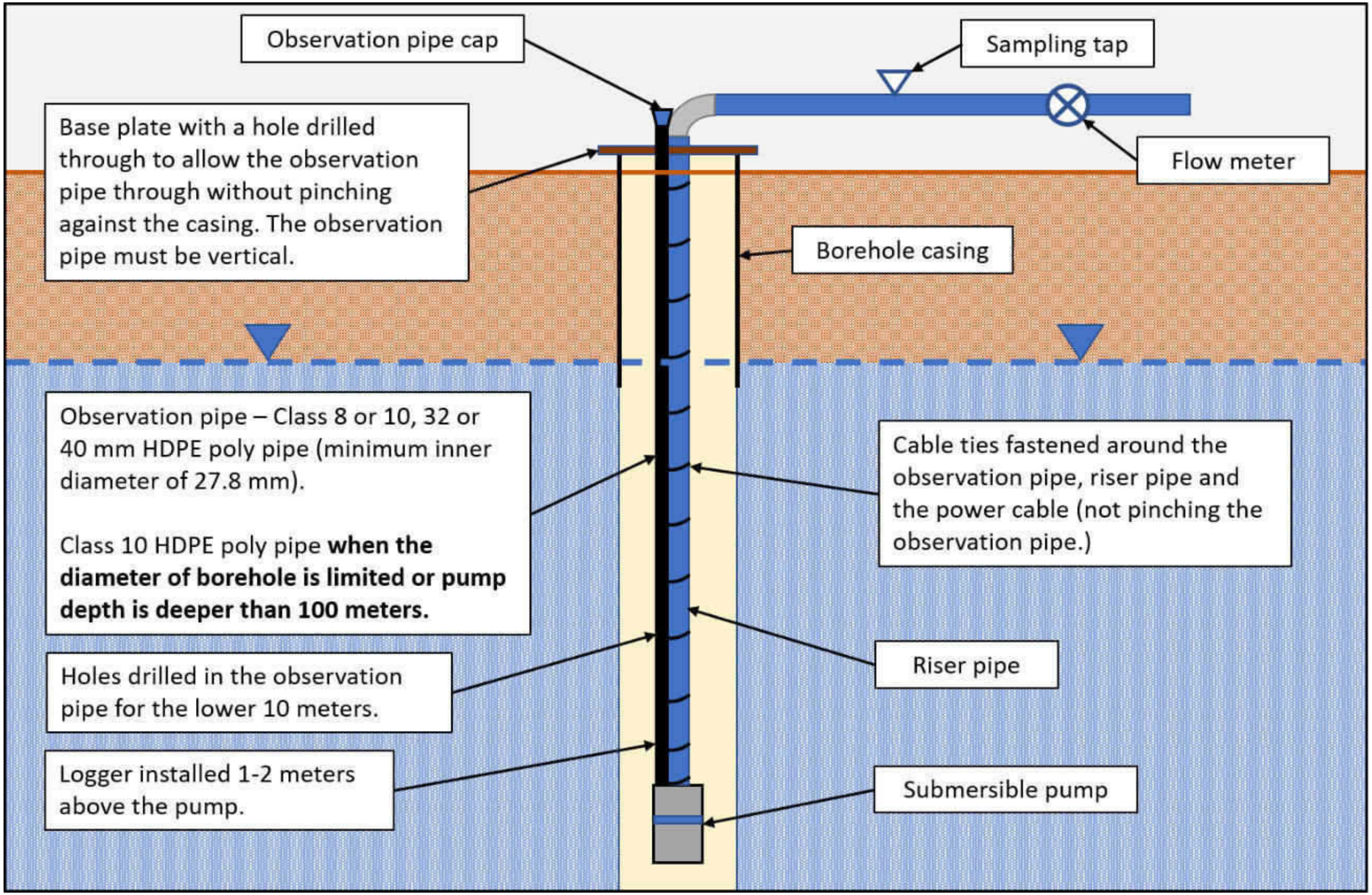
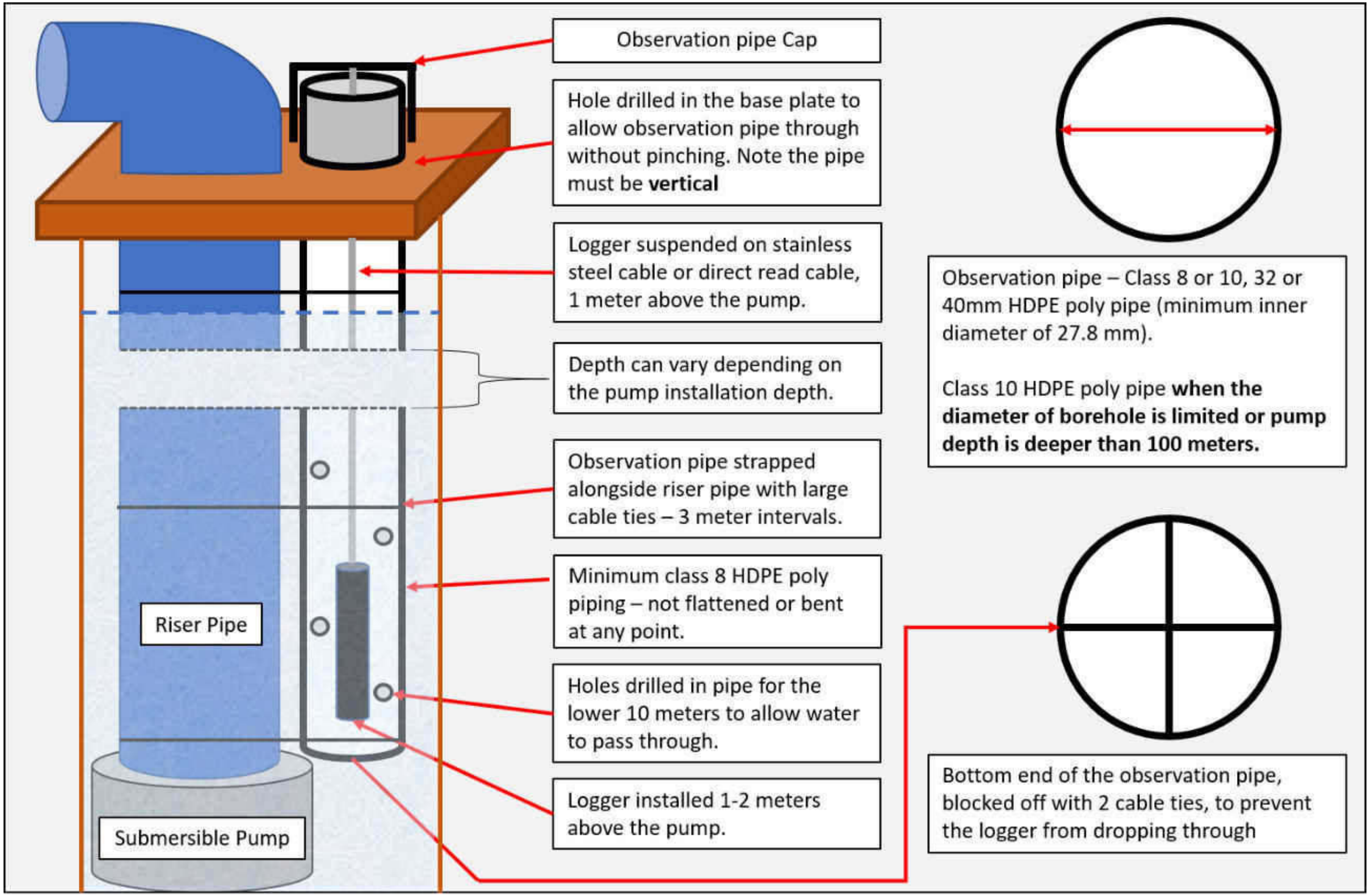
10 Appendix D: Monitoring Infrastructure Diagram


Observation pipe cap
Sampling tap
Base plate with a hole drilled through to allow the observation pipe through without pinching against the casing. The observation pipe must be vertical.
Flow meter
Borehole casing
Observation pipe – Class 8 or 10, 32 or 40 mm HDPE poly pipe (minimum inner diameter of 27.8 mm).
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**
Cable ties fastened around the observation pipe, riser pipe and the power cable (not pinching the observation pipe.)
Holes drilled in the observation pipe for the lower 10 meters.
Riser pipe
Logger installed 1-2 meters above the pump.
Submersible pump



Observation pipe Cap

Hole drilled in the base plate to allow observation pipe through without pinching. Note the pipe must be **vertical**

Logger suspended on stainless steel cable or direct read cable, 1 meter above the pump.

Depth can vary depending on the pump installation depth.

Observation pipe strapped alongside riser pipe with large cable ties – 3 meter intervals.

Minimum class 8 HDPE poly piping – not flattened or bent at any point.

Holes drilled in pipe for the lower 10 meters to allow water to pass through.

Logger installed 1-2 meters above the pump.

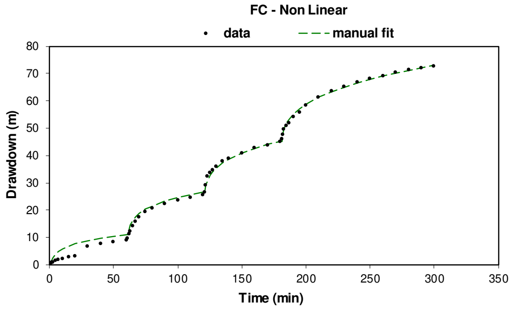
Observation pipe – Class 8 or 10, 32 or 40mm HDPE poly pipe (minimum inner diameter of 27.8 mm).

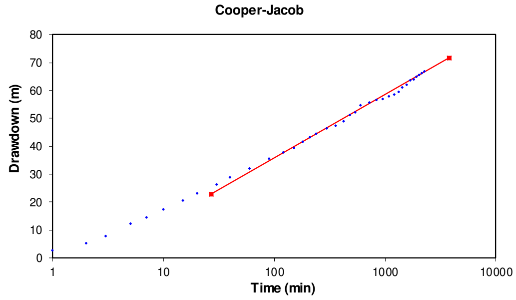
Class 10 HDPE poly pipe **when the diameter of borehole is limited or pump depth is deeper than 100 meters.**

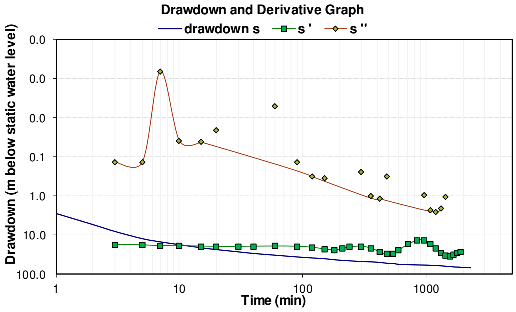
Bottom end of the observation pipe, blocked off with 2 cable ties, to prevent the logger from dropping through

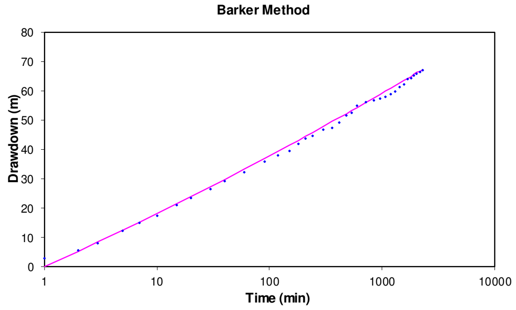
11 Appendix E: Yield Test Data Analysis

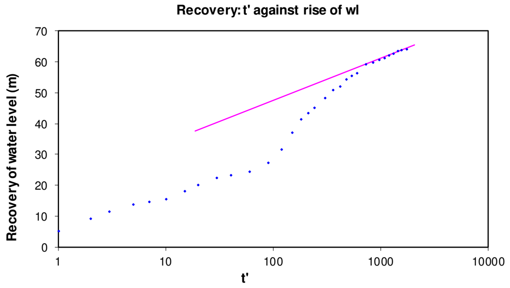
CWA_BH003


FC - Non Linear


Cooper-Jacob

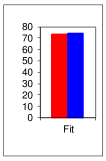

Drawdown and Derivative Graph


Barker Method


Recovery: t' against rise of wl

FC - Non Linear Method to estimate Q_Sust

skin effect	Non-Darcian loss		Darcian loss		
A	**C**	**p**	**B**	**n**	**e**
2.47E-03	0.00E+00	2.03E+00	1.40E-02	1.56E+00	1.13E+00



Extrapolation	
Ext_pol time (min)	
1051200	
Q (L/s)	Drawdown (m)
3.4	73.31

Available drawdown (m) =	74		
No boundaries	1 no-flow	2 no-flow	Closed
3.4	1.7	1.1	0.6
Q_Sust (L/s)=	1.39	std.dev = 1.22	

Boundaries selected	0 -closed

Cooper-Jacob method

$T(m^2/d)$ =	4.3	r_e (m)=	0.1
S =	1.78E+00	Q (l/s) =	6.13

	No boundaries	1 no-flow	2 no-flow	Closed
Q_sust	3.56	1.78	1.18	0.89
Avg. Q_sust =		1.85	std. dev =	1.20

Boundaries selected	0 -closed

FC method

Extrapolation time in years	2	1051200	Extrapol.time in minutes	
Effective borehole radius (r_e)	43.4680469	43.46804688	Est. r_e	From r(e) sheet
Q (l/s) from pumping test	6.13	5.67579E-05	S-late	Change r_e
s_a (available drawdown), sigma_s	**74**	0	Sigma_s from risk	
Annual effective recharge (mm)	0	74	s_available w orking draw dow n(m)	
t(end) and s(end) of pumping test	2280	66.96	End time and draw dow n of test	
Average maximum derivative	**25.84**	33.45366835	Estimate of average of max deriv	
Average second derivative	**1.04**	0.039859876	Estimate of average second deriv	
Derivative at radial flow period	18.4510323	18.45103228	Read from derivative graph	
T-early[m^2/d]		5.252966584	Aqui. thick (m)	60
T and S estimates	**T-late [m^2/d]**	**3.75087678**	Est. S-late	0.0033
	S-late	0.0033		

BASIC SOLUTION

	No boundaries	1 no-flow	2 no-flow	Closed no-flow
sWell (Extrapol.time) =	139.48	208.31	277.14	483.64
Q_sust (l/s) =	3.25	2.18	1.64	0.94
Average Q_sust (l/s) =	**1.82**			
w ith standard deviation=	0.98			

Boundaries selected	0 -closed

Barker method

	K_f [m/d]	S_f [1/m]	b	n	N
Fit Parameters	0.20	1.21E-03	22.66	1.93	0.0350

	No boundaries	1 no-flow	2 no-flow	Closed
sWell(Extrapol.time)	135.21	272.87	341.70	410.54
Q_sust	3.35	1.66	1.33	1.10

Fractal n = 1.93	**Average Q-sust (l/s)=**	1.69	std. dev =	1.02
	Boundaries selected	0 -closed		

Recovery

T [m2/d]	7.13
CDT Duration	2280
Recovery Duration	1740
Max % Recovery	95.6

(LAST PAGE)