Groundwater Complete

MISGUNST AAN DE GOURITZ RIVIER PLOT 19: PHASE 1 REPORT ON GROUNDWATER FEASIBILITY

APRIL 2020

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ABBREVIATION		MEANING
mbs	-	**Meters below surface**
mamsl	-	**Meters above mean sea level**
m^2/s	-	**Meter squared per second**
m^2/d	-	**Meter squared per day**
m^3/d	-	**Cubic meters per day**
l/s	-	**Litres per second**
km	-	**Kilometre**
ha	-	**Hectare**
DWS	-	**Department of water & sanitation**
I&APs	-	**Interested & affected persons**
MAP	-	**Mean annual precipitation**
WULA	-	**Water Use License Application**
mm/a	-	**Millimetres per year**
GQM	-	**Groundwater Quality Management**

MISGUNST AAN DE GOURITZ RIVIER PLOT 19: PHASE 1 REPORT ON GROUNDWATER FEASIBILITY: APRIL 2020

EXECUTIVE SUMMARY:

This Phase 1 report describes the properties of groundwater in general and a borehole specifically on Portion 19/257 Farm Misgunst aan de Gouritz Rivier. A basic EIA assessment Is underway on the property for development of a dwelling in a regulated zone. The borehole will be a supplementary water source for domestic use. The geohydrological environment can be summarised as follows:

- The Misgunst area is underlain by Cape Supergroup sedimentary and quaternary geological groups.
- No geophysics was used in the drilling of the borehole.
- The borehole is drilled into the transitional zone between a primary and secondary aquifer.
- A blow yield of 3600 litres per hour was reported after drilling was completed down to 70 mbs.
- The estimated effective recharge is in excess of 30% of the MAP.
- The static groundwater level depth for the borehole is about 42 mbs.
- A 24-hour pump and recovery test was conducted on the borehole.
- A sustainable yield was calculated from the pumping test to be 1460 litres per hour, or 35 m^3 per day.
- The borehole will be operated through a solar pump at 1250 litres per hour for 8 hours a day (10 m^3/day). The household only plans to use a maximum of 10m^3 per day.
- The groundwater is dominated by calcium and sodium anions and chloride and nitrate cations and the water is unsuitable for potable purposes due to the high salinity. The high salinity of the groundwater is attributed mainly to leachate of sea spray on the dunes to the water table.
- The project area achieved a vulnerability score of 4 and the underlying aquifer can therefore be regarded as having a LOW vulnerability.
- The GQM for the Misgunst aquifer calculates to 2, which indicates a low level of protection.
- The impact of the borehole extraction on the environment is expected to be minimal, due to the high effective recharge, the distance from neighbouring users and low extraction rate from the borehole.

1 INTRODUCTION AND BACKGROUND

Groundwater Complete compiled this geohydrological study report for the property Portion 19/257 Farm Misgunst aan de Gouritz Rivier (herein after referred to only as Misgunst). The technical report is required as input to the “Application for Environmental Authorisation” process as one of the technical studies to the Environmental Impact Assessment process.

One part of the application is to describe the groundwater environment and more specifically confirm the potential of groundwater to supply the project with water for the intended use(s). The reason is that the property is not connected to municipal services and must supply its own water requirements. In this regard, a borehole has already been drilled in November 2019. The main purpose of this report will thus be to:

- Characterise the geology, geohydrology and related aspects such as climate and rainfall around the site;
- Provide details of the borehole, its sustainable yield and water quality;
- Discuss the groundwater characteristics of the catchment and the potential impact of the proposed abstraction on the regional and local groundwater environment; and
- Comment on the suitability of the borehole for the intended use.

The borehole is located on Portion 19/257 of Farm Misgunst aan de Gouritz Rivier, which is situated approximately 1 kilometer south of the town of Vleesbaai in the Western Cape Province. A map showing the location of the plot and the borehole is provided in **Figure 1**.

2 GEOGRAPHICAL SETTING

2.1 SURFACE TOPOGRAPHY AND WATER COURSES

The study area is situated in the fynbos biome region of Western Cape, South Africa. The project is located at the coast and the southern edge of the property area is located some 220m from the highwater mark at elevation of 34 meters above mean sea level (mamsl). The highest surface elevations in and around the property outline include dunes to the north at around 90 mamsl. The borehole is located at approximately 71 mamsl. A contour map of the property is presented in Figure 2. The contours were generated from a drone survey conducted in July 2019 to less than 10 centimetres accuracy on elevation.

Due to the porous nature of the dunes, water does not flow overland. The water seeps into the dune sand at high rates and does not create runoff or drainage lines. As a result, no water courses are present.

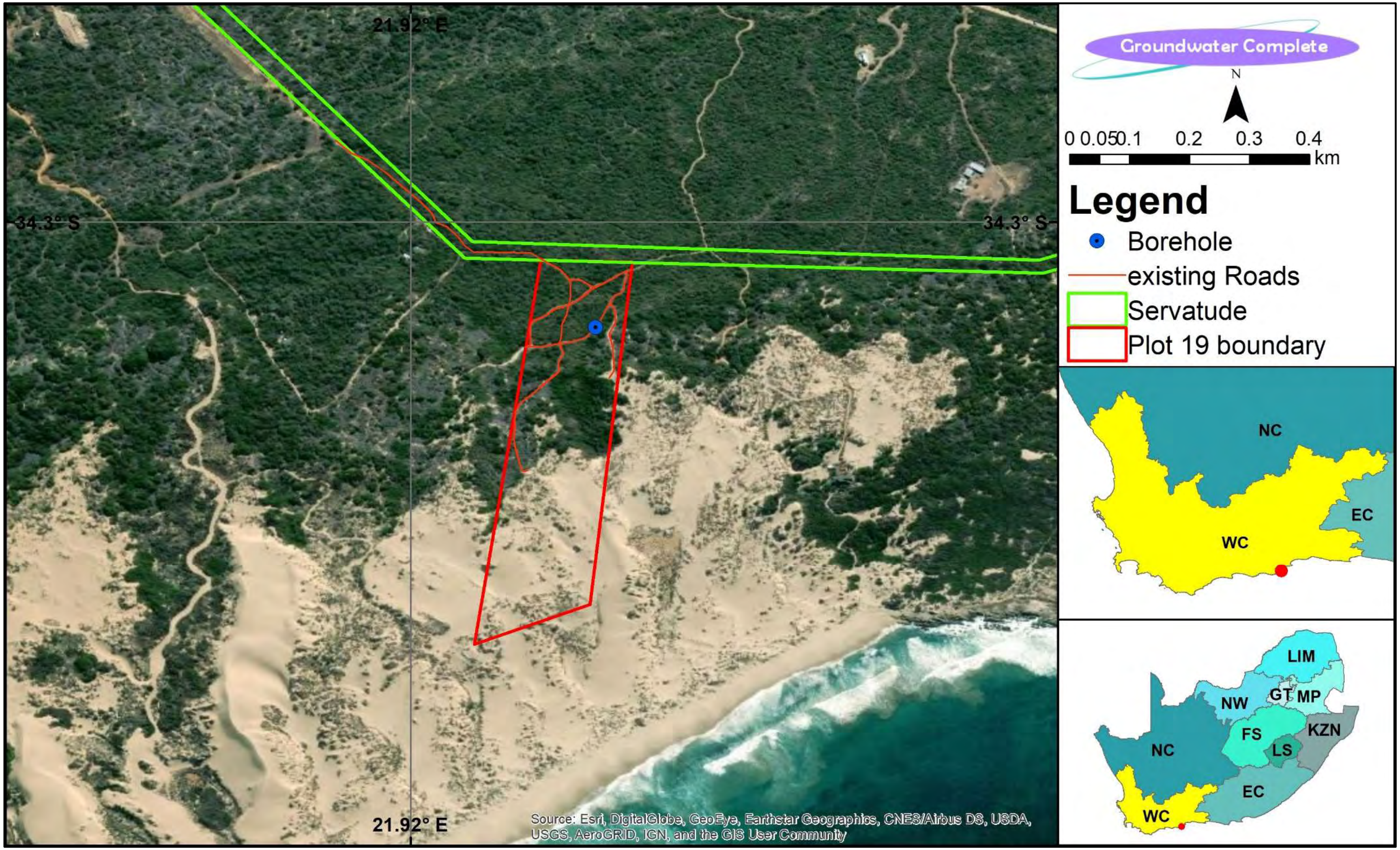


Figure 1: Locality map showing the project locality

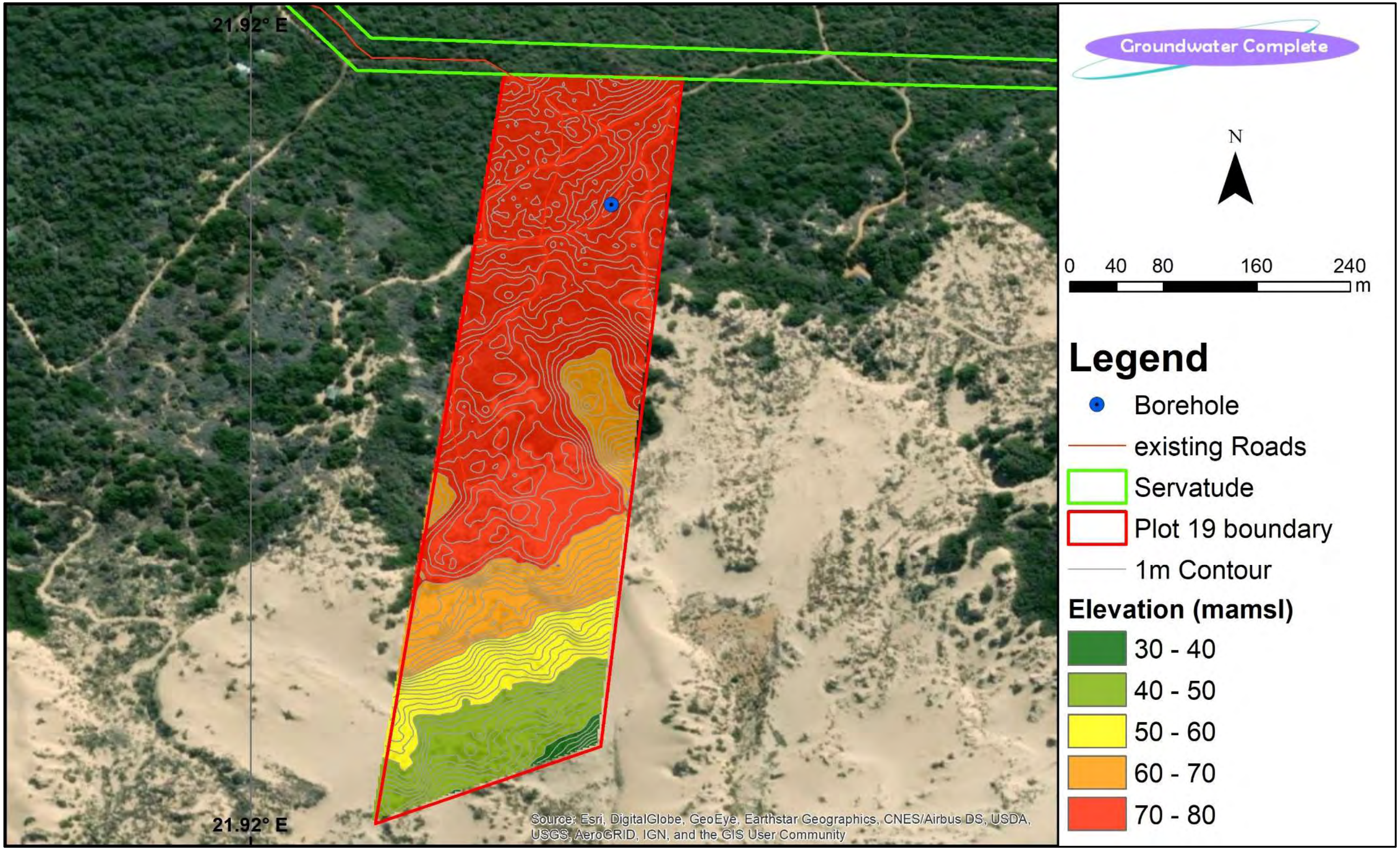


Figure 2: Surface elevations within the Misgunst boundary

2.2 CLIMATIC CONDITIONS

The project area is located within a region that receives rain throughout the year with a slight domination in winter months winter months of April to October **(Figure 3)**. The DWS site with rainfall station data was down at the time of compiling this report. The average monthly rainfall was obtained from internet sources (Figure 3) with an annual average of 470 mm.

Average daily temperatures vary from approximately 24 ^{0}C in the summer to ± 21 ^{0}C in the winter. Average nocturnal temperatures vary from approximately 15 ^{0}C in the summer to ± 10 ^{0}C in the winter **(Figure 4)**

Evapotranspiration is moderate (between 1 400 and 1 600 mm/a), but still results in an environmental moisture deficit throughout the year **(Figure 5)**.

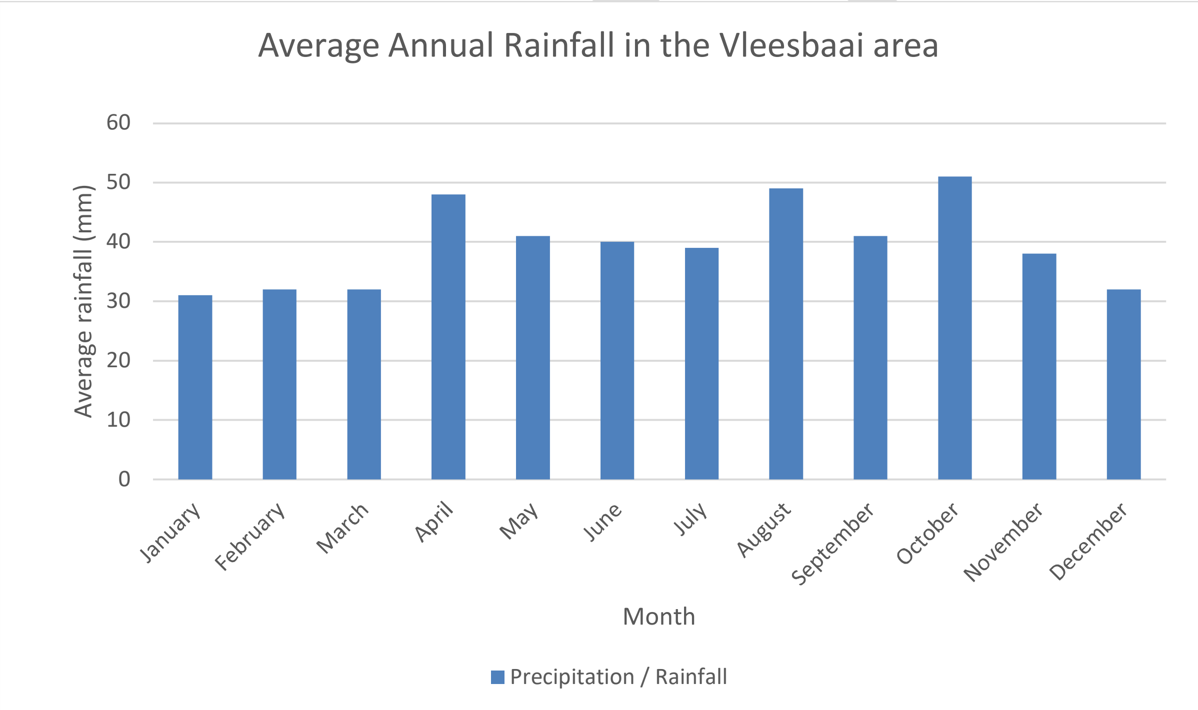


Figure 3: Average Monthly Rainfall for the Vleesbaai area (DWA, 2015)

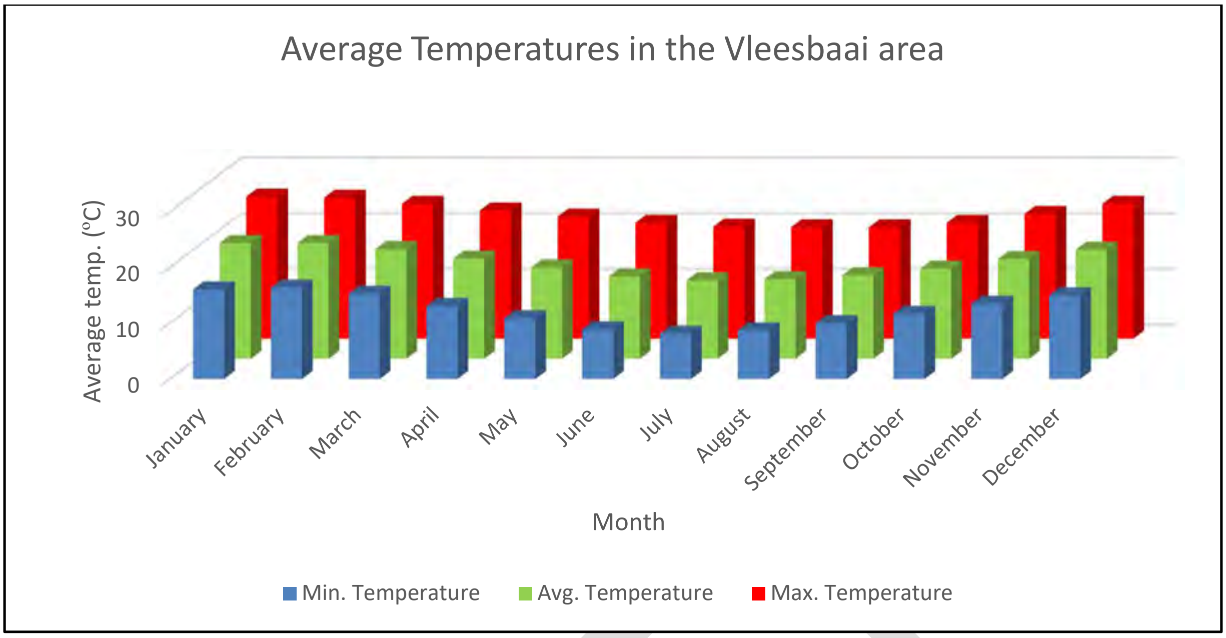


Figure 4: Average monthly temperatures for the Vleesbaai area *(en.climate-data.org, 2019)*

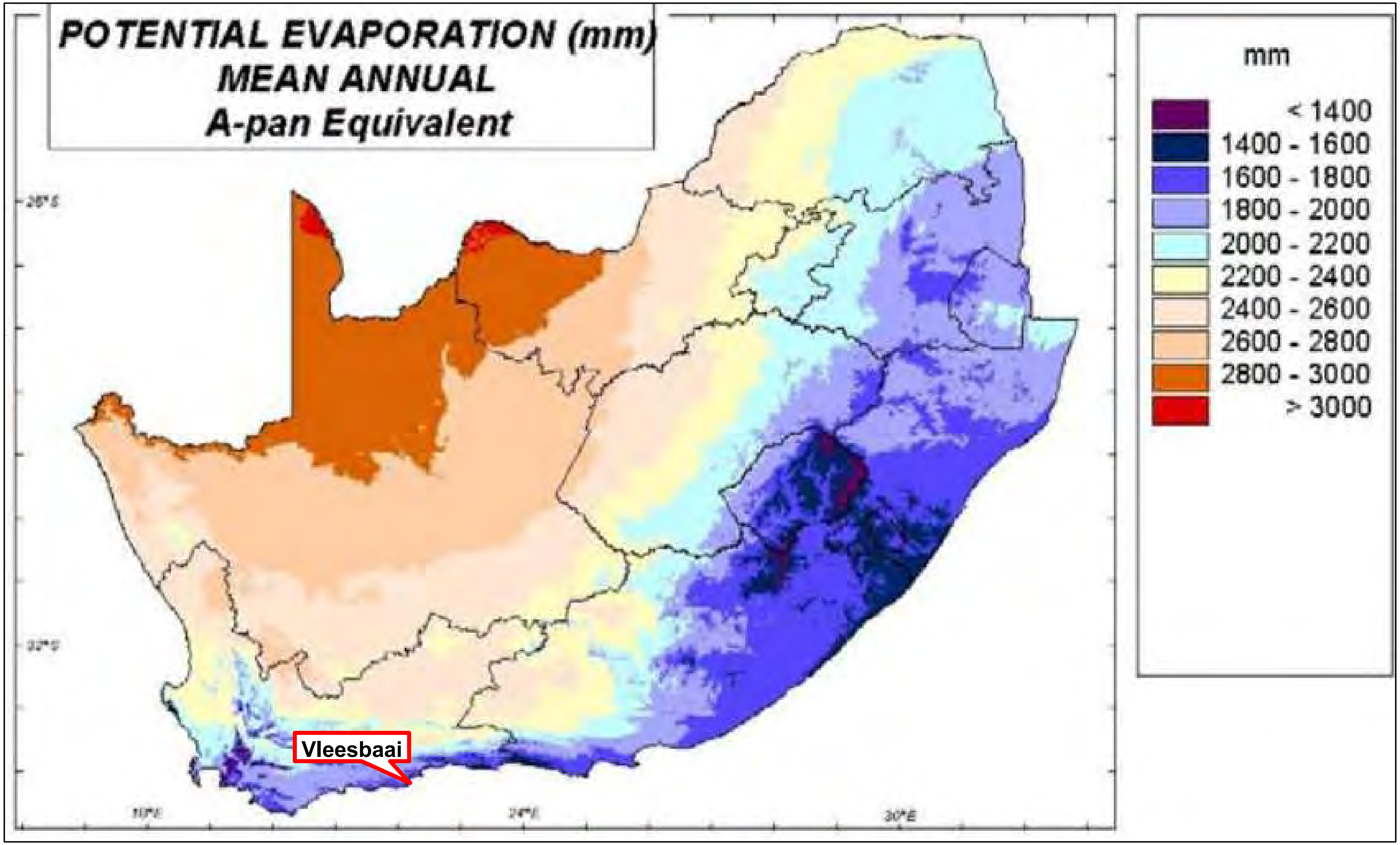


Figure 5: Mean Annual Evaporation for the Project area *(Lynch, 2004)*

3 METHODOLOGY

3.1 DESK STUDY

No previous groundwater studies could be located for and no boreholes are known to occur in the immediate vicinity of Misgunst. It is known that water supply boreholes were used for Vleesbaai and results viewed of groundwater exploration in the Springerbaai-Vleesbaai area, but no information was available for the larger context of the project.

Existing 1:250 000 geological and 1:500 000 hydrogeological maps were used during the assessment **(Figure 7)**.

3.2 SITING AND DRILLING OF BOREHOLES

Only one borehole was drilled on the Misgunst farm. No geophysics was done to assist in the siting of the borehole since it was expected that the thick sand cover would negate the efficiency of most of the applicable geophysical methods such resistivity and electro-magnetic.

A desktop assessment of the underlying geology was done preceding the drilling. The study revealed a relatively homogeneous geology over the plot area.

The borehole was drilled on the position where:

- It as closest to the supply point to the proposed development without a high risk of the drill rig of getting stuck in the sand; and
- Where no bush clearing was required to result in undue damage to the vegetation.

3.3 AQUIFER TESTING

The borehole was tested with a mobile submersible pump. The pump test was conducted for 24 hours after which recovery was measured for 24 hours. A manual dip meter was used in conjunction with an automatic data logger to measure the water levels. FC program and AQTESOLV was used to analyse the data collected during the aquifer test. The aquifer test and results will be discussed in detail **Section 4.3**.

3.4 GROUNDWATER RECHARGE CALCULATIONS

According to **Figure 6** the mean annual recharge to the aquifer underlying the project area should be in the order of 40 mm, which based on an average rainfall of approximately 470mm/a **(Figure 3)** translates to a recharge percentage of ± 8.5%. Recharge to the sandy dune aquifer underlying the project area, according to most recharge maps, represents some off the highest effective recharge values in the country. The high (in a South African context) effective recharge is supported by aspects such as the moderate climate and the highly permeable, thick sandy dune cover. The water table is deep and vegetation is often sparse, resulting in a relative lack of transpiration, which further supports the estimation of a high effective recharge percentage.

Groundwater modelling of well fields in the dunes directly west of Stilbaai were calibrated on 30% effective recharge (Dennis, 2008). It is estimated that the effective recharge at Misgunst is at least 30% of MAP.

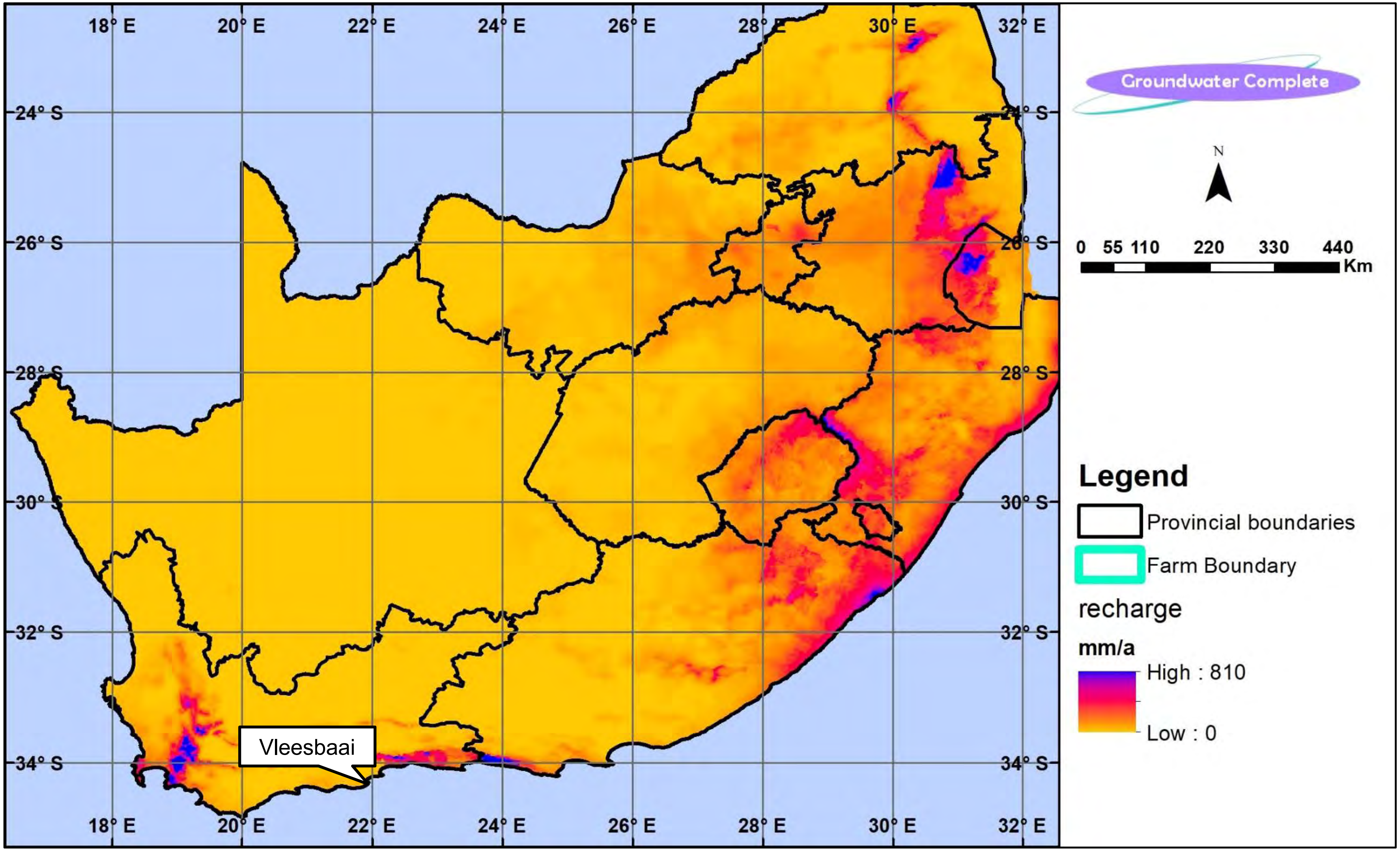


Figure 6: Mean annual aquifer recharge for South Africa *(Vegter, 1995)*

3.5 GROUNDWATER RESERVE DETERMINATION

A rapid reserve determination for the Misgunst area is conducted in this section. The following assumptions were made in terms of groundwater use and surface area:

- By far the most significant ''use'' of groundwater at Misgunst will be the water pumped from the borehole for domestic use.
- There will be virtually no seepage water returning to the groundwater.

The property boundaries fall within quaternary catchment K10A which has a surface area of 177.5 km^2. The farm has a total area of 0.086 km^2 (8.6 hectares). The Misgunst property area, however, is technically not a part of the Gouritz River's catchment area. The water flows from the farm directly towards the ocean to the south-east (however no surface drainage features occur due to sandy dunes). The general authorised groundwater use in the catchment is in the order of 75 m^3/ha/year.

Table 1: Most salient parameters relevant to Catchment K10A *(Groundwater Resource Directed Measures, 2000) (WR90, 1990)*

Description	*Unit*	Value	Comment
Catchment Area	*km^2*	177.5	-
Population	*persons*	61 000	Estimated population in catchment.
General Authorised Use	*m³/ha/a*	75	
Mean Annual Rainfall	*mm/a*	470	
Effective Annual Recharge	*mm/a*	140	Recharge depth per year.
Annual Recharge Volume	*Mm^3/a*	2.485	Recharge volume per year.
Current Groundwater Use	*Mm^3/a*	0.24	
Basic Human Need	*Mm^3/a*	0.5	Based on 25 l per day per person.
Base flow	*Mm^3/a*	1	Volume of groundwater lost to baseflow annually
Abstraction as % of Recharge	*%*	10	(Current groundwater use/Annual recharge volume) x 100
Groundwater Allocation	*Mm^3/a*	0.018	

There are no other groundwater users in the direct vicinity of the Misgunst property. Nearby properties rely mostly on harvested rainwater or water delivered monthly by Mossel Bay Municipality. Thus, the groundwater in the area is a resource that goes mostly unutilised.

The volume of recharge on the property area alone is estimated to be approximately 10 300 m^3/a (0.08 km^2 surface area x 0.014 m/a recharge).

The intended groundwater abstraction is less than 10 m^3/day, or 3 650 m^3/a, which represents approximately 35% (3 650m^3/a requested / 10 300 m^3/a recharge on premises) of the recharge to the property.

The Department of Water and Sanitation (DWS) categorises the water use licence applications in three categories based on the amount of recharge that is used by the applicant in relation to the specified property area:

1 - Category A: Small scale abstractions (<60% recharge on property)
2 - Category B: Medium scale abstractions (60-100% recharge on property)
3 - Category C: Large scale abstractions (>100% recharge on property)

Based on the rapid reserve determination for Misgunst it will fall within a **Category A abstraction**. The usage also falls within Schedule 1 authorized use. The usage of the borehole will not have a meaningful negative impact on the groundwater availability or quality in the area.

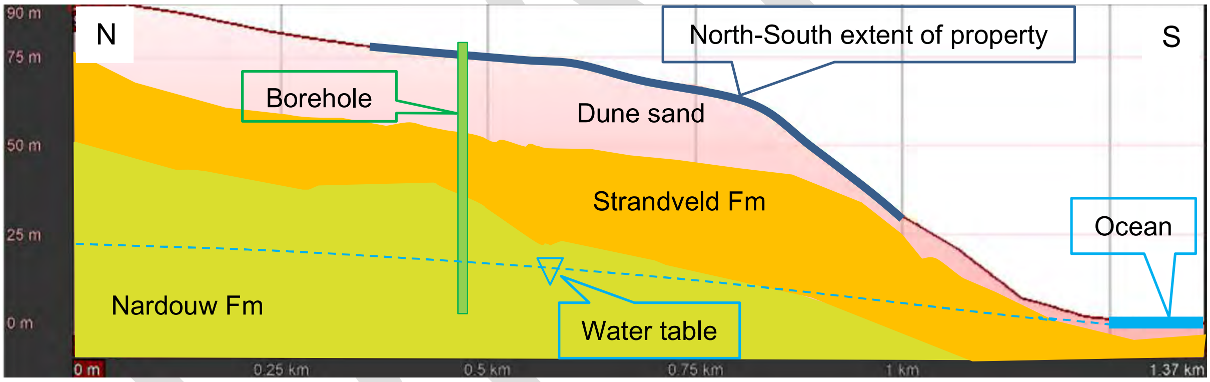
Taking into account the very few other user that rely on groundwater, the relatively small usage and the relatively small volume planned for abstraction, the effect of the groundwater us will be negligible.

4 PREVAILING GROUNDWATER CONDITIONS

4.1 GEOLOGY

Geological information on and around the property as provided in this report was interpreted from the 1:250 000 scale geological map of the project area (provided in **Figure 9**) and confirmed at the position of the borehole through description of the geological material intersected during drilling.

The project area is underlain by Cape Supergroup sedimentary rocks. The Cape Supergroup rocks outcrop along large parts of the southern coast of South Africa unless where it is overlain by quaternary and other younger sediments. The entire surface of the Misgunst property is covered by dune sand of very recent age. Below the dune sand a few meters of consolidated sand and interlayered calcrete of the Strandveld Formation (of the Bredasdorp Group) occurs. The basement of the younger formations is formed by the Skurweberg member of the Nardouw Formation (Table Mountain Group). The Skurweberg member consists of coarse grained, quarzitic sandstone with subordinate calcareous sandstone. A simplified north-south sectional sketch of the lithologies underlying the site based on actual surface elevations (but not drawn to scale) is provided below.



North-South sectional sketch indicating geological and groundwater relationships below the Misgunst property

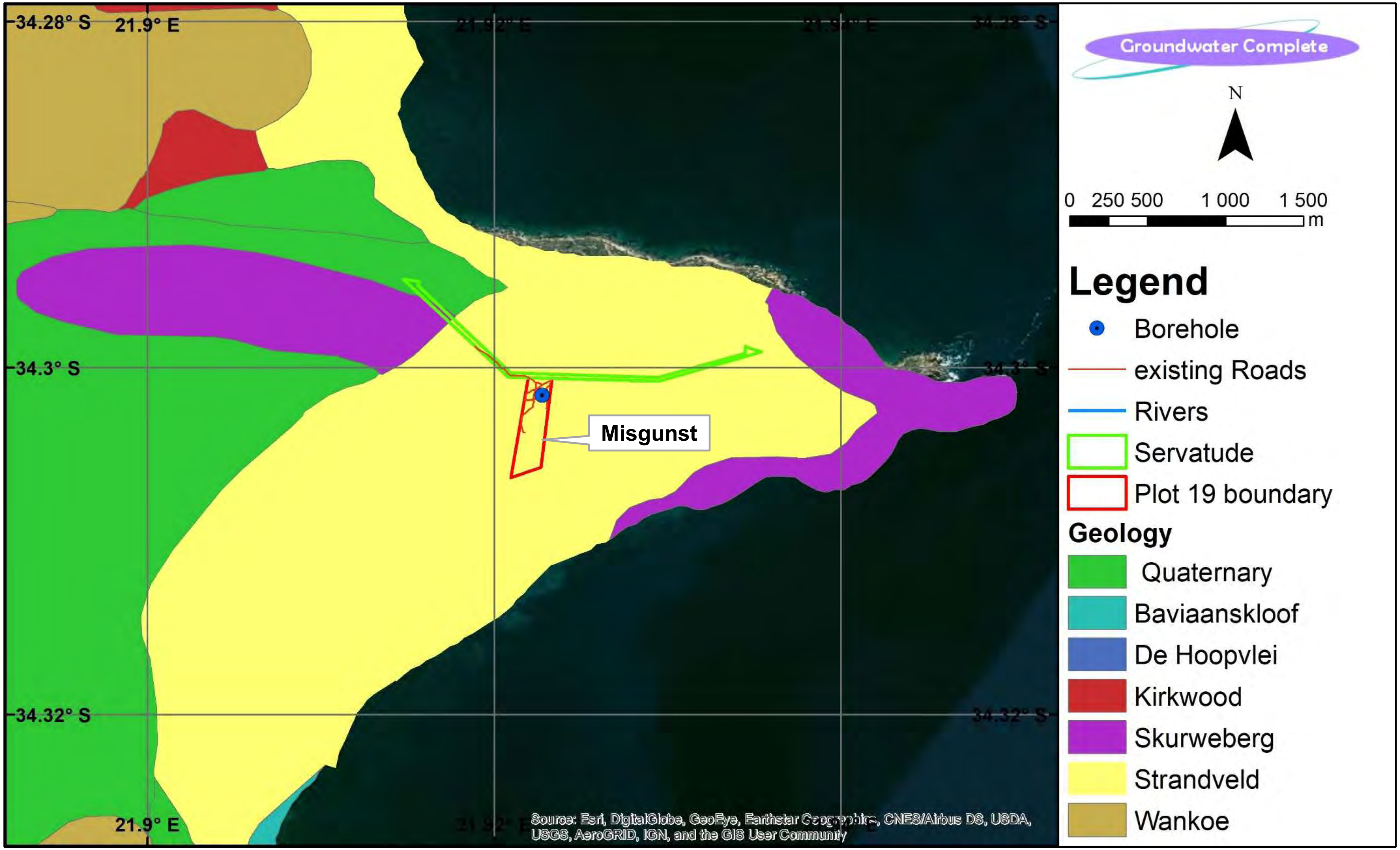


Figure 7: 1:250 000 scale geological map of the project area

4.2 HYDROGEOLOGY

4.2.1 UNSATURATED ZONE

The unsaturated zone refers to the portion of the geological/soil profile that is located above the static groundwater elevation or water table. Based on the drilling results of borehole, the unsaturated zone is predominantly composed of unconsolidated sand at surface followed by consolidated sand and calcrete.

The unsaturated zone affects both the quality and quantity of the underlying groundwater. The type of material forming the unsaturated zone as well as the permeability and texture thereof will significantly influence aquifer recharge as well as the mass transport of surface contamination to the underlying aquifer(s). Factors like ion exchange, retardation, bio-degradation and dispersion all play a role in the unsaturated zone.

The thickness of the unsaturated zone is determined by subtracting the static water level elevation in the project area from the surface elevation, or simply by measuring the depth of the groundwater level below surface. The thickness of the unsaturated zone at Misgunst is estimated to range between 30 and 50 meters.

4.2.2 SATURATED ZONE

The saturated zone, as the name suggests, is the portion of the geological/soil profile that is located below the static groundwater elevation or water table. The depth to the saturated zone is therefore equal to the thickness of the unsaturated zone, which can range between 30 and 50 meters below surface in the Misgunst area.

The saturated zone is important as it forms the groundwater zone or system on which groundwater users rely for their water supply.

4.2.3 TRANSMISSIVITY AND STORATIVITY OF THE AQUIFER

A constant rate pumping test was performed on the Misgunst borehole to calculate representative aquifer parameters (transmissivity or hydraulic conductivity and apply them to estimate sustainable yield of the borehole.

The aquifer parameters and sustainable yield estimation is discussed in Section 4.3 below.

4.3 SUSTAINABLE YIELD ESTIMATION

An aquifer test was performed on the borehole by Groundwater Complete in March 2020. The pumping test was conducted for a 12-hour period, which was considered sufficient given:

- The blow yield of the borehole during drilling of more than 3 600 liters per hour; and
- the limited yield of only about 1 250 liters per hour for 10 hours per day required from the borehole.

4.3.1 BACKGROUND AND THEORY TO AQUIFER TESTING

An aquifer test (also referred to as a pump test) is performed to determine aquifer parameters, especially transmissivity or hydraulic conductivity. The test basically involves the abstraction of groundwater from a borehole by means of a pump (submersible- or mono pump) at a known rate. Measurements of the decreasing water level within the borehole are taken at predetermined intervals, which are generally short at the start of the test and increase as the test progresses. After the test has been completed and the pump has been shut down, measurements are again taken of the water level as it starts to recover/rise in the borehole (i.e. recovery test).

Misgunst-BH01 was tested in the manner described above and the pump test data was analyzed with the AQTESOLV Professional software package, which offers a wide range of mathematical equations/solutions for the calculation of aquifer parameters. The time-water level data collected during the constant rate pump test is plotted on a log-linear graph. A straight line or curve (depending on equation used) can then be fitted to the different flow stages on the graph (process known as curve matching) and the aquifer transmissivity and storativity are calculated in accordance with the preselected analytical equation. Aquifer parameters provided in this report were calculated with the *Cooper-Jacob (1946)* equation.

It is important to note that the abovementioned equation for pump test analysis was designed for pump test interpretation in a primary porosity aquifer environment with the following assumptions:

- The aquifer is a homogeneous medium,
- Of infinite extent,
- No recharge is considered, and
- An observation borehole is used for water level recording at a distance from the pumped borehole.

Although few of these assumptions apply to Misgunst-BH01, the methods/equations could still be used as long as the assumptions and 'shortcomings' are recognized and taken into account.

Analysis of the data showed that the transmissivity around the borehole is approximately 2.2 m^2/d, while the storativity is in the vicinity of 0.05.

If this data is then applied in the FC borehole analysis program the sustainable yield of the borehole is estimated at 0.4 l/s (35 m^3/d) for a 24 hours per day cycle for a total of 12 700 m^3/year. For a solar installation that only operates for about 8 hours a day it translates to an abstraction rate of 1.2 l/s to get the same 35 m^3/d.

Note that the requirement is only 10 m^3/d, calculating to a rate of 0.34 l/s for 8 hours per day.

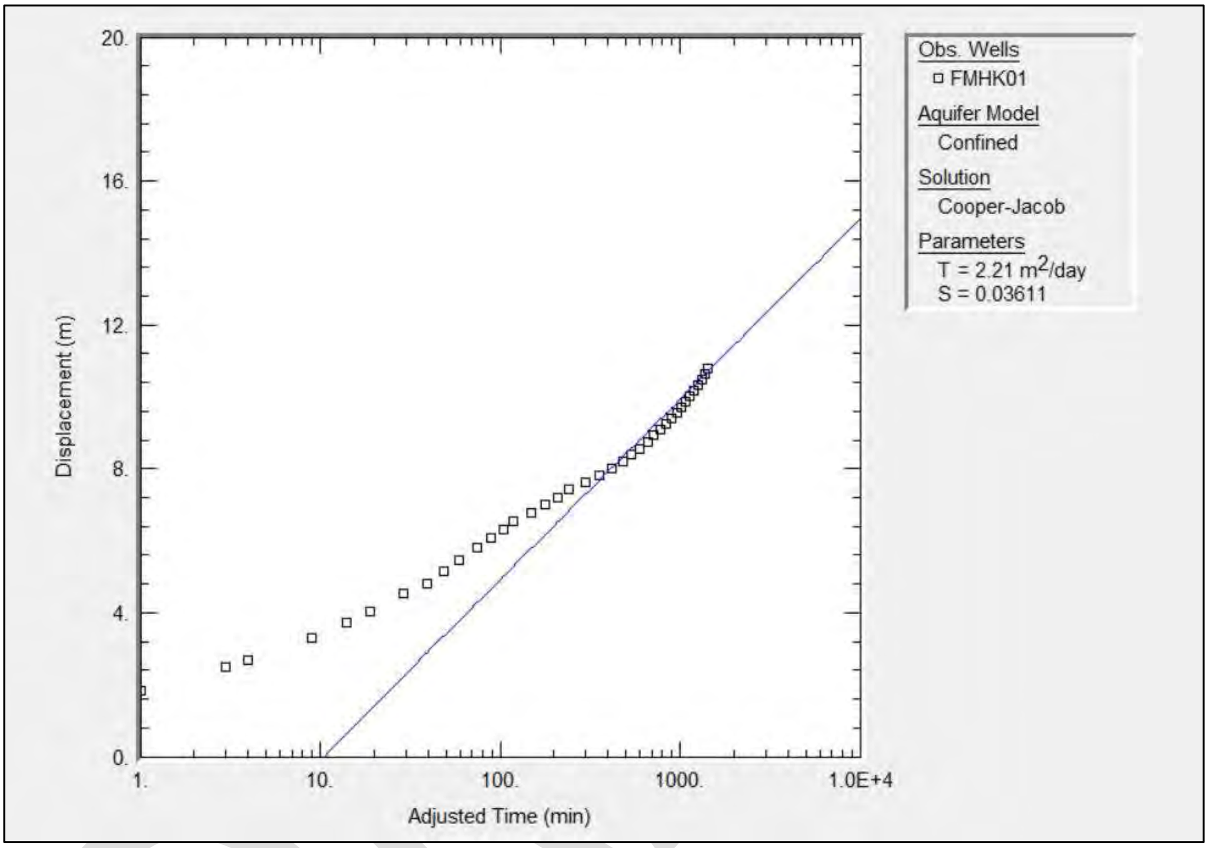


Figure 8: Cooper-Jacob plot for analysis of pump test data

After completing the pumping test, the recovery of the borehole was also measured. This is another way to determine the parameters of the borehole. The recovery behaviour can be viewed in **Figure 11.** The recovery data measured in FMHK01 results in a higher sustainable yield estimation than the pump test itself. The recovery test was conducted for the same duration as the pumping test. The borehole made a 99.1% recovery within 12 hours of the pump being switched off. The transmissivity calculated from the recovery test (Figure 9) is 6.6 m^2/s and is much higher than the transmissivity calculated from the pumping test. This indicates that the sustainable yield recommended from the results of the pumping test is quite conservative.

The cone of depression was estimated using the Cooper-Jacob equation **(Equation 1)**. The Cooper-Jacob formula uses pumping rate, transmissivity and storativity to calculate the radius on influence. This radius of influence can be used as an estimation of the cone of depression caused by the borehole. The theoretical radius of influence calculated for Misgunst-FMHK1 after 1 year of daily pumping at 10 000 litres per day is approximately 150 meters. The radius of influence was calculated mathematically with the *Cooper-Jacob* approximation:

$$s = \frac{Q}{4\pi T} \ln\left[2.2459 \frac{Tt}{r^2 S}\right]$$

Equation 1: Cooper-Jacob Equation

Where	*s*	*= Drawdown (1 m);*
	Q	*= Pumping rate (10 m^3/d);*
	T	*= Transmissivity (2.2 m^2/d);*
	t	*= Time (365 days);*
	r	*= Radial distance from pumping well (? m); and*
	S	*= Storage coefficient (0.005).*

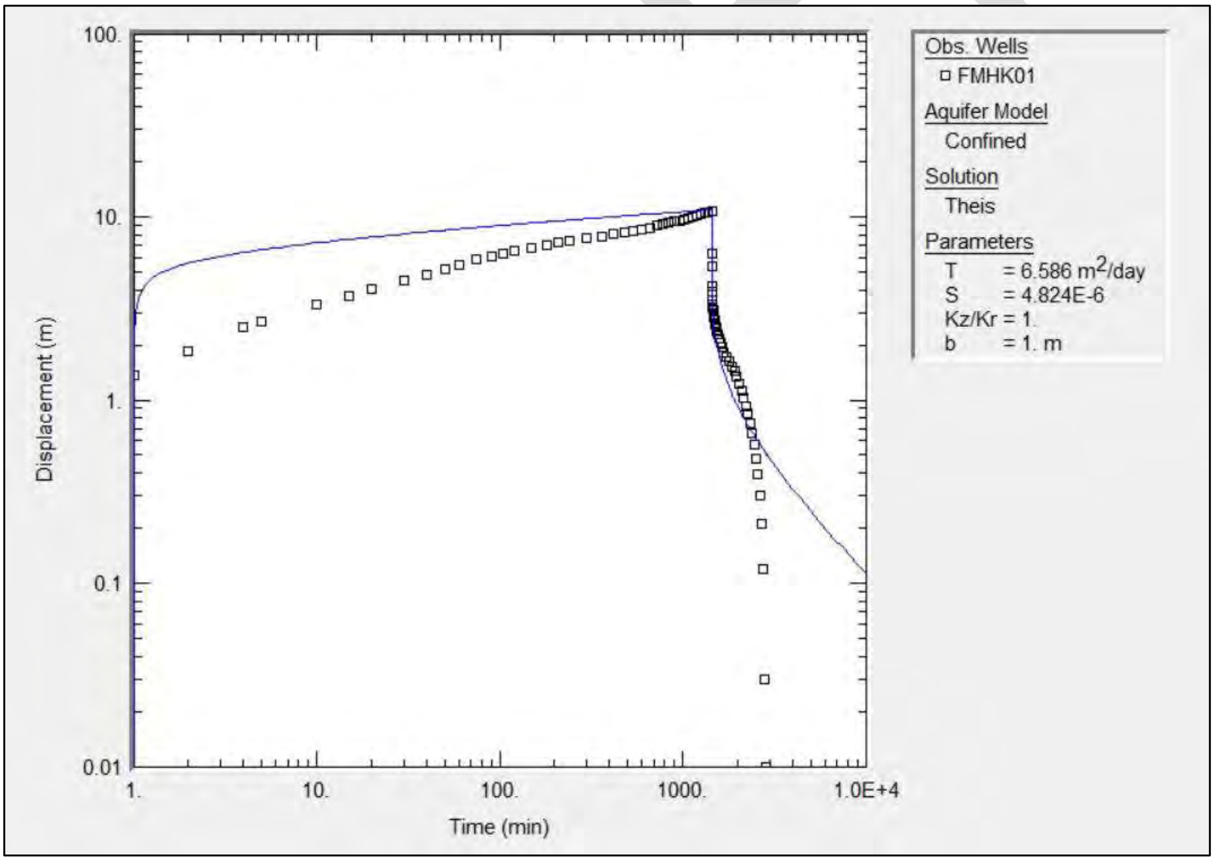


Figure 9: Recovery data measured after the pump test (AQTESOLV)

4.4 GROUNDWATER QUALITY

Groundwater quality from Misgunst-FMHK1 was analysed by SANAS-accredited Aquatico Laboratories on February 4, 2020. The results of the test are available in **Table 2**.

The groundwater has high overall salinity as is expected from a borehole in the dunes near the coast. The dominating ions are sodium and chloride, which far exceed guidelines for potable water, but nitrate also exceeds concentrations for potable water as stated in the SANS 241/2015 water quality guidelines. The groundwater quality from FMHK01 plots in field 8 of the expanded Durov diagram and the Stiff diagram also confirms the strong domination by **sodium** and **chloride** in the water.

The water will thus be applied as is for domestic use (i.e. washing, bathing, showering) because there are no parameters (e.g. Fe, Mn) that indicate a negative effect on aesthetic aspects if applied for domestic use but not for potable purposes.

The primary source of potable water will be harvested rainwater. If there is a shortfall, the groundwater will be treated with a household-scale reverse osmosis (RO) unit before use.

The origin of the high salinity groundwater is considered to be mainly a result of the leaching to the groundwater of salt spray from the ocean deposited onto the dunes. In situ salinity from the Nardouw Formation probably also contribute but considering the significant recharge to the dune system the salt spray component is expected to have the highest contribution to groundwater salinity.

Table 2: Concentrations measured in borehole FMHK01

Locality		Fransmans-hoek	SANS limit for drinking water	**Locality**		Fransmans-hoek	SANS limit for drinking water
Sample ID		FMHK01		**Sample ID**		FMHK01	
Sampled date		04-Feb-2020		**Sampled date**		04-Feb-2020	
pH		7.7	5 - 9.7	**K**	mg/l	19.4	-
EC	mS/m	775	170	**Al**	mg/l	-0.002	0.3
TDS	mg/l	4026	1200	**Fe**	mg/l	-0.004	2
Alk	mg CaCO3/l	274	-	**Thard - Ca**	mg CaCO3/l	1788	-
Cl	mg/l	2179	300	**Mn**	mg/l	0.031	0.4
SO4	mg/l	161	500	**Cr**	mg/l	-0.003	0.05
NO3	mg/l	29.4	11	**Cu**	mg/l	-0.002	2
NH4	mg/l	0.404	1.5	**Ni**	mg/l	-0.002	0.07
PO4	mg/l	0.007	1.5	**Zn**	mg/l	-0.002	5
F	mg/l	0.406	1.5	**Co**	mg/l	-0.003	0.5
Ca	mg/l	487	-	**Cd**	mg/l	-0.002	0.003
Mg	mg/l	139	-	**Pb**	mg/l	-0.004	0.01
Na	mg/l	743	200				

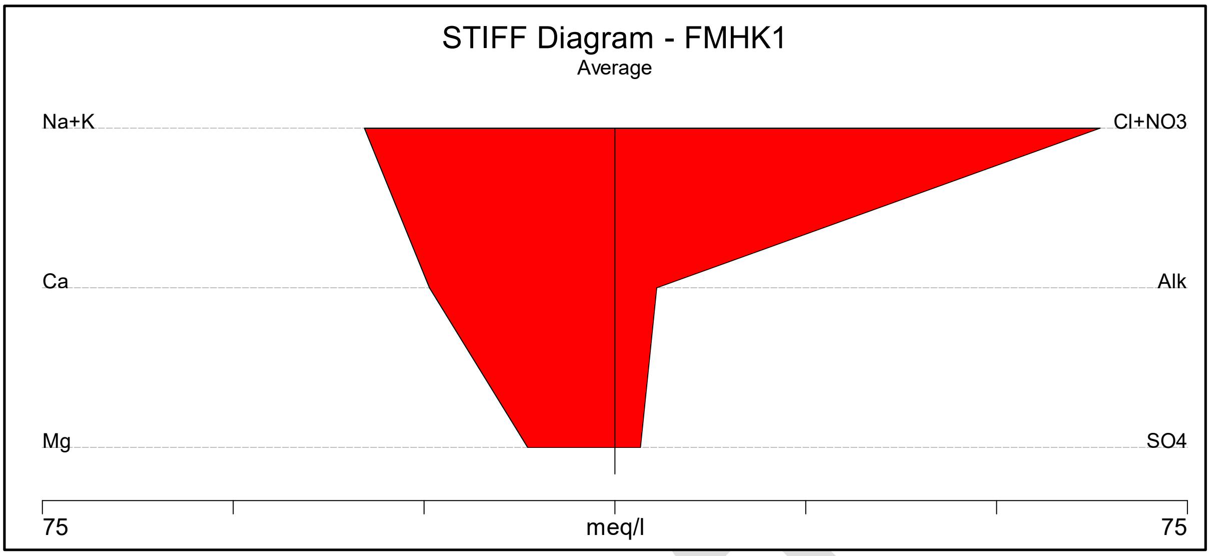


Figure 10: Stiff diagram for borehole FMHK01 groundwater quality

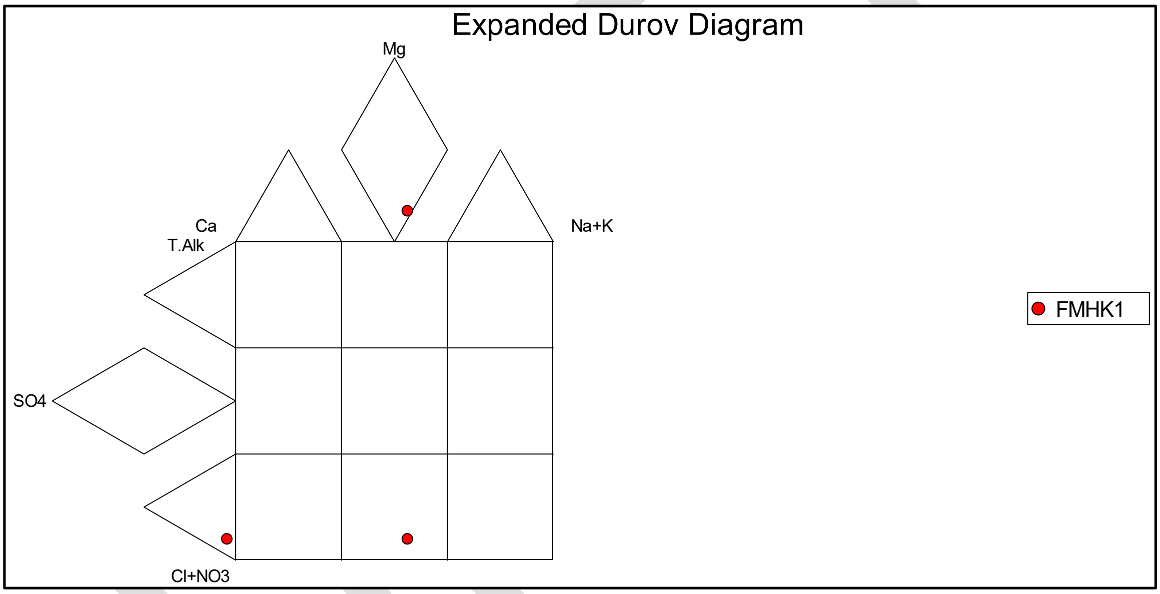


Figure 11: Expanded Durov Diagram for borehole FMHK01 groundwater quality

4.5 GROUNDWATER USES

Groundwater will be used for domestic purposes of a small household. The water will also be used in support of dune stabilization and to maintain the natural coastal gardening for a period of more-or-less 24 months.

Different sources of water will be used in the household:

- The primary source of water for the household will be rainwater from the roof of the house, which will be directed in tanks for timely use.
- The borehole water will only be used as a supplementary source in times of draught. The borehole water will be treated with Reverse Osmosis to render it potable.

- Gray water (from washing machines, wash basins and showers) will be used for dune stabilization.
- Black water (from toilets) will be treated through a bio-gas digester.
-

5 AQUIFER CHARACTERISATION

5.1 GROUNDWATER VULNERABILITY

The *Groundwater Vulnerability Classification System* used in this investigation was developed as a first order assessment tool to aid in the determination of an aquifer's vulnerability/susceptibility to groundwater contamination. This system incorporates the well-known and widely used *Parsons Aquifer Classification System* as well as drinking water quality guidelines as stated by the *Department of Water Affairs and Forestry*. This system is especially useful in situations where limited groundwater related information is available and is explained in **Table 5** and **Table 6**. The project area achieved a score of 4 **(Table 4)** and the underlying aquifer can therefore be regarded as having a LOW vulnerability.

Table 3: Groundwater vulnerability rating for project area

	Rating
Depth to groundwater level	1
Groundwater quality	1
Aquifer type	2
Total score:	**4**

Table 4: Groundwater vulnerability classification system

Rating	***4***	***3***	***2***	***1***
Depth to groundwater level	0 – 3 m	3 – 6 m	6 – 10 m	>10 m
Groundwater quality *(Domestic WQG*)*	Excellent (TDS < 450 mg/l)	Good (TDS > 450 < 1 000 mg/l)	Marginal (TDS > 1 000 < 2 400 mg/l)	Poor (TDS > 2 400 mg/l)
Aquifer type *(Parsons Aquifer Classification)*	Sole aquifer system	Major aquifer system	Minor aquifer system	Non-aquifer system

** WQG = Water Quality Guideline.*

Table 5: Groundwater vulnerability rating

Vulnerability	Rating
Low vulnerability	≤ 4
Medium vulnerability	> 4 ≤ 8
High vulnerability	≥ 9

5.1 AQUIFER CLASSIFICATION

For the purpose of this study an aquifer is defined as a geological formation or group of formations that can yield groundwater in economically useable quantities. Aquifer classification according to the Parsons Classification system is summarised in **Table 6**.

According to the Parsons Classification system, the Misgunst aquifer is regarded as a minor- and in some cases a non-aquifer system.

Table 6: Parsons Aquifer Classification *(Parsons, 1995)*

Sole Aquifer System	An aquifer that is used to supply 50% or more of domestic water for a given area, and for which there is no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality are immaterial.
Major Aquifer System	Highly permeable formation, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (less than 150 mS/m).
Minor Aquifer System	These can be fractured or potentially fractured rocks that do not have a primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large volumes of water, they are important both for local suppliers and in supplying base flow for rivers.
Non-Aquifer System	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks, although impermeable, does take place, and needs to be considered when assessing the risk associated with persistent pollutants.
Special Aquifer System	An aquifer designated as such by the Minister of Water Affairs, after due process.

5.2 AQUIFER PROTECTION CLASSIFICATION

The combination of Aquifer Vulnerability Classification rating and Aquifer System management Classification provides a protection level referred to as Groundwater Quality Management Classification (GQM).

The GQM for the Misgunst aquifer calculates to 2, which indicates a low level of protection.

Table 7: GQM = Aquifer System Management (ASM) x Aquifer Vulnerability (AV)

ASM Classification		AV Classification		GQM		Misgunst GQM
Class	**Points**	**Class**	**Points**	**Index**	**Level of protection**	
Sole Source Aquifer System	6	High	3	<1	Limited	
Major Aquifer System	4			1 - 3	Low	
Minor Aquifer System	2	Medium	2	3 – 6	Medium	2
Non-aquifer System	0			6 – 10	High	
Special Aquifer System	0 - 6	Low	1	>10	Strictly non-degradation	

6 IMPACT ASSESSMENT

6.1 IMPACTS ON GROUNDWATER QUANTITY

Groundwater will regularly be extracted daily from the borehole on Misgunst via a solar pump. The pumping test provides a sustainable yield for the aquifer system. The recommended yield will not be exceeded and the abstraction is not expected to have any lasting adverse impacts on the groundwater.

6.2 GROUNDWATER MANAGEMENT

The following guidelines can be followed to ensure that the aquifer is not overstressed or abused:

- Use water only at the recommended sustainable yield as to not over-exploit the aquifer.
- When the reservoir is full and the water is not being used, switch of pumps and let the borehole recover.
- For a solar installation, install a return flow line to the borehole when the reservoir is full.
- Avoid any activities (especially in the vicinity of the borehole) that could adversely affect the groundwater quality.

6.3 SUMMARY

Impacts on the groundwater quantity are expected to be insignificant during the operational phase.

7 CONCLUSIONS AND RECOMMENDATIONS

The geohydrological environment at Misgunst can be summarised as follows:

- Misgunst is underlain by Cape Supergroup sedimentary and quaternary geological formations.
- No geophysics was used in the placement of the borehole.
- A blow yield of 3600 litres per hour was reported after drilling was completed down to 70 mbs.
- The effective recharge is estimated to be in excess of 30% of the MAP.
- The static groundwater level depth for the borehole is about 42 mbs.
- A 24-hour pump and recovery test were conducted on the borehole.
- A sustainable yield was calculated from the pumping test to be 1460 litres per hour, or 35 m^3 per day.
- The borehole will be operated at 1 250 litres per hour for 8 hours a day (10 m^3/day). The household only plans to use a maximum of 10m^3 per day.
- The groundwater is dominated by calcium and sodium anions and chloride and nitrate cations and the salinity is too high for potable use. The high salinity of the groundwater is attributed to leachate of sea spray on the dunes to the water table.
- The project area achieved a vulnerability score of 4 and the underlying aquifer can therefore be regarded as having a LOW vulnerability.
- The GQM for the Misgunst aquifer calculates to 2, which indicates a low level of protection.
- The impact of the borehole extraction on the groundwater environment is expected to be insignificant due to the high effective recharge, the distance from neighbouring user and low extraction rate from the borehole.

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