Appendix H.13

GEOHYDROLOGICAL ASSESSMENT

Geohydrological Assessment for groundwater development and identification of potential borehole locations, Mura Solar Development , near Beaufort West.

REPORT:	**PREPARED BY:**
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GROUNDWATER AND EARTH SCIENCES
GEOSS
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EXECUTIVE SUMMARY

GEOSS was appointed by Red Cap Energy and their affiliate companies to complete a groundwater potential and development assessment for four planned Solar Facilities, namely Mura Solar Facility 1, Mura Solar Facility 2, Mura Solar Facility 3, and Mura Solar Facility 4, collectively termed the Mura Solar Development. The Mura Solar Development is located to the east of the R381, and approximately 60 km north of Beaufort West. This geohydrological assessment was necessary to identify potential boreholes for use and potential areas for groundwater development to provide sufficient water for each of the four solar facilities.

The water requirements for each of the proposed Mura Solar Facilities are as follows:

- Mura Solar Facility 1:
  - Construction phase: 30 000 m^3/a (0.95 L/s)
  - Operational phase: 18 000 m^3/a (0.57 L/s)
- Mura Solar Facility 2:
  - Construction phase: 48 000 m^3/a (1.52 L/s)
  - Operational phase: 28 000 m^3/a (0.89 L/s)
- Mura Solar Facility 3:
  - Construction phase: 48 000 m^3/a (1.52 L/s)
  - Operational phase: 28 000 m^3/a (0.89 L/s)
- Mura Solar Facility 4:
  - Construction phase: 48 000 m^3/a (1.52 L/s)
  - Operational phase: 28 000 m^3/a (0.89 L/s)

The proposed site is directly underlain by three main lithologies (rock/soil types):

- Various shales and combinations of purple, red, green and grey, mudstone or sandstone, (predominantly horizontal layers).
- These formations have subsequently been intruded by a large dolerite sill structure, (including associated dyke structures).
- The area is locally covered by alluvial and/or other quaternary deposits.

The Mura Solar Development is underlain by two aquifers:

- A fractured aquifer with an average borehole yield potential of 0.5 – 2.0 L/s.
- An intergranular and fractured aquifer with an average borehole yield potential of 0.1 – 0.5 L/s.

Based on regional datasets and a field hydrocensus, the regional groundwater electrical conductivity (EC) ranges between 70 and 300 mS/m. Data was collected during a site visit which was carried out early in November 2022, as well as from the National Groundwater Archive (NGA) and GEOSS databases.

The distribution of boreholes across the proposed areas have been assessed in relation to the farm portions with special reference to the allowable General Authorisation volumes for each of the constituent farm portions that comprise the proposed Mura Solar Development.

Reference has been made to three scenarios to meet the required peak (construction) water supply of 174 078.72 m3/a for the proposed Mura Solar Development, assuming all four projects are constructed simultaneously. The volumes of water required for the development should be readily available, and could be supplied by groundwater in the region. It may, however, not be feasible or practical to extract water under a General Authorisation for the Mura Solar Development since several triggers for a Water Use License (WUL) exist, e.g. pipelines may be required to distribute the groundwater to the areas in which it is required which could be costly, and could potentially trigger the need for a WUL. Further, roads traversing water courses, which may not have been mapped at a regional scale, but are evident in the field, could potentially trigger a WUL. Therefore, such practical considerations will need to be considered. This can be guided by a professional with knowledge of the National Water Act ensuring that the water used, during construction and operation of the solar farms, is lawful. The need for a WUL for the activities will be confirmed by outcomes of the Risk Assessment Matrix (RAM) to be compiled by the appointed Aquatic specialist for this project. Finally, the cumulative water demand (i.e. the Mura Solar Development and agricultural activities) of the property need to be considered when establishing whether groundwater will be extracted under a General Authorisation use or a WUL.

Finally, the following recommendations have been made in this report:

- The groundwater supply can be sourced from either existing boreholes, newly developed boreholes, or a combination of these options.
- The legal status of groundwater use at each property should be confirmed. This will inform the need for future water use authorisations.
- Every effort should be made to visit all boreholes and undertake yield and quality tests at boreholes that could be considered for future supply (based on their relative proximity). The information obtained from the NGA database would be a useful starting point in determining which of the boreholes should be tested for their yields. Further, the relative sizes, GA volumes (and cap volumes) of the respective farm portions should also be considered when planning scientific yield testing.
- Groundwater exploration via geological and geophysical methods is recommended for all of the proposed solar facilities, should existing boreholes not be sufficient to meet the demand. Groundwater exploration aims to understand the geological environment, which can increase the chance of borehole success, and provide more realistic yields and depths of a borehole to be drilled, which could be expected.
- All boreholes planned for use will require scientific yield and quality testing and analysis.
- Monitoring of groundwater (abstraction volumes, quality and water levels) will be required, this should ideally be implemented one year prior to the start of construction if the project timeframes permit.

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ABBREVIATIONS

AOI	Area of Interest
BH	Borehole
CGS	Council for Geoscience
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water Affairs and Sanitation
EC	electrical conductivity
L/s	litres per second
m	metres
mbch	meters below collar height
mbgl	metres below ground level
mS/m	milli-Siemens per metre
NGA	National Groundwater Archive

GLOSSARY OF TERMS

Aquifer: a geological formation, which has structures or textures that hold water or permit appreciable water movement through them [from National Water Act (Act No. 36 of 1998)].

Borehole: includes a well, excavation, or any other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer [from National Water Act (Act No. 36 of 1998)].

Electrical Conductivity: the ability of groundwater to conduct electrical current, due to the presence of charged ionic species in solution (Freeze and Cherry, 1979).

Fractured aquifer: Fissured and fractured bedrock resulting from decompression and/or tectonic action. Groundwater occurs predominantly within fissures and fractures.

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.

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Cover photo:

Photo taken during site visit on Farm 16, Booiskraal.

GEOSS project number:

2022_19-4924

Review by: Dale Barrow (11 January 2023) and Julian Conrad (30 January 2023).

1. INTRODUCTION

GEOSS was appointed by Red Cap Energy (Pty) Ltd and their affiliate companies to complete a groundwater potential and development assessment for the proposed Mura Solar Development. The Mura Solar Development (Mura Solar 1, 2, 3 and 4) is located approximately 60 km north of Beaufort West and about 50 km south-west of Victoria West, to the east of the R 381 (**Map 1**). This geohydrological assessment is necessary to identify potential boreholes and potential areas for groundwater development to provide sufficient water for the proposed solar facilities (i.e. a cumulative 174 000 m^3 per annum (5.52 L/s) during the construction phase and 102 000 m^3 per annum (3.23 L/s) for the operational phase for Mura Solar Development), assuming all four projects are developed simultaneously.

It is understood that the water will be used across the solar facilities, i.e., in the proposed Site Camps, Concrete Batching Plants, and Substations..

This report outlines the work completed to assess the likelihood of using existing sources of groundwater for the project, as well as the potential to develop additional areas for groundwater abstraction.

2. TERMS OF REFERENCE

The terms of reference for this project are as follows:

1. Desktop study.
2. Site visits and hydrocensus investigation.
3. Groundwater supply source identification.
4. Guidance on water use permitting requirements.
5. Indication of potential impacts of development on surrounding environment.
6. Data analysis and hydrogeological report.

3. PROPOSED DEVELOPMENT

The Mura Solar Development, which includes Mura Solar Facility 1, 2, 3, and 4, falls across a total area of 25 735.34 ha, with a proposed area of 1 511.85 ha earmarked for the erection of solar panels. Several key components are required to facilitate the generation of electricity at a large scale. This includes:

- Solar panels mounted to photovoltaic tables.
- Access roads.
- Battery Energy Storage System.
- Underground cables and/or overhead high voltage power lines.
- Substations.

4. METHODOLOGY

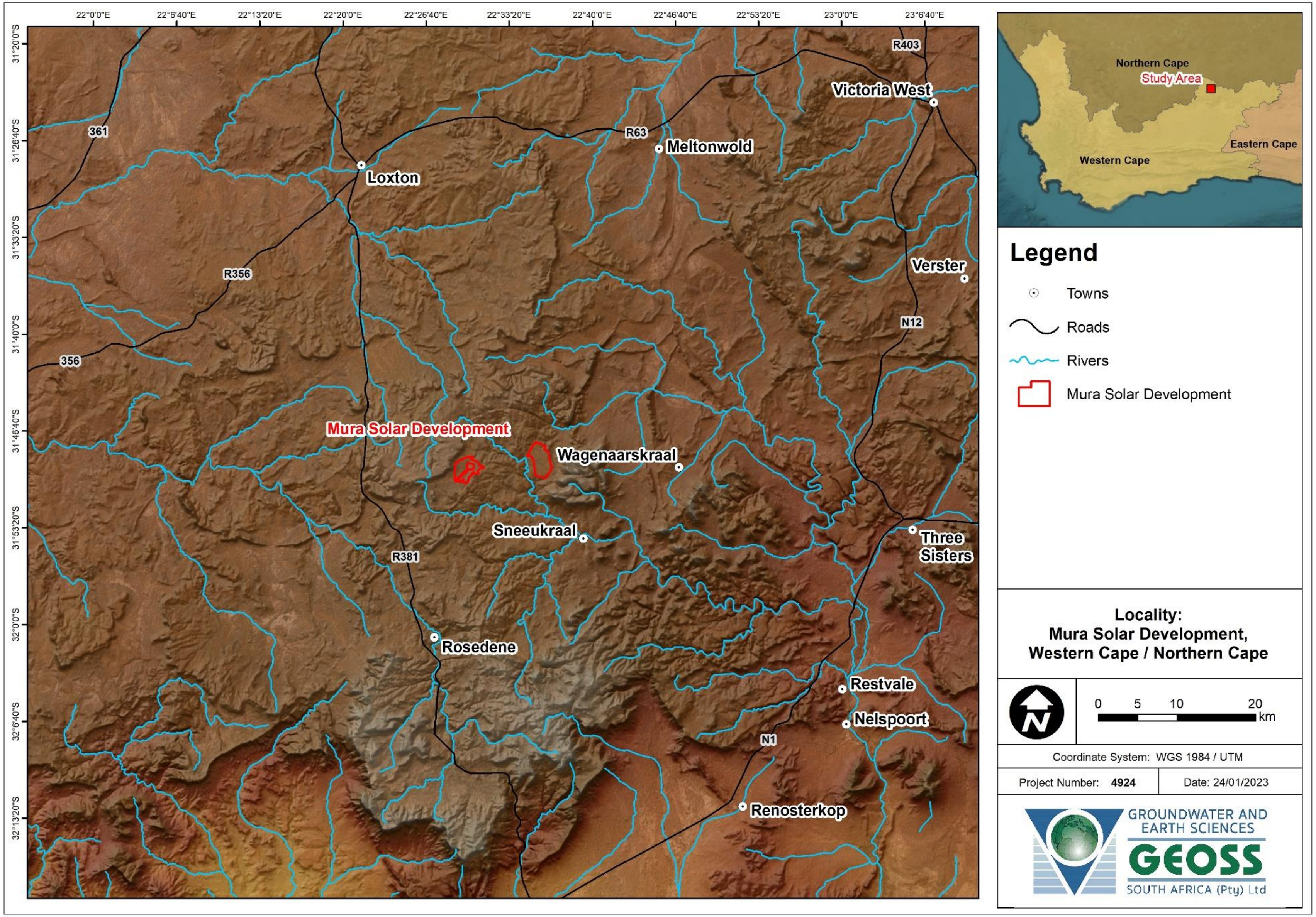
The procedure adopted for this study involved a desktop study. The initial desktop study involved obtaining and reviewing relevant data to the project. This included analysing data from the National Groundwater Archive (NGA), as well as additional groundwater yield and groundwater chemistry from other databases, as well as geological maps of the area.

The site visit was conducted between 7 November to 10 November 2022 to verify collected/existing data and collect additional data, where possible. This included a hydrocensus of groundwater users in the area and noting hydrogeological features of relevance.

Calculations based on the general authorisations of the respective catchments and farm extents were carried out to determine whether the water volumes required for construction and operation of the proposed development could be met by groundwater abstraction.

Additional information will be discussed in this report addressing the potential use of boreholes identified during the hydrocensus, as well as providing areas optimal for further groundwater development should existing sources prove insufficient.

Finally, the hydrogeological risks associated with the proposed development have been highlighted and appropriate mitigation measures have been provided where possible.



Map 1: Regional locality of the Mura Solar Development, Beaufort West.

5. SETTING

5.1 Geology

The Council for Geoscience (CGS) mapped the region at 1:250 000 scale (3122 Victoria West, GCS 1989). The geological setting is shown in **Map 2** and the main geology of the region is listed in **Table 1**.

Table 1: Geological formations within the study area.

Code	Formation	Group	Lithology
	n/a – Quaternary age		Alluvium.
Jd	n/a – Intrusion (Jurassic age)		Dolerite.
Pto	Oukloof Formation	Beaufort Group	Purple mudstone, sandstone.
Pth	Hoedemaker Formation		Red and purple mudstone, subordinate sandstone.
Ptp	Poortjie Formation		Purple, green and grey mudstone, sandstone.

The proposed sites are directly underlain by three distinct geological Groups/Formations, the first being of the Beaufort Group consisting of various shales and combinations of purple, red, green and grey, mudstone or sandstone, predominantly horizontal layers. These formations have subsequently been intruded by a large dolerite sill structure, including associated dyke structures, which form part of the Jurassic-aged Karoo Dolerite Suite. The area is locally covered by alluvial and/or other Quaternary-aged deposits.

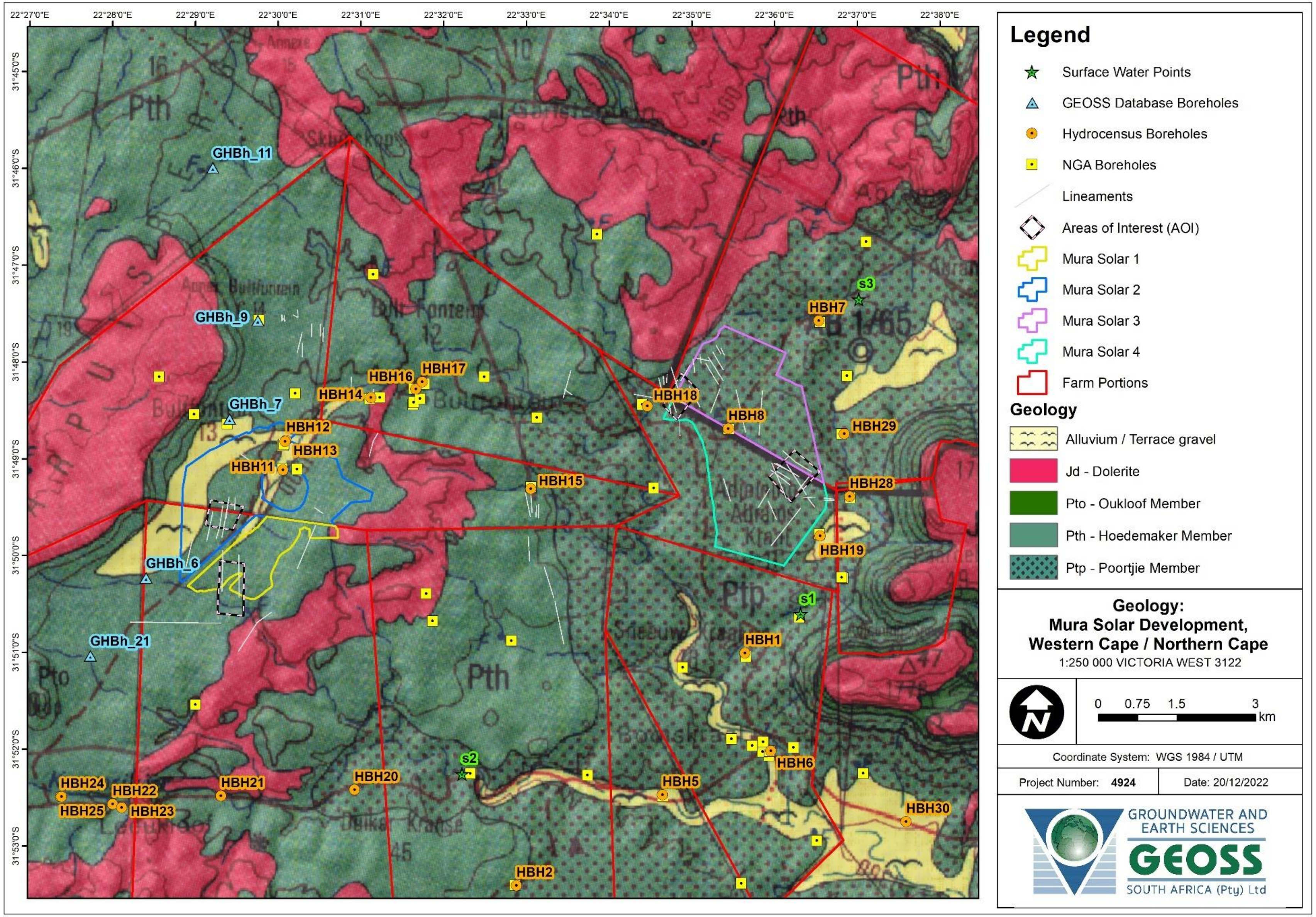
5.2 Hydrogeology

The Mura Solar Development is shown to be underlain by two aquifers. The larger of the two aquifers is classified by the Department of Water Affairs and Forestry (DWAF, 2002) as a **fractured aquifer**. The subordinate, more localised aquifer, is classified by DWAF as an intergranular and fractured aquifer. An intergranular aquifer describes an aquifer in which groundwater flows in openings and void space between grains or weathered rock. A fractured aquifer refers to an aquifer in which groundwater flows in joints, fissures, cracks and fractures within the rock. The larger fractured aquifer is classified as having average **yield potential of 0.5 – 2.0 litres per second (L/s)**, whereas the smaller intergranular & fractured aquifer is classified as having an average **yield potential 0.1 – 0.5 L/s** (**Map 3**). Based on the DWAF (2002) mapping of the **regional groundwater quality**, the electrical conductivity[§] (EC) of the groundwater in the area generally ranges between 70 and 300 milli-Siemens per metre[**] (mS/m). This is considered "**moderate**" groundwater quality (**Map 4**), with respect to drinking water standards. The quality improves towards the east with an indicated electrical conductivity of 0 – 70 mS/m, which is considered "**good**" in terms of drinking water standards.

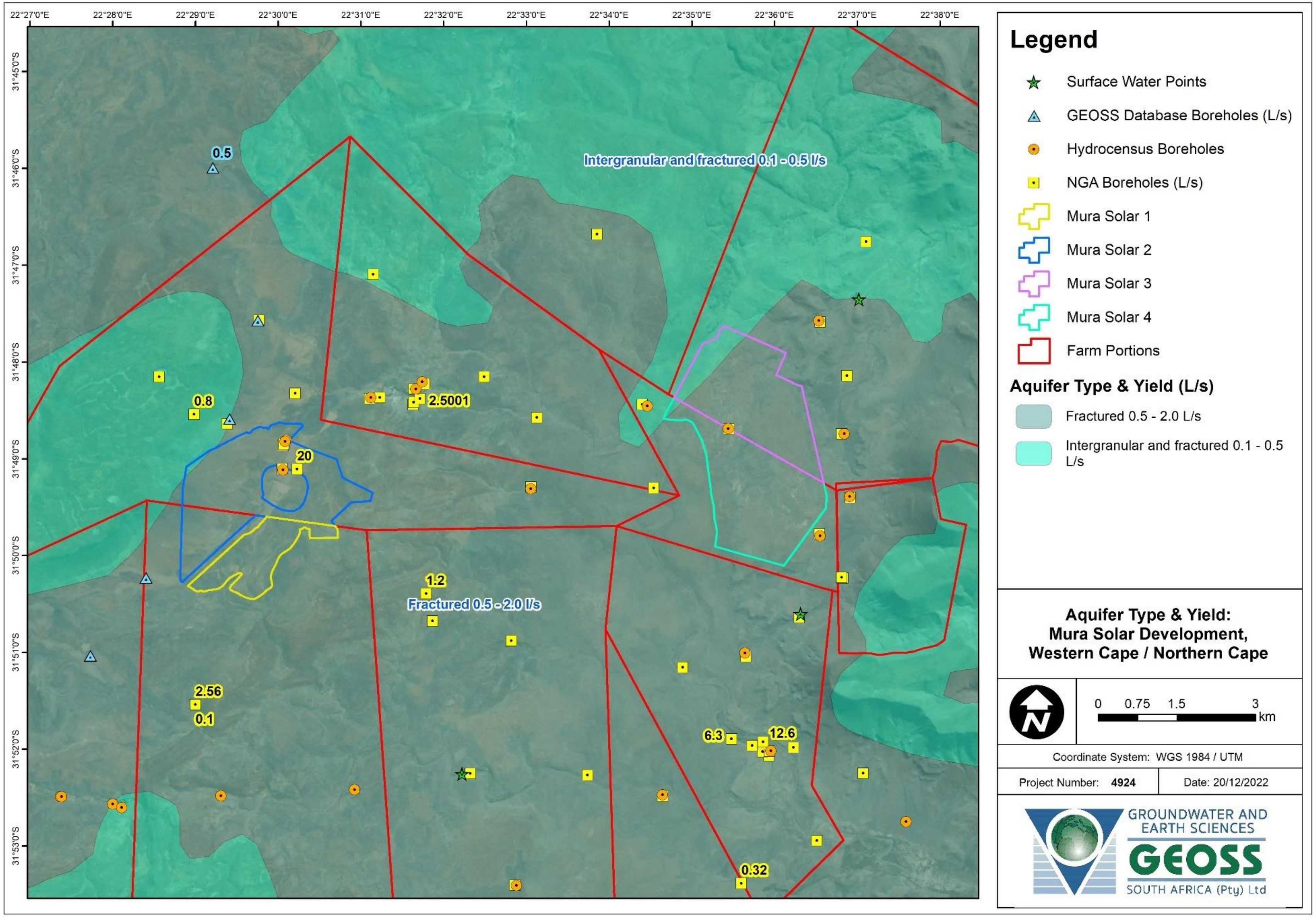
Both these classifications are based on regional datasets, and therefore, only provide an indication of the possible/likely conditions. Groundwater in the area is generally considered as being of marginal quality and boreholes have a low yield.

[§] EC indicates the level of dissolved substances, chemicals, and minerals present in the water. Higher amounts of these impurities will lead to a higher conductivity.

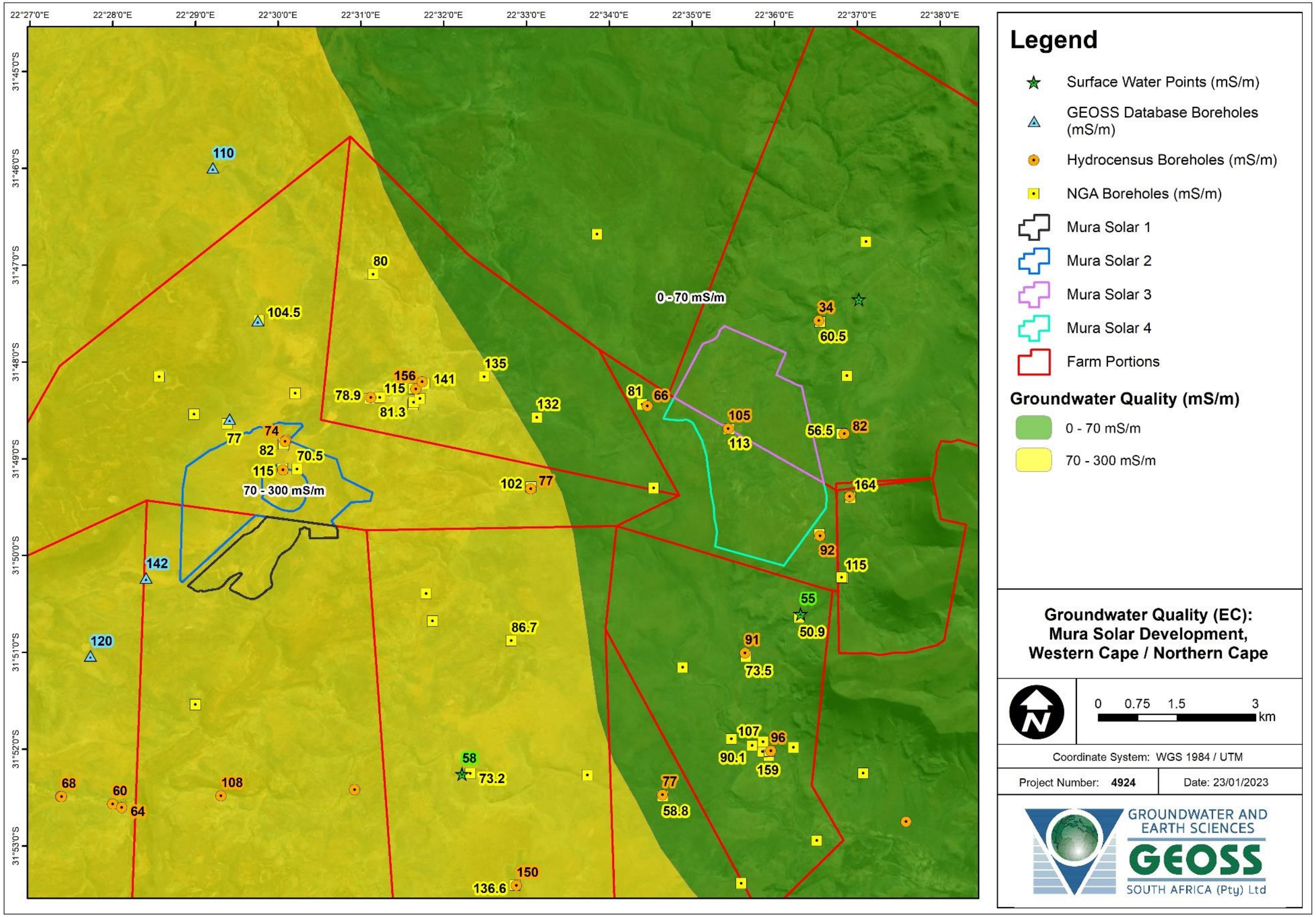
[**] Millisiemens per meter is a unit of measurement for electrical conductivity. It describes electrical conductivity of material which as electrical conductance of one milliSiemens per length of one meter.



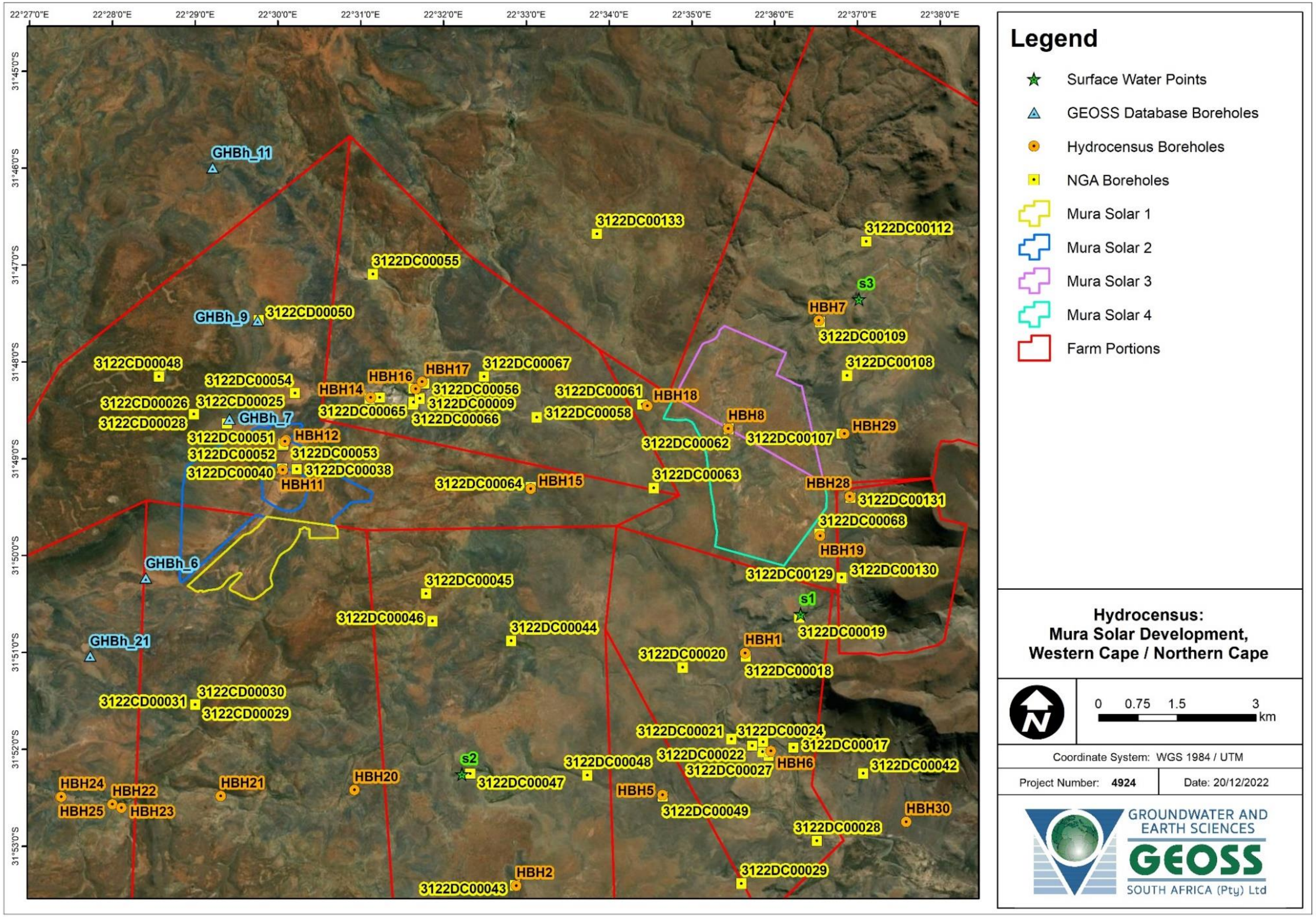
Map 2: Geological setting of Mura Solar Development, and surrounds (1: 250 000 scale 3122 Victoria West (CGS, 1989)).



Map 3: Regional aquifer yield (DWAF, 2002) and borehole yields (L/s).



Map 4: Regional groundwater quality (mS/m) from DWAF (2002) and borehole groundwater quality (EC in mS/m).



Map 5: Aerial imagery showing hydrocensus and NGA boreholes, development boundaries and spring locations.

5.3 Climate

The Mura area (region surrounding the Mura Solar Development) experiences a continental climate with hot summers with scattered rains, and cold dry winters. **Figure 1** shows the monthly average range of air temperatures, and **Figure 2** shows the monthly mean rainfall and evaporation distribution for the Mura area (Schulze, 2009). The long-term (1950 – 2000) mean annual precipitation for the Mura area is 192 mm/a. The evaporation rates rainfall typically exceeds the rainfall throughout the year.

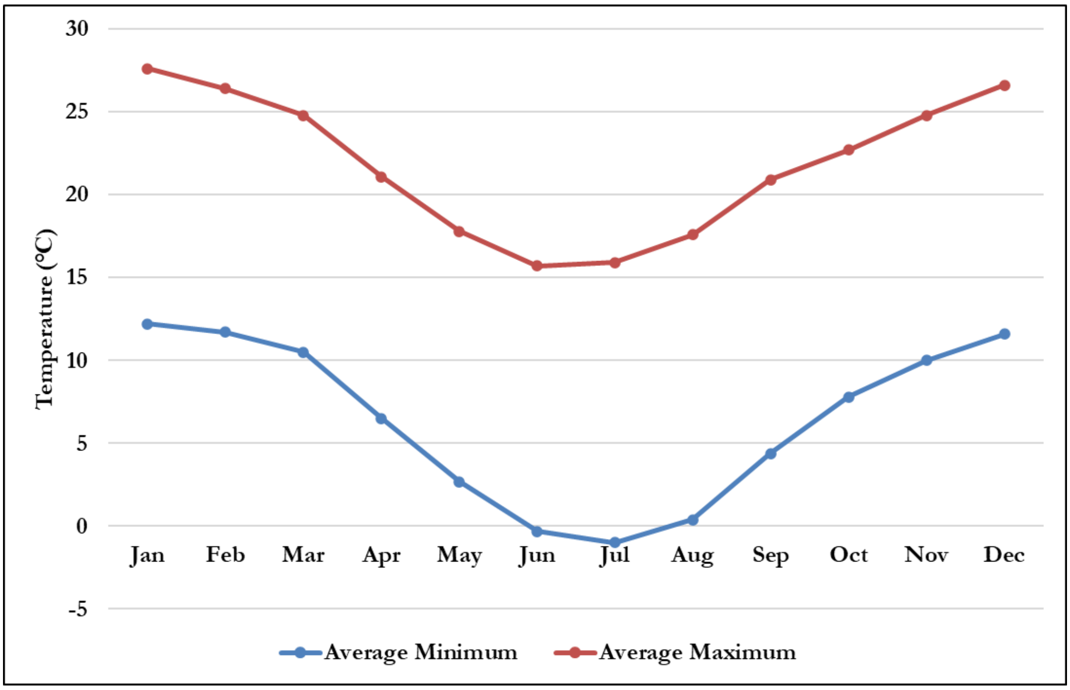


Figure 1: Monthly average air temperature for the Mura area (Schulze, 2009).

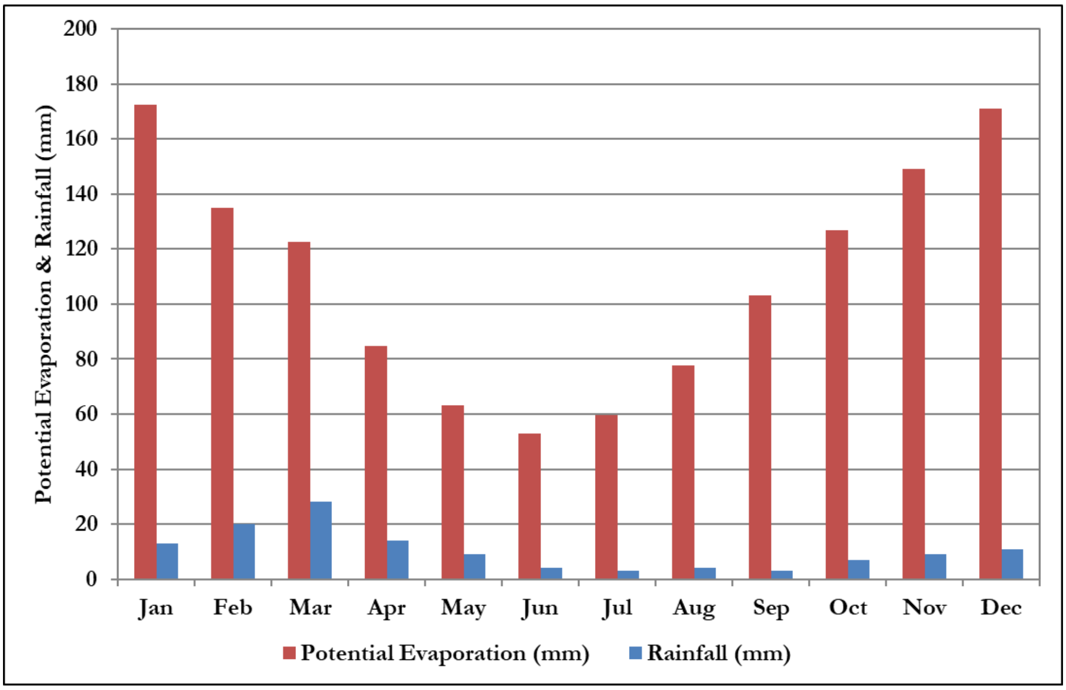


Figure 2: Monthly average rainfall and potential evaporation for the Mura area (Schulze, 2009).

6. HYDROCENSUS AND FIELD WORK

6.1 NGA Database (Desktop)

A desktop assessment was carried out within the farm/property portions that form part of the proposed Mura Solar Development. A search of the National Groundwater Archive (NGA) was completed to determine if there are any groundwater users in the area. The NGA database provides data on borehole positions, groundwater chemistry, borehole yield, groundwater level and borehole geology. The NGA search indicated 66 boreholes exist within the property boundaries. The data for the NGA boreholes are provided in Appendix A and are represented spatially in **Map 5**. The accuracy of NGA borehole data requires validation prior to use, but does provide an indication of conditions that are to be anticipated for an area. Descriptive statistics of the NGA borehole data for the area are provided in **Table 2**. The mean Electrical conductivity (EC) measured for these boreholes was 101.55 mS/m, and ranged between 50.90 – 169.50 mS/m, which falls within the ideal to moderate (70 – 300 mS/m) classification according to DWAF (2002). The depths of the boreholes in the region are shown to range between 0.4 m and 122 m, with a mean depth of 43.41 m. This is supported by anecdotal evidence suggests that the majority of the boreholes in the area are of a depth in the region of 30 m depth (Messrs Wiehahn & Potgieter 2022, personal communication, 08 & 09 Nov) (**Appendix C**).

Table 2: Descriptive statistics for NGA data within the affected farm portions.

NGA	WL (mbgl)	EC (mS/m)	Depth (m)	Yield (L/s)
Maximum	45,06	169,50	122,00	20,00
Mean ($\bar{x}$)	12,70	101,55	43,41	4,70
Minimum	0,80	50,90	0,40	0,10
Range	44,26	118,60	121,60	19,90
Standard deviation (σ)	10,36	33,88	28,64	6,61
Variance (σ^2)	107,27	1147,84	820,09	43,65

6.2 Hydrocensus (field work)

A site visit was conducted between 7 to 10 November 2022 to assess groundwater use and hydrogeological features of interest within the study area. During the hydrocensus, meetings were held with most landowners to discuss their groundwater use and borehole distribution. From these meetings, it became clear that the farmers make use of a number of boreholes. Most boreholes in this area are used for watering of livestock/'veldwater'; therefore, the farmers often pointed to certain boreholes which they believed should be targeted for the field visit to represent the 'best' boreholes for groundwater potential, in their experience. Further, in effort to provide a representative spread across the proposed Mura Solar Development, boreholes encountered in between were also visited. In total 30 boreholes were visited, of which, 21 were equipped with windpumps, three with submersible pumps (two solar powered), four boreholes with no equipment/open, a single artesian hole (HBH22), and one borehole was noted as being 'broken'. Further, three springs labelled S1 to S3 were encountered across the area. The boreholes and springs are indicated spatially in **Map 3**, the data collected at these locations can be found in **Appendix A**, and images of the boreholes in **Appendix B**.

Field chemistry and water level measurements were taken at boreholes, where possible. The results of the hydrocensus are presented spatially on **Maps 2 - 8,** which indicate the hydrocensus and NGA boreholes across the proposed development. An overview of the hydrogeological data is provided in **Table 3**. The data collected is contained in **Appendix A**. The field chemistry (EC, pH[††]; ORP[‡‡] and TDS[§§]) provide a reasonable indication of the expected groundwater quality in the region. The mean Electrical conductivity (EC) measured for these boreholes was 92 mS/m, and ranged between 34 – 156 mS/m, which falls within the ideal to moderate (70 – 300 mS/m) classification according to DWAF (2002). Interestingly, the EC parameters measured during hydrocensus undertaken by GEOSS in 2021 and 2022 were almost always lower than those presented in similar regions by the NGA database (**Map 4**). Further the pH (hydrogen potential) of the groundwater assessed varied between 6.70 and 7.80 with an average pH of 7.36. There is variance in the water quality (Electrical Conductivity (EC) and Total Dissolved Solids (TDS) parameters), yield, water level (WL). Variance in the pH of the waters in the region is generally low by comparison.

Table 3: Descriptive statistics for field hydrocensus data.

Hydrocensus	WL (mbgl)	EC (mS/m)	pH	TDS (mg/L)	Yield (L/s)
Maximum	22,00	156,00	7,80	780,00	3,33
Mean ($\bar{x}$)	9,60	92,00	7,36	449,17	1,31
Minimum	1,80	34,00	6,70	160,00	0,40
Range	20,20	122,00	1,10	620,00	2,93
Standard deviation (σ)	6,41	30,98	0,31	157,92	1,37
Variance (σ^2)	41,09	960,00	0,10	24938,41	1,89

6.3 Groundwater Quality

During the site investigation seven (7) groundwater samples were collected from HBH1, HBH3, HBH7, HBH13, HBH15, and HBH22, between 7 and 10 November 2022. Further, a sample was extracted from GHBh_1 in March of 2019. The samples have been classified according to the SANS241-1: 2015 standards for domestic water, as a common point of reference. **Table 4** enables an evaluation of the water quality with regards to the various SANS241-1: 2015 limits. **Table 5** allows for evaluation of the water chemistry results according to DWAF drinking water assessment standards.

Table 4: Classification table for specific limits according to the SANS241-1: 2015 standard

Acute Health	Chronic Health	Aesthetic	Operational	Acceptable

The groundwater chemistry analysis results have been colour coded according to the SANS241-1: 2015 standard in **Table 6**, and according to the DWAF (1998) guidelines in **Table 7**.

[††] pH is a measure of how acidic/basic water is. The range goes from 0 to 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base.

[‡‡] Oxidation-reduction potential (ORP) measures the ability of a lake or river to cleanse itself or break down waste products, such as contaminants and dead plants and animals. When the ORP value is high, there is lots of oxygen present in the water.

[§§] Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are usually calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulphate, and nitrate anions.

Table 5: Classification table for the groundwater results as per 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.

Previous work undertaken in the vicinity for the Nuweveld Wind Farms (proposed development adjacent to the proposed Mura Solar Development) (including laboratory testing) has shown the groundwater qualities of the respective sampled boreholes to be good, in terms of dissolved mineral concentrations (GEOSS, 2021). No negative effect or impacts on human or animal health upon consumption was expected based on the undertaken laboratory analysis results. It should, however, be noted that microbiological analysis was not conducted. A result from this assessment undertaken in 2019 has been added to the laboratory results in the data presented below. The analysis results are associated with GHbh_1. The laboratory analysis results of the present study and the results from GHbh_1 have been plotted on a tri-linear diagram known as a Piper diagram (**Figure 3**). This diagram indicates the distribution of cations and anions in separate triangles and then a combination of the chemistry in the central diamond. From the figure (central diamond) the samples are classified as having a **calcium-bicarbonate** with HBH15 and HBH22 tending to the **calcium-sodium-bicarbonate** hydrofacies, typical of **shallow and fresh groundwater**. It should be noted, however, that most of the water in this area tastes slightly brackish[***] despite the above classification.

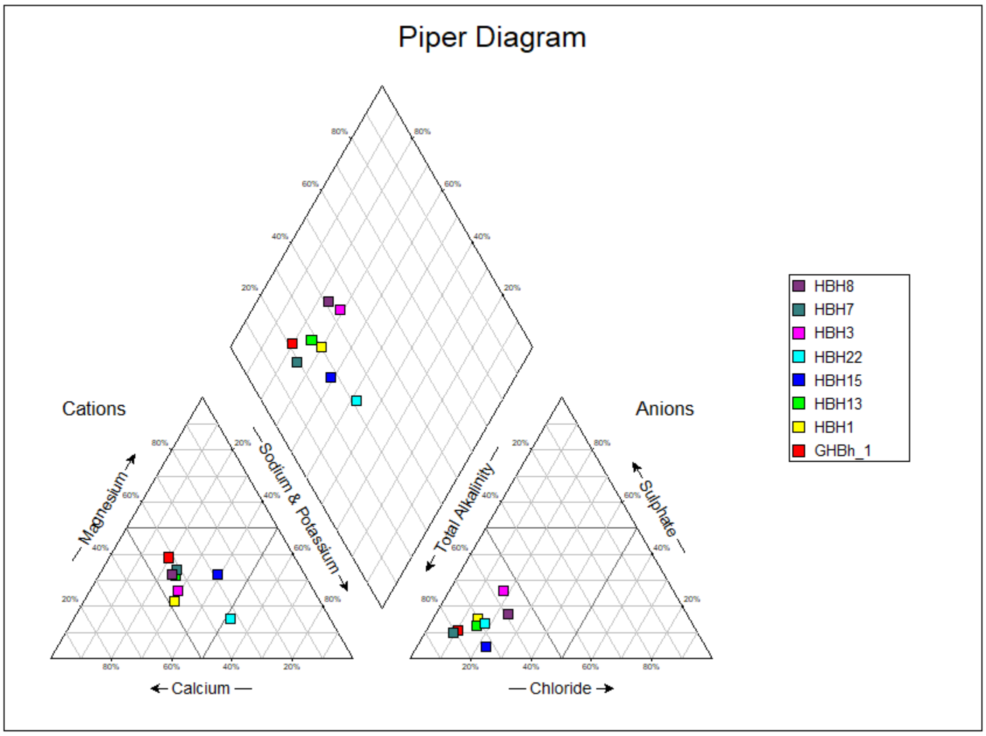


Figure 3: Piper diagram showing representative groundwater chemistry in the region.

[***] Water source that is somewhat salty (more so than freshwater) but not as salty as seawater

The results were also plotted on Stiff Diagrams, which are graphical representations 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 shape of the Stiff plots below indicate that similar concentrations of major ions are present in the groundwater across the proposed Mura Solar Development Footprint and surrounding areas (**Figure 4**). The water samples collected from the proposed Mura Solar Development are notably elevated in bicarbonate (alkalinity) with calcium often being the dominant cation (six of the samples). For the samples extracted from HBH15 and HBH22, the dominant anion is bicarbonate (alkalinity) with elevated concentrations of sodium and potassium cations.

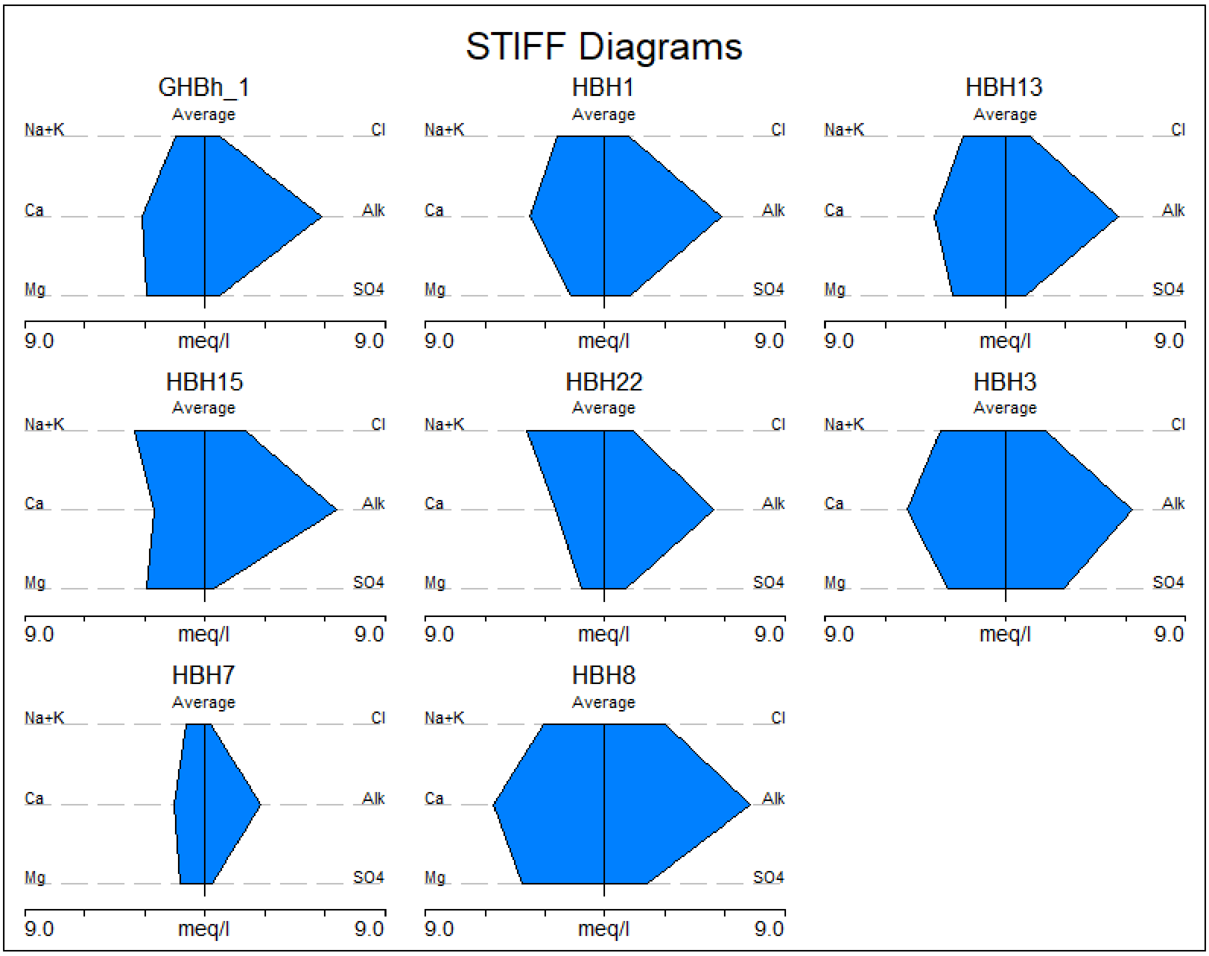


Figure 4: Stiff diagram showing representative groundwater chemistry in the region.

Table 6: Groundwater sample analysis results in relation to SANS 241-1: 2015 limits.

Analyses	HBH 22	HBH 15	HBH 13	HBH 8	HBH 7	HBH 3	HBH 1	GHB h_1	SANS 241-1:2015
pH (at 25 °C)	8.0	7.8	7.5	7.6	7.2	7.3	7.4	7.2	≥5 - ≤9.7 Operational
Conductivity (mS/m) (at 25 °C)	71.1	82.2	76.9	117.0	33.8	102.8	75.0	69.5	≤170 Aesthetic
Total Dissolved Solids (mg/L)	482.06	557.32	521.38	793.26	229.16	696.98	508.50	471.21	≤1200 Aesthetic
Turbidity (NTU)	0.54	2.34	0.77	1.95	10.70	0.80	6.15	0.40	≤5 Aesthetic ≤1 Operational
Colour (mg/L as Pt)	<15	31.00	18.00	15.00	<15	<15	<15	<15	≤15 Aesthetic
Sodium (mg/L as Na)	89	79	47	63	19	71	53	33	≤200 Aesthetic
Potassium (mg/L as K)	2	2	3	13	3	6	3	2	N/A
Magnesium (mg/L as Mg)	14	35	32	50	15	35	21	35	N/A
Calcium (mg/L as Ca)	49	51	71	112	30	99	76	62	N/A
Chloride (mg/L as Cl)	50.79	72.86	43.65	106.18	11.28	71.84	42.92	27.52	≤300 Aesthetic
Sulphate (mg/L as SO4)	51.09	20.11	47.91	102.11	16.20	138.95	60.75	37.27	≤250 Aesthetic ≤500 Acute Health
Nitrate & Nitrite Nitrogen (mg/L as N)	<1.05	<1.05	7.20	6.28	2.98	5.11	1.70	2.87	≤12 Acute Health
Nitrate Nitrogen (mg/L as N)	<1.00	<1.00	7.20	6.28	2.98	5.11	1.70	2.87	≤11 Acute Health
Nitrite Nitrogen (mg/L as N)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.00	≤0.9 Acute Health
Ammonia Nitrogen (mg/L as N)	<0.15	<0.15	<0.15	<0.15	0.21	<0.15	<0.15	0.01	≤1.5 Aesthetic
Total Alkalinity (mg/L as CaCO3)	269.9	328.5	282.0	364.1	138.3	317.6	289.0	290.9	N/A
Total Hardness (mg/L as CaCO3)	179.9	271.0	308.7	485.0	136.5	391.0	276.1	298.5	N/A
Fluoride (mg/L as F)	<0.15	0.88	0.91	1.22	0.57	0.88	0.48	0.60	≤1.5 Chronic Health
Manganese (mg/L as Mn)	0.018	<0.018	<0.018	<0.018	<0.018	<0.018	0.010	<0.018	≤0.1 Aesthetic ≤0.4 Chronic Health
Iron (mg/L as Fe)	0.025	0.075	0.029	0.131	0.357	0.051	0.490	<0.002	≤0.3 Aesthetic ≤2 Chronic Health
Copper (mg/L as Cu)	0.008	0.007	0.007	0.008	0.016	0.008	0.009	<0.002	≤2 Chronic Health
Zinc (mg/L as Zn)	<0.008	<0.008	<0.008	0.062	0.015	0.040	0.106	<0,008	≤5 Aesthetic
Charge balance %	-2.4	-0.7	2.7	1.5	3.2	-0.9	-2.1	0.6	≥-5 - ≤5 Acceptable

Table 7: Classified borehole results in relation to DWAF 1998 parameter limits.

Sample	**HBH22**	**HBH15**	**HBH13**	**HBH 8**	**HBH 7**	**HBH 3**	**HBH 1**	**GHBh_1 (2019)**	**DWA (1998) Drinking Water Assessment Guide**				
									Class 0	**Class I**	**Class II**	**Class III**	**Class IV**
pH	8.0	7.8	7.5	7.6	7.2	7.3	7.4	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)	71.1	82.2	76.9	117.0	33.8	102.8	75.0	69.5	<70	70-150	150-370	370-520	>520
Turbidity (NTU)	0.54	2.34	0.77	1.95	10.70	0.80	6.15	0.40	<0.1	0.1-1	1.0-20	20-50	>50
	mg/L												
Total Dissolved Solids	482.06	557.32	521.38	793.26	229.16	696.98	508.50	471.21	<450	450-1000	1000-2400	2400-3400	>3400
Sodium (as Na)	89	79	47	63	19	71	53	33	<100	100-200	200-400	400-1000	>1000
Potassium (as K)	2	2	3	13	3	6	3	2	<25	25-50	50-100	100-500	>500
Magnesium (as Mg)	14	35	32	50	15	35	21	35	<70	70-100	100-200	200-400	>400
Calcium (as Ca)	49	51	71	112	30	99	76	62	<80	80-150	150-300	>300	
Chloride (as Cl)	50.79	72.86	43.65	106.18	11.28	71.84	42.92	27.52	<100	100-200	200-600	600-1200	>1200
Sulphate (as SO4)	51.09	20.11	47.91	102.11	16.20	138.95	60.75	37.27	<200	200-400	400-600	600-1000	>1000
Nitrate& Nitrite (as N)	<1.05	<1.05	7.20	6.28	2.98	5.11	1.70	2.87	<6	6.0-10	10.0-20	20-40	>40
Fluoride (as F)	<0.15	0.88	0.91	1.22	0.57	0.88	0.48	0.60	<0.7	0.7-1.0	1.0-1.5	1.5-3.5	>3.5
Manganese (as Mn)	0.018	<0.018	<0.018	<0.018	<0.018	<0.018	0.010	<0.018	<0.1	0.1-0.4	0.4-4	4.0-10.0	>10
Iron (as Fe)	0.025	0.075	0.029	0.131	0.357	0.051	0.490	<0.002	<0.5	0.5-1.0	1.0-5.0	5.0-10.0	>10
Copper (as Cu)	0.008	0.007	0.007	0.008	0.016	0.008	0.009	<0.002	<1	1-1.3	1.3-2	2.0-15	>15
Zinc (as Zn)	<0.008	<0.008	<0.008	0.062	0.015	0.040	0.106	<0,008	<20	>20			
Arsenic (as As)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	<0.010	<0.010	0.01-0.05	0.05-0.2	0.2-2.0	>2.0
Cadmium (as Cd)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	<0.001	<0.003	0.003-0.005	0.005-0.020	0.020-0.050	>0.050
Hardness (as $CaCO_3$)	179.900	271.00	308.70	485.00	136.50	391.00	276.10	298.50	<200	200-300	300-600	>600	
Charge Balance %	-2.4	-0.7	2.7	1.5	3.2	-0.9	-2.1	0.6	≥-5 - ≤5 Acceptable				

6.4 Isotope Analysis

Conservative tracers are particularly useful and provide insight into groundwater origin, mixing patterns and recharge areas. Stable isotope ratios of hydrogen and oxygen have been widely used to understand broad hydrological processes. The 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. In hydrology, stable isotopes are conventionally reported as per mil (‰) deviation from a standard using the δ (delta) notation (Eq. 1). R is the isotope ratio of the heavier over the lighter isotope ($^{2}H/^{1}H$ and $^{18}O/^{16}O$).

$$\delta\ (‰) = [R_{sample}/R_{standard} - 1] \times 1000 \qquad \text{(Eq. 1)}$$

It is important to note that isotopic signatures of water are reported in terms of the heavier isotopes i.e. ^{2}H and ^{18}O. During evaporation, the light molecule of water ($^{1}H_2{}^{16}O$) is more volatile than the heavier molecule of water ($^{2}H_2{}^{18}O$). As a result, vapour that evaporates from the ocean is depleted in heavier isotopes. This enrichment in the light isotope provides an isotopically negative signature. When this vapour undergoes cooling, the precipitation is enriched in heavier isotope. The lighter isotopes preferentially remain in the vapour phase therefore the condensation (liquid phase) is isotopically positive. Given this information, successive precipitation events from the same initial vapour mass will be more and more isotopically negative (Figure 9). $\delta^{18}O$ and $\delta^{2}H$ represents the ratio of heavy to light isotopes for hydrogen and oxygen, respectively (i.e. $^{18}O/^{16}O$, $^{2}H/^{1}H$).

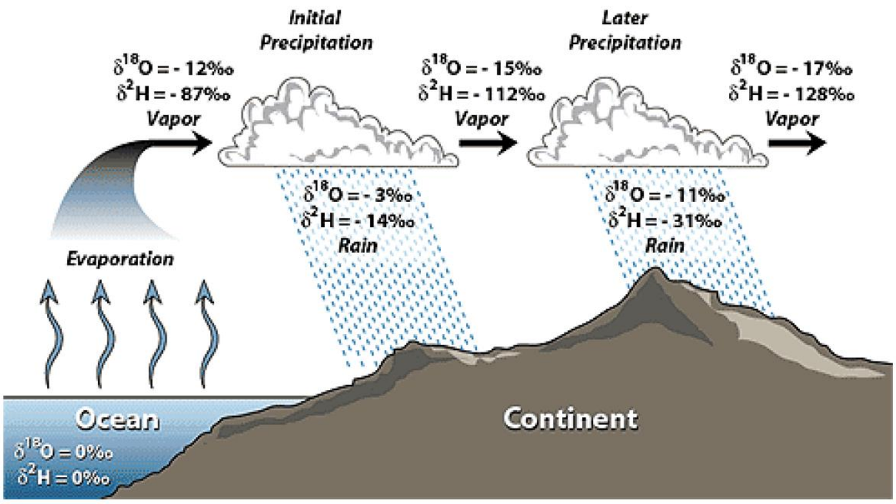


Figure 5: Evolution of stable isotopic composition due to successive rainfall events, also termed the 'rainout effect' (c).

All rainfall across the world should roughly plot along the global meteoric water line (GMWL) which describes the global annual average isotopic composition of $\delta^{2}H$ and $\delta^{18}O$ in meteoric water (precipitation, ice and snow). The GMWL can be characterised through the equation below (Craig, 1961):

$$\delta^{2}H = 8 * \delta^{18}O + 10 \qquad \text{(Eq. 2)}$$

In most aquifers when precipitation infiltrates to recharge groundwater, the δ2H and δ18O values remain relatively constant. The isotopic composition of groundwater is therefore related to that of precipitation in the recharge area at the time of recharge. Thus, the groundwater stable isotope composition can be used to infer the source of groundwater recharge as well as the climatic conditions during recharge. Groundwater may also be recharged by surface waters; in which case the stable isotope composition of the groundwater should reflect that of the surface water body. Evaporation from open water and exchange with rock minerals are two common processes which cause deviations from the meteoric water line (**Figure 6**). Therefore, stable isotope ratios are particularly useful in providing a "signature" or "fingerprint" to particular water types and identifying mixing of two or more water types (Clark and Fritz, 1997; Gat, 2010).

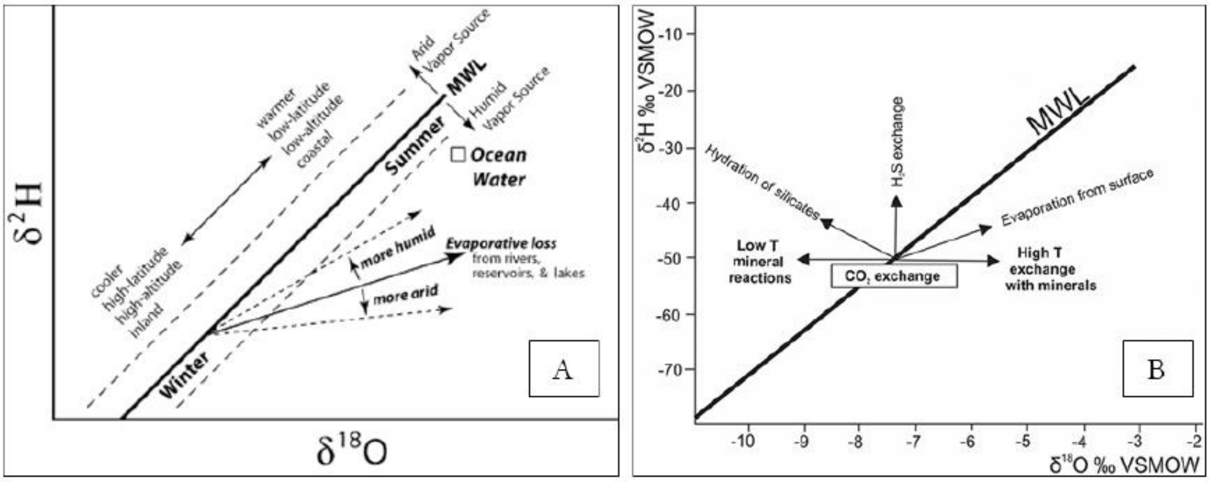


Figure 6: A) The effects of climatic conditions on stable hydrogen and oxygen compositions of water (SAHRA, 2005); B: The effects of hydrologic processes on stable hydrogen and oxygen compositions of water (Serno et al., 2017).

Seven (7) water samples were submitted to IThemba Labs for analysis of δ^2H (δD) and δ^{18}O ratios. The analysis was undertaken on 21 November 2022. Based on the analysis data there are at least two populations of water with different δ^2H and δ^{18}O signatures (or ratios). The majority of the samples (HBH 1, HBH3, HBH13, HBH15, HBH22) fall within the δ^2H range of -36 to -28 and δ^{18}O of between –4.5 and -6.0, and plot along the GMWL. The other population (HBH7 and HBH8) yielded δ^2H ratios between -14.0 and -25.0, and the δ^{18}O ranges from -3.3 to -3.8, and plot either above or below the GMWL. The second population (HBH7 and HBH8) are depleted in lighter isotopes (i.e. greater δ^2H (δD) and δ^{18}O ratios) suggesting they have been exposed to a fractionation process. The clustering of the other population (HBH 1, HBH3, HBH13, HBH15, HBH22) may be due to groundwater arising from a similar host lithology (rock type).

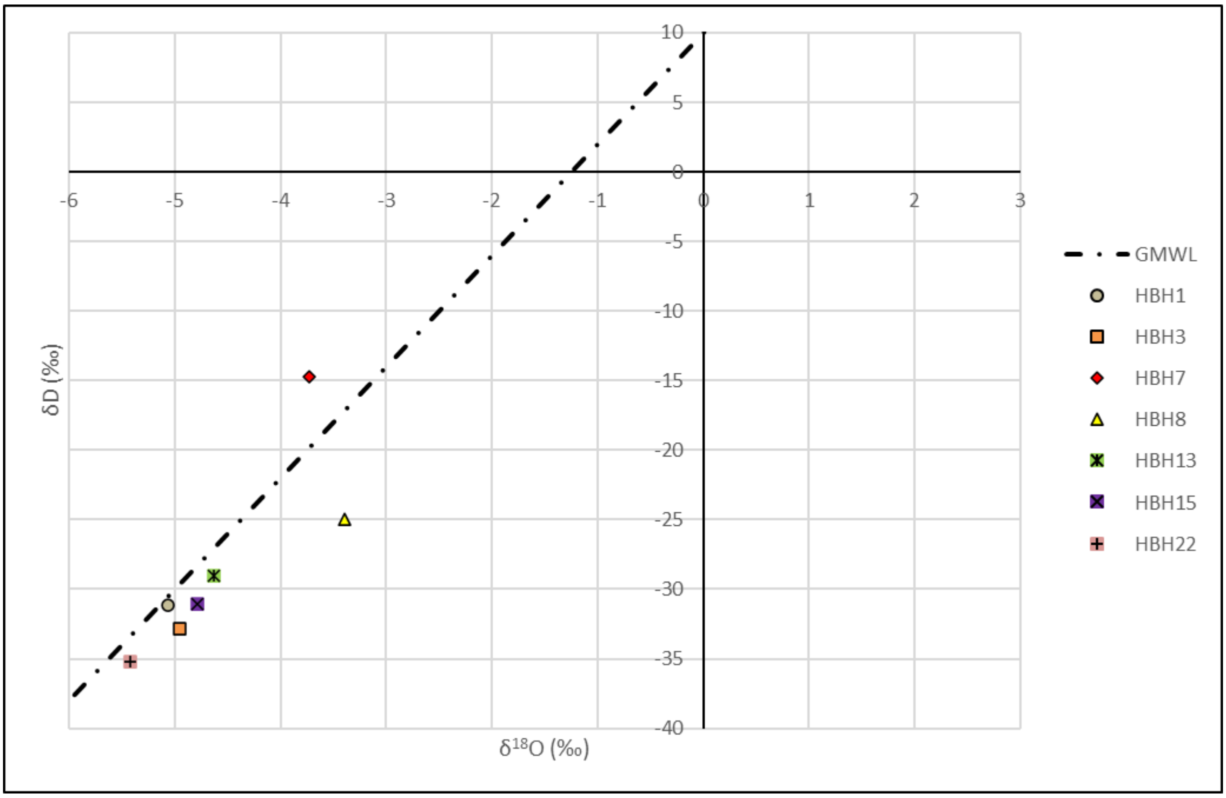


***Figure 7:** Stable isotope results from selected boreholes across the proposed Mura Solar Development.*

7. APPLICABLE LEGISLATION AND PERMIT REQUIREMENTS

The National Water Act (1998) is administered by the Department of Water and Sanitation (DWS) and is the main legislation for managing water resources in South Africa. The purpose of the National Water Act is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorisation and register as users. The National Water Act also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

The properties on which the proposed Mura Solar Development (Mura 1 to 4) fall across three quaternary catchments, namely D55C, L11D, and L11A. This proposed Mura Solar Development falls under the Orange Water Management Area and primarily the Mzimvubu - Tsitsikamma (DWS, 2016). The groundwater General Authorisation (GA) for all three catchments is 45 m^3/ha/a. This means that in these catchments, 45 m^3 of water can be abstracted per year for every hectare, under the GA. For example, a 100ha property could be abstracting a maximum of 4 500 (45 x 100) m^3/a under the GA. However, the GA volume is capped at 40 000 m^3/a per property. Therefore, a property with an extent of 20 000 ha would only be allowed to abstract 40 000 m^3/a under the GA. If larger volumes are needed, a Water Use Licence will have to be applied for.

The cumulative area of the affected farm portions in the development of the Mura Solar Development is approximately 25 735.34 hectares consisting of several farm portions (**Table 8**). The water requirements for the respective Mura Solar Facilities are understood to be as follows:

- Mura Solar Facility 1:
    - Construction phase: 30 000 m^3/a (0.95 L/s)
    - Operational phase: 18 000 m^3/a (0.57 L/s)
- Mura Solar Facility 2:
    - Construction phase: 48 000 m^3/a (1.52 L/s)
    - Operational phase: 28 000 m^3/a (0.89 L/s)
- Mura Solar Facility 3:
    - Construction phase: 48 000 m^3/a (1.52 L/s)
    - Operational phase: 28 000 m^3/a (0.89 L/s)
- Mura Solar Facility 4:
    - Construction phase: 48 000 m^3/a (1.52 L/s)
    - Operational phase: 28 000 m^3/a (0.89 L/s)

The requirements Mura Solar Facility 1 fall within the GA of Farm 4/45 (**Table 8**). The water demands for Mura Solar Facilities 2 to 4 cannot be met during the construction phase from a single farm portion under a GA water use; however, this requirement could potentially be met by combining neighbouring farm portions. As examples, the respective Mura Solar Facilities could be supplemented by the listed farm portions:

- Mura Solar Facility 2 – Farm 4/45, 3/45 & 12
- Mura Solar Facility 3: – Farm 12, 2/49
- Mura Solar Facility 4: – Farm 46, 2/49, RE/45

It is important to point out that there is a surplus of 0.32 L/s during peak water demand on Farm 4/45 available for Mura Solar Facility 2, after deducting the water requirements for Mura Solar 1. This could, pending authorisation, be used to reduce the shortfall for Mura Solar Facility 2, and additional supply could potentially be sourced from Farm portions 3/45 & 12 (**Table 8**). Such solutions may require considerable development of infrastructure, e.g. a pipeline of some kilometres depending on location and proximity of borehole(s) in relation to the position at which the supply is required, which itself could result in additional (c) and (i) water uses.

If such a solution of using multiple farm portions and boreholes to remain within the GA threshold proves unfeasible for the project the demand could potentially be met by each of the respective farm portions, if sufficient groundwater resources are proven (e.g. 1.57 L/s [>1.27 L/s] for a given farm portion by exploration and scientific yield testing etc.), the water use will have to be licensed with the Department of Water and Sanitation under Section 40 of the National Water Act, 1998 (Act No. 36 of 1998). If the GA is not exceeded, the intended water use will only need to be registered with the Department of Water and Sanitation under Section 39 of the National Water Act, 1998 (Act No. 36 of 1998).

It must be stressed that the use of groundwater in terms of the GA excludes use within 500 m of a wetland, pan or estuary, and 100 m from the riparian edge of a water course or state dam. Onsite verification of borehole proximity to water courses would be necessary to determine which could be used in terms of the GA.

Table 8 shows the Calculated GA abstraction rates. The GA volume is based on the extent of the farm portions where a cap of 40 000 m^3 has been implemented for farm portions larger than 889 ha in extent.

Table 8: General Authorisation water use, construction and operational requirements and abstraction rates for all farm portions of the proposed Mura Solar Facilities 1 to 4.

Farm Name	Mura Solar Facility	GA (m^3/ha/a)	Area (ha)	GA (m^3/a)	GA (L/s)	Requirement for	
						Construction (L/s)	Operation (L/s)
RE/45	-	45	1 009.48	40 000	1.27	-	-
3/45	-	45	3 837.03	40 000	1.27	-	-
11	4	45	904.11	40 000	1.27	1.52	0.89
13	2	45	3 846.05	40 000	1.27	1.52	0.89
12	-	45	2 161.94	40 000	1.27	-	-
4/45	1 (&2*)	45	3 890.18	40 000	1.27	0.95	0.57
46	-	45	1 981.94	40 000	1.27	-	-
2/49	-	45	700.95	31 542.75	1.00	-	-
RE/206	3	45	8 104.59	40 000	1.27	1.52	0.89
Totals			25 735.34	351 542.75	11.15	5.52	3.23

* For practical purposes, water requirement for Mura Solar Facility 2 has been allocated to Farm 13 only, despite a portion of Mura Solar Facility 2 having been earmarked for construction on Farm 4/45. GA – General Authorisation water use (permissible use with general authorisation application).

8. SCENARIO 1: EXISTING BOREHOLES

There are several existing boreholes that could potentially be utilised for groundwater abstraction to meet the required volumes for construction (pending detailed testing and relevant consent from land owners and DWS). An overview of the potential groundwater supply from existing boreholes for the respective Solar Facilities is given in **Table 9**.

Table 9: Existing boreholes to potentially meet demands for Mura Solar Facilities.

Mura Solar Facility Number	Farm Portion	Borehole(s)	Approximate distance from development (km)	Comment
1	4/45	HBH21/ HBH20	4.0	Equipped with solar pump/wind pump
		3122CD00029	2.3	-
		3122CD00030	2.3	-
		3122CD00031	2.3	-
		GHbh_6	0.8	Equipped with solar pump
	13	GHbh_7	1.9	Not visited.
2	13	HBH11	0.05	Will need to be inspected and equipped
		HBH13	Inside footprint	Equipped with windpump
		GHbh_7	0.2	Not visited.
	12	HBH14	1.4	Equipped with windpump
3	RE/206	HBH7	0.9	Equipped with windpump
		HBH29	0.6	Equipped with windpump
		3122DC00108	0.9	Needs to be confirmed in the field
	2/49	HBH28	0.4	Status unknown
	11	HBH8 3122DC00062	0.01	Equipped with windpump
4	11	HBH8 3122DC00062	Inside footprint	Equipped with windpump
		HBH18	0.4	Equipped with windpump
		HBH19	0.2	Will require equipment
	2/49	HBH28 3122DC00131	0.4	Not equipped will need to be inspected and equipped

It is anticipated that the existing boreholes will require some upgrading to meet the water demands of each of the respective solar facilities and that at least a two (2) boreholes situated on two (2) different farm portions will be required to meet the demand of each of the solar facilities, with the exception of Mura Solar Facility 1. Mura Solar Facility 1 could potentially be supplied under a GA by a single borehole on farm portion 4/45, if sufficient sustainable supply is scientifically proved by yield testing of said borehole.

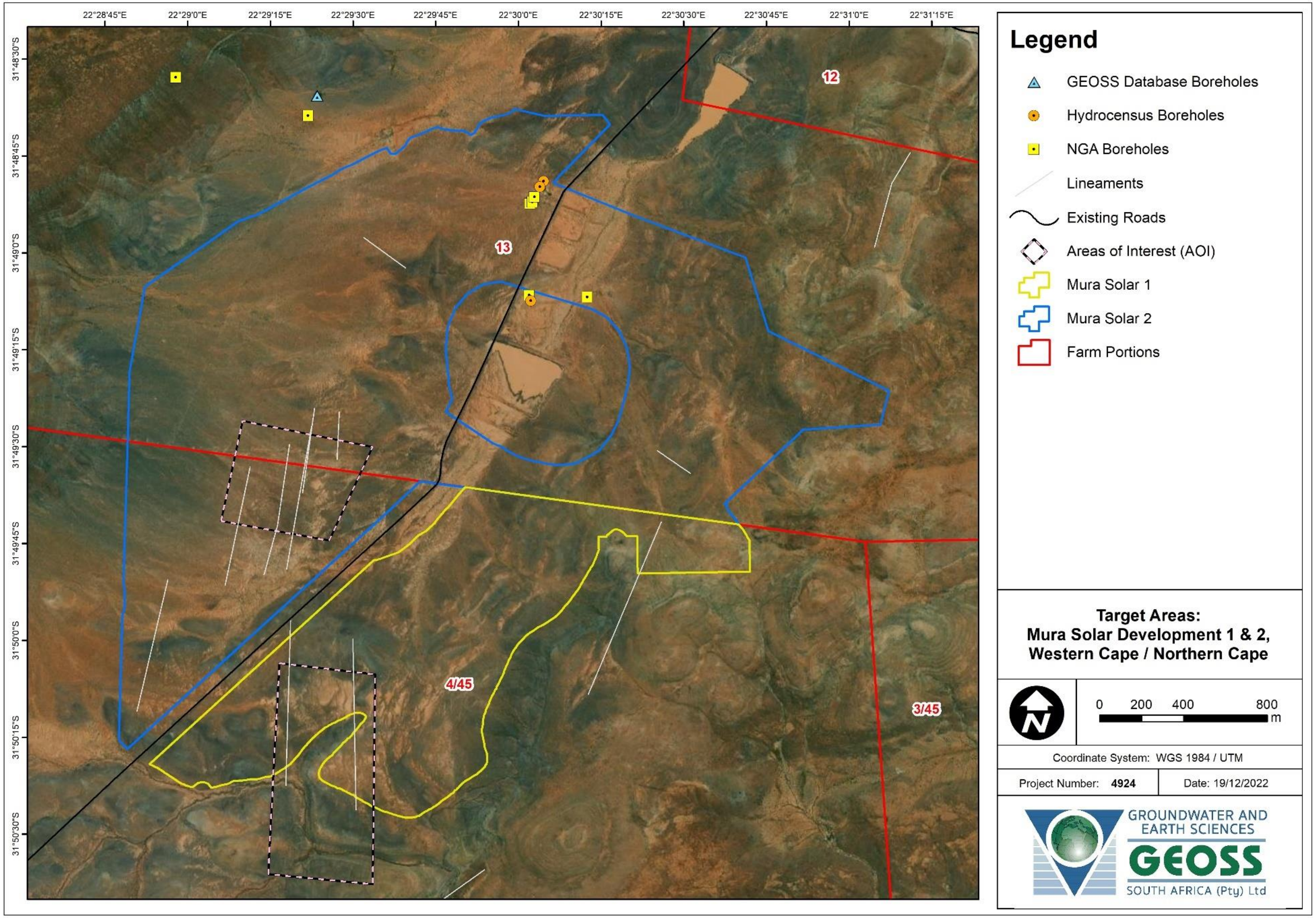
Based on the hydrocensus results, an overview of boreholes that could potentially be used is provided in **Table 9**. It is important to stress that the GA volume is capped at 40 000 m^3/a per farm portion, hence the requisite minimum of two boreholes. The water requirements of some of the Solar Facilities vary; for this reason, potential groundwater resource requirement explanations have been divided in the subsequent sections.

8.1 Water requirements for Mura Solar Facility 1

We understand that the water requirement for Mura Solar Facility 1 is 30 000 m^3/a (0.95 L/s) during the Construction Phase, and 18 000 m^3/a (0.57 L/s) during the Operational Phase. It is important to mention that this requirement falls within the General Authorisation abstraction volume for this region per year, and therefore the water could be abstracted under a General Authorisation and a Water Use License need not be applied for.

For a borehole to supply 30 000 m^3/a it will need to deliver 0.95 L/s, 24 hours per day, year-round. For a borehole to supply 18 000 m^3/a it will need to deliver 0.57 L/s, 24 hours per day, year-round.

In this region, most boreholes are equipped with wind pumps, which deliver yields of between 0.1 and 0.25 L/s depending on the size of the rotor, the local wind rose, and the depth of the pump (and water table).



Map 6: Mura Solar Farms 1 and 2 boundaries showing hydrocensus boreholes, lineaments, areas of interest and farm portions.

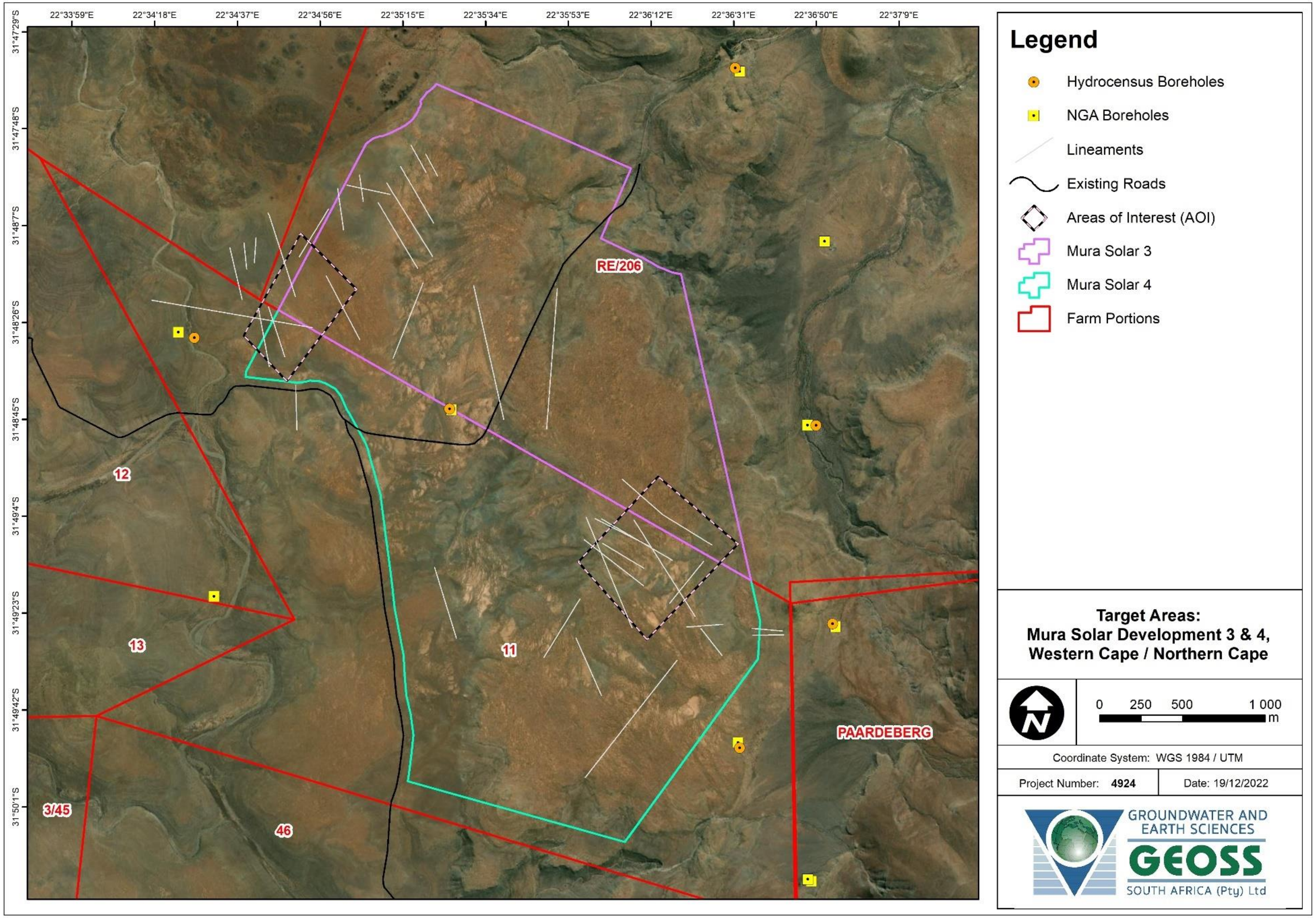
8.2 *Water requirements for Mura Solar Facilities 2, 3 & 4*

We understand the water requirements for Mura Solar Facilities 2, 3 and 4, is/are 48 000 m^3/a (1.52 L/s) during the Construction Phase, and 28 000 m^3/a (0.89 L/s) during the Operational Phase. It is important to note that the annual volumes required for the Construction Phase of Mura Solar Facilities 2, 3 and 4 exceed the volume that may be abstracted from a single farm portion under a General Authorisation. Therefore, two means could overcome this either, two farm portions with at least one (1) borehole on each farm must be used to abstract the requisite volume, or a Water Use License must be applied for. However, the annual water requirements of the Operational Phase of Mura Solar Facilities 2, 3, and 4 fall below the General Authorisation volumes for this region.

For two boreholes to supply a cumulative 48 000 m^3/a (1.52 L/s), each borehole (on each separate farm portion) will need to deliver 0.76 L/s, 24 hours per day, year-round.

Since the water demand during the Operational Phase of the projects is less than the maximum allowable annual volume under General Authorisation, the Operational water requirements could potentially be met by a single borehole on a single farm/property. For a borehole to supply 28 000 m^3/a it will need to deliver 0.89 L/s, 24 hours per day, year-round.

In this region, most boreholes are equipped with wind pumps, which deliver yields of between 0.1 and 0.25 L/s depending on the size of the rotor, the local wind rose, and the depth of the pump (and water table).



Map 7: Mura Solar Farm 3 and 4 boundaries showing hydrocensus boreholes, lineaments, areas of interest, and farm portions.

8.3 General remarks

Boreholes that could potentially be used to meet the water requirements are presented in **Table 9**. The following will need to be considered when only making use of existing boreholes for water supply for each of the Mura Solar Facilities:

- A maximum of either 45/m^3/ha/a, or 40 000 m^3/a (for farms larger than 889 ha) can be abstracted from a single farm portion. Where water demands exceed this, numerous farm portions will be required to meet the demand.
- Boreholes on neighbouring properties may be several kilometres away from the proposed development (i.e. Mura Solar Facilities 1, 2, 3, or 4). This would either require carting of water, or development of pipelines for transport of water. Further, water storage may be required in this case.
- The majority of the boreholes in this region are equipped with windpumps and solar pumps which deliver between 0.1 L/s and 0.25 L/s depending on the size of the rotor, the climate (wind speed/cloud cover) and the depth of the pump (and water table). To meet the demands, upgrades to such windpumps and solar pumps may be required.
- Boreholes that are selected for supply will need to scientifically yield tested according to relevant standards to ensure that the supply can be sustainably met by the borehole.
- Boreholes may need to be deepened, or additional boreholes may need to be drilled.

9. SCENARIO 2: NEW BOREHOLES

An alternative to the utilisation of existing boreholes, is the development of additional groundwater supply. Accordingly, GEOSS sought to identify potential Areas of Interest (AOI) that can be targeted for groundwater development. The delineation of AOIs has been based on identified geologic structures that may potentially control groundwater flow, which in this area, consist mainly of dolerite dykes, contacts between different geological units, and potentially fractured units. The identification of dolerite dykes has been based on published geological maps of the area, interpretation of the available aerial imagery, as well as basic geological mapping and ground truthing during the site visit. GEOSS made use of available Google Earth imagery and ESRI Imagery (sourced from Cape Farm Mapper) of the area. In this section, all the identified dykes, and joints, coupled with areas of interest for the Mura Solar Facilities have been presented (**Map 6; Map 7**) and are discussed.

9.1 Mura Solar Facilities 1 & 2

Several observations that may be helpful during exploration have been made, based on these observations a number of areas of interest for Mura Solar Facilities 1 & 2 have been defined, these are as follows:

- Several lineaments, potential discontinuities have been identified based on the aerial imagery. Where these are abundant or intersect has been delineated as an Area of Interest (AOI) (**Map 6**).

  - o Along the boundary within Mura Solar Facility 2 (and along the boundary of Farm 13 and 4/45).
  - o Within a portion of Mura Solar Facility 1 (within Farm 4/45).
- There is a major dolerite dyke trending in a northeast-southwest orientation to the south and east of Mura Solar Facilities 1 & 2 (**Map 2**). The contact between the Beaufort Group and this dyke could also be investigated in detailed during an exploration phase, if required.

9.2 Mura Solar Facilities 3 & 4

Several observations that may be helpful during exploration have been made, based on these observations a number of areas of interest for Mura Solar Facilities 1 & 2 have been defined, these are as follows:

- The geology underlying Mura Solar Facilities 3 and 4 consist predominantly of the Poortjie Formation of the Beaufort Group (**Map 2**). There is a laterally extensive intrusive dyke/sill that has been mapped along the north-western border of Mura Solar Facility 3 (**Map 2**).
- Two areas, which have several lineations, have been mapped and appear to intersect, occur along the border between Mura Solar Facilities 3 and 4 (and Farm RE/206 and Farm 11) (**Map 7**).

10. SCENARIO 3: COMBINATION OF SCENARIO 1 AND SCENARIO 2

Finally, a third option to consider is to make use of a combination of existing boreholes and drilling new boreholes for further groundwater development. This scenario will depend on the following:

- Whether permission is granted by land/farm owner to make use of the existing boreholes on their properties.
- The volumes that could sustainably be abstracted from the relevant boreholes, this would need to be proven by scientific yield testing according to relevant standards.
- The volumes that are currently being used by the farmer while bearing in mind permissible abstraction in terms of the GA.
- Successful borehole drilling, i.e. intersection of groundwater with a reasonable quality and sufficient sustainable yield, which could supplement any shortfall required on Mura Solar Facilities 1, 2, 3, and 4.

Groundwater quality will be a further factor in determining which boreholes are considered most appropriate for supply.

11. POTENTIAL IMPACTS

11.1 Groundwater impact as a result of groundwater abstraction.

Based on the cumulative area of 25 735.34 ha (i.e. total area of Farm portions 11, 13, 12, 3/45, 4/45, RE/45, 46, RE/206) over which the Mura Solar Development is to be constructed 351 542.75 m^3/a (11.15 L/s) of groundwater may be abstracted under a GA (Table 8). However, this comes with several caveats which would need to be clarified with a professional prior to submission of GA to the Department of Water Affairs, e.g. this entire volume may not be extracted from a single farm portion. The cumulative groundwater volume requirement (per annum) during the construction phase is 174 000 m^3/a (5.52 L/s), and during the operational phase is 102 000 m^3/a (3.23 L/s). These yields exceed the average yield potential of single boreholes within the underlying aquifers (0.1 – 2.0 L/s). For this reason, it is anticipated that several boreholes, across several farm portions, will be required to meet the demands of the proposed development.

Assuming that a conservatively low borehole yield of 0.1 L/s is attained in the region (e.g. wind pump - lower bound), fifty-five (55) boreholes would be required to meet the Construction Phase water demands for the Mura Solar Facilities. Based on information collected during the hydrocensus from Mr Potgieter (**Appendix C**), there are at least 55 boreholes in this area, and it must be pointed out that this does not cover the entire area over which the Mura Solar Development is to be constructed. Therefore, it is believed that the impact on the groundwater availability of this facility is low/insignificant, since there is likely a similar lower cumulative volume presently being extracted. Presently, these boreholes are solely used for livestock watering and domestic use, the impact of which is minimal in terms of groundwater abstraction volumes.

Groundwater monitoring is recommended to ensure that groundwater abstraction is sustainable due to the high number of existing boreholes in the area. This would also be required to ensure that the abstraction volume is kept under the calculated GA volume for the development of the proposed Mura Solar Facilities.

The monitoring will also indicate if the groundwater resource is impacted and mitigation measures can be instituted before long term impacts occur. Mitigation for over-abstraction would be reduction in abstraction. It is therefore highly improbable that the groundwater resource will be depleted as a result of over abstraction, should a quarterly monitoring programme be instated. Broadly, the quarterly monitoring programme should include the following:

1. Monitoring of abstracted volumes, this would allow for the determination of the cumulative abstraction across each of the Farm portions and boreholes to be made. This can be achieved using flow meters.
2. Monitoring of groundwater levels, to evaluate the response of groundwater abstraction on the water table. This was be conducted manually or using telemetry systems.
3. Monitoring of general field chemistry, e.g. pH, EC and temperature. However, during the construction period, the analysis and sample collection should include SANS 241 analysis for one year before and after the construction period – if the project schedule allows.

The final monitoring programme should be guided by a hydrogeologist.

11.2 Aquifer vulnerability classification (DRASTIC)

The national scale groundwater vulnerability map, which was developed according to the DRASTIC methodology (DWAF, 2005), indicates that the site has a "Low / Medium" vulnerability to surface-based contaminants (Conrad and Munch, 2007) (**Map 8**).

The DRASTIC method considers the following factors:

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

The number indicated in parenthesis at the end of each factor description is the weighting or relative importance of that factor. The "Low / Medium" rating is associated with, amongst other factors, the depth to the water table, the geology/soil type(s) in the area, the amount of recharge and the topography in this region.

11.3 Potential Impact on Groundwater Quality as a result of Accidental Oil Spillages or Fuel Leakages, and cleaning agents

Groundwater vulnerability can be defined as the "tendency for contaminants to reach a specified position in the groundwater system after introduction at some location" (National Research Council, 1993). The national scale groundwater vulnerability map, which was developed according to the DRASTIC[†††] methodology (Conrad and Munch, 2007) indicates that the study site has a low/medium to low vulnerability to surface-based contaminants (**Map 8**).

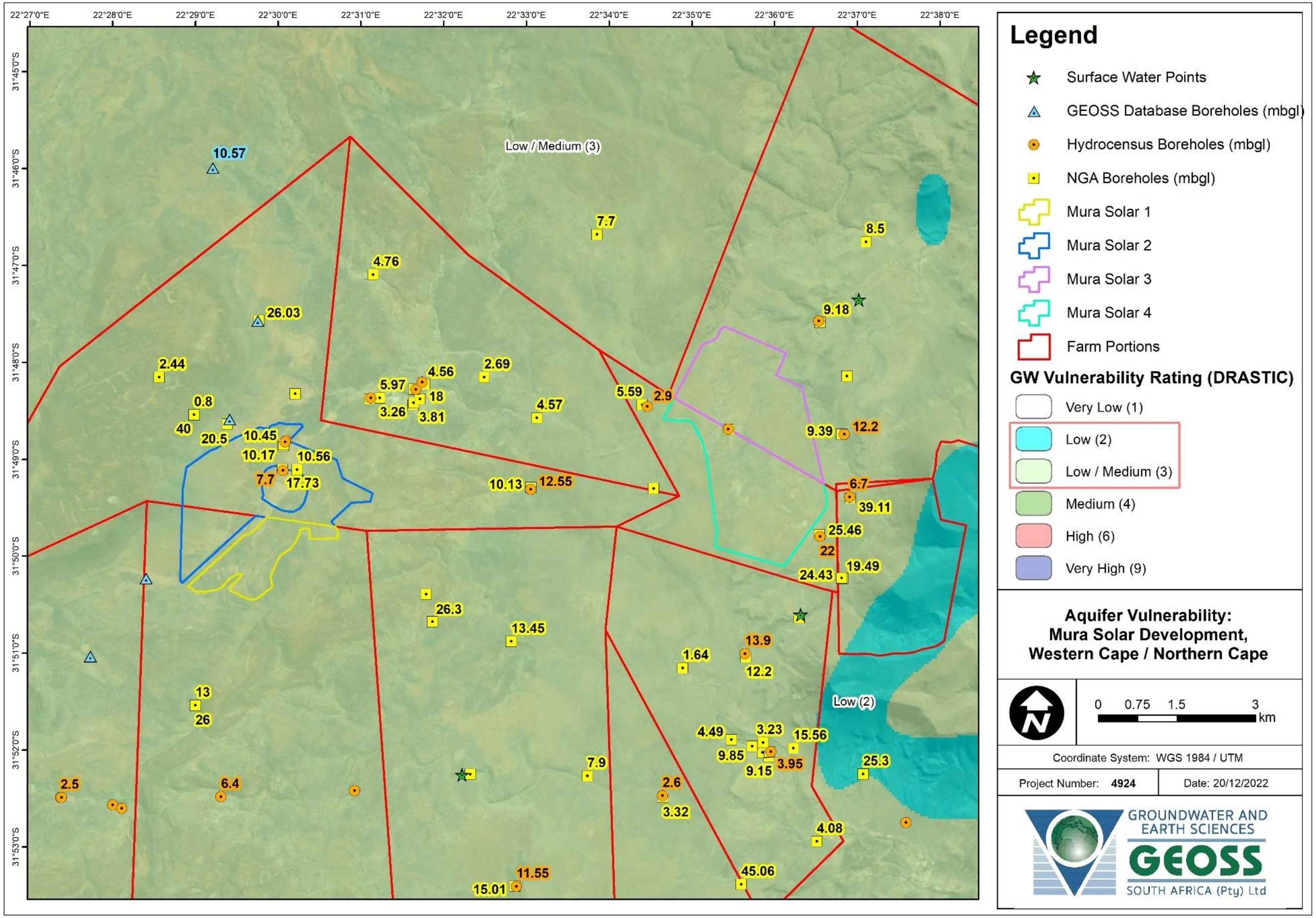
A precautionary approach must be implemented and reasonable measures must be undertaken to prevent oil spillages and fuel leakages from occurring during the construction phase:

1. Vehicles must be regularly serviced and maintained to check and ensure there are no leakages. A designated area should be established at the construction site camp for this purpose.
2. Any engines that stand in one place for an excessive length of time must have drip trays.
3. Diesel fuel storage tanks should be above ground on an impermeable concrete surface in a bunded area.
4. Construction vehicles and equipment should also be refuelled on an impermeable surface. A designated area should be established at the construction site camp for this purpose, if off-site refuelling is not possible.
5. If spillages occur, they should be contained and removed as rapidly as possible, with correct disposal procedures of the spilled material, and reported.
6. Proof of disposal (waste disposal slips or waybills) should be obtained and retained on file for auditing purposes.

Further, for solar panels to function optimally the solar panels will need to be cleaned. We understand that cleaning agents may be required for cleaning of solar panels; should this be the case, biodegradable and/or environmentally friendly agents should be used to reduce/minimise the impact of solar panel cleaning on the quality of the regional/local groundwater quality. To ensure that any harmful chemicals are detected, an appropriate groundwater monitoring program should be instated. If harmful chemicals are detected, the services of a specialist subconsultant should be

[†††] DRASTIC is a model that considers the main hydrological and geological factors with a potential impact on aquifer pollution. Its acronym stands for D—depth to groundwater, R—recharge rate, A—aquifer, S—soil, T—topography, I—vadose zone's impact, and C—aquifer's hydraulic conductivity

sought to remediate contamination of the groundwater. With effective implementation of the above prevention / mitigation actions, the impact of the project on groundwater as a consequence of accidental oil spillages and fuel leakages, and cleaning of solar panels is predicted to be of very low significance.



Map 8: Vulnerability rating superimposed on aerial imagery showing borehole locations and associated depths to groundwater (Conrad and Munch, 2007).

11.4 Cumulative Impacts

The water requirements during the construction and operational phases of the proposed Mura Solar Development are outlined in **Section 8**. There are several similar renewable developments (e.g. wind energy facilities) that have been planned for this region. We understand that portions of the Nuweveld Wind Farm (Nuweveld North Wind Farm and Nuweveld East Wind Farm) will be constructed within the same farm portions as those earmarked for the Mura Solar Cluster. We understand that typical water requirements for the construction phase of such facilities are of the order of 90 000 m^3/a (1.27 L/s), and approximately 2 500 m^3/a (0.079 L/s) during the operational phase (GEOSS, 2021a; GEOSS, 2021b).

Assuming a worst-case scenario, that each facility (i.e. the Mura Solar Development and the Nuweveld North Wind Farm and Nuweveld East Wind Farm) will commence with the construction phase simultaneously, a total volume of 354 000 m^3/a would be required, which exceeds the annual water available under a GA (351 542.75 m^3/a, see **Table 8**). Assuming all facilities (i.e. the Mura Solar Development and Nuweveld North Wind Farm and Nuweveld East Wind Farm) will assume the operational phase simultaneously, the cumulative water demands for these facilities will be in the region of 106 861.28 m^3/a, which is less than the cumulative groundwater abstraction that is allowable under a GA (**Table 8**).

However, the above assumes that the Wind Farms and Solar Farms will be developed simultaneously, that each component of the facility is constructed and operated in parallel, and that the entirety of the water requirements for the Nuweveld North Wind Farm and Nuweveld East Wind Farm will be allocated to the Farm portions on which Mura Solar Development is to be constructed. Further, it is important to point out the GA volume includes Farm Portion 2/49.

The cumulative impacts due to the water requirements are unlikely to cause a significant impact on the aquifer(s) underlying the Mura Solar Facilities and/or the Nuweveld Wind Farms. However, the impact would need to be monitored during these periods to assess the potential impact in real time for the life of the facility.

Chemical contamination of the soils, rocks and groundwater beneath the sites that have been proposed for development also pose risk to the environment due to cleaning of solar panels, albeit low. However, it is advised that (chemical) groundwater monitoring be conducted on at least a quarterly basis as precaution for contamination during the construction phase and for a year following. If changes in the groundwater chemistry are detected (e.g. chemicals derived from cleaning agents or compounds derived from petroleum), the advice of a specialist subcontractor should be sought for remediation of the groundwater chemistry.

The amount and use of water during decommissioning phases of each solar facility, at this stage, is uncertain. Decommissioning will likely require the usage of heavy machinery and other equipment; therefore, precaution should be taken for spilling of hydrocarbons and contamination related to the operation of this equipment. It is recommended that monitoring of groundwater quality be implemented during this phase. The monitoring interval would depend on the works to be undertaken and the stipulated time-frame in which the works would have to take place.

The cumulative impacts of the Mura Solar Facilities and the Nuweveld Wind Farms, with respect to groundwater quality, is believed to be minimal. Considering that the sites will be exposed to contamination sources during construction and decommissioning phases mainly, which is expected to be short periods of time in comparison to the operation phase of the facilities. The total water usage is also relatively low and will also be at a minimum during the longer operation phase. Thus, the cumulative impacts are considered minimal.

It would be prudent to consider the implementation of a quarterly monitoring programme, ideally initiated at least one year prior to the commencement of construction if the project timeframes permit. This would serve to confirm the baseline water levels throughout one wet and dry season cycle, as well as confirm the baseline water quality. Monitoring would also ensure that the extracted volumes comply with relevant authorised abstraction volumes. Temporal water level, water quality and abstraction data should be collected. This data should be reviewed and interpreted on at least a quarterly basis. This assessment (and similar assessments in the area) would need to be reviewed if and when final water requirements for the area become available, e.g. if additional water is required for additional/new developments in the region, or if water requirements for any of the facilities change.

12. RECOMMENDATIONS

The following recommendations are made:

- The groundwater supply can be sourced from either existing boreholes, newly developed boreholes, or a combination of these options.
- The legal status of groundwater use at each property should be confirmed. This will inform the need for future water use authorisations. All water uses as defined in the NWA (1998) need to be considered.
- Every effort should be made to visit all boreholes and undertake yield and quality tests at boreholes that could be considered for future supply (based on their relative proximity). The information obtained from the NGA database would be a useful starting point in determining which of the boreholes should be tested for their yields. Further, the relative sizes, GA volumes (if the intention to use water in terms of GA) of the respective farm portions should also be considered when planning scientific yield testing.
- Groundwater exploration via geological and geophysical methods is recommended for all of the proposed wind farms, should existing boreholes not be sufficient to meet the demand. Groundwater exploration aims to understand the geological environment, which can increase the chance of borehole success, and provide more realistic yields and depths of a borehole to be drilled, which could be expected.
- All boreholes planned for use will require scientific yield and quality testing and analysis.
- Monitoring of groundwater (abstraction volumes, quality and water levels) will be required, this should ideally be implemented one year prior to the start of construction if the project timeframes permit.

13. CONCLUSION

There are multiple sources and scenarios that could potentially supply the required peak requirement (during the construction phase) of 174 000 m^3/a for the proposed Mura Solar Development. This could be achieved through utilising existing boreholes only which are close to existing and planned infrastructure (pending relevant consent and authorisations). The use of existing boreholes will depend on a number of factors such as scientifically proven sustainable yields of the boreholes, existing use and authorisation of the farmer, as well as whether the farmer would engage in an agreement for the wind farms to make use of his boreholes. It is anticipated that the bulk of the requisite 174 000 m^3/a could be sourced from existing boreholes. However, this would depend on cost and logistics and supply available from each borehole.

An additional option would be to drill new boreholes. This can be achieved by conducting a geological and geophysical study to confirm lineaments (dykes) visible on aerial imagery followed by drilling and scientific yield and quality testing. The region shows promise for further groundwater development; however, this will need to be confirmed by groundwater exploration, drilling and testing.

The third and final scenario entails a combination of the above-mentioned options, i.e., making use of existing borehole and drilling of new boreholes.

It must be stressed that the GA limit of 40 000 m^3 applies to each farm portion larger than 889 hectares and this should be adhered to – should the application for a water use license not be an option. All conditions of groundwater use in terms of the general authorisation will be applicable and important to consider. This can be guided by a professional with knowledge of the National Water Act ensuring that the water used, during construction and operation of the solar farms, is lawful.

The volumes of water required for the development should be readily available, and could be sourced from groundwater in the region. It may not be feasible or practical to extract water under a General Authorisation for the Mura Solar Facility since several triggers for WULs exist, e.g. pipelines may be required to distribute the groundwater to areas in which it is required which could be costly, and could potentially trigger the need for a WUL. Further, roads traversing water courses, which may not have been mapped, but are evident in the field could potentially trigger a WUL. Therefore, such practical considerations will need to be considered. Finally, present/future groundwater abstraction taking place on the farms annually for agricultural purposes will also need to be considered when determining the total volumes used across the property, i.e. the cumulative demands of agriculture and construction and/or operation of the Mura Solar Facility (and/or other such facilities in the region).

In general, it is anticipated that the underlying aquifers will be able to deliver the requisite cumulative demands during the construction (354 000 m^3/a) and operational (106 000 m^3/a) phases, for all of the proposed Mura Solar Development, i.e., Mura Solar Facility 1 to 4, as well as the Nuweveld Wind Development, i.e., Nuweveld North, and East. That being said, a quarterly groundwater monitoring programme should be instated to ensure that no groundwater contamination takes place during the construction or decommissioning phases of this development. Further, monitoring would serve to ensure that the water use is lawful, and confirm that impacts of abstraction on the regional aquifer(s) is negligible. Therefore, these recommendations are considered imperative.

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15. APPENDIX A: NGA & HYDROCENSUS DATABASE

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 DC0 0033	-31.91684	22.54276	23.83				69.00					BH	
3122 DC0 0034	-31.91298	22.51868	12.54				88.60					BH	
3122 CD0 0047	-31.91168	22.47604	21.71				78.10					BH	
3122 DC0 0030	-31.91095	22.56548					79.00	0.6300				BH	
3122 DC0 0050	-31.89840	22.58284	3.23				14.50					BH	
3122 DC0 0015	-31.89543	22.60084	7.84	83.0			40.00					BH	
3122 DC0 0043	-31.89054	22.54707	15.01	136.6			25.00					BH	
3122 DC0 0029	-31.89034	22.59268	45.06				122.00	0.3200				BH	
3122 DC0 0028	-31.88301	22.60798	4.08				43.00					BH	
3122 DC0 0049	-31.87534	22.57690	3.32	58.8			55.00				HBH5?	BH	
3122 DC0 0048	-31.87159	22.56176	7.90				35.50					BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS/m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122DC00042	-31.87145	22.61736	25.30				44.00					BH	
3122DC00047	-31.87126	22.53810		73.2							S2?	S	
3122DC00027	-31.86837	22.59834	9.15	159.0			79.00					BH	
3122DC00023	-31.86770	22.59707	5.89	155.6			84.00					BH	
3122DC00026	-31.86759	22.59851	4.20	169.5			76.00					BH	
3122DC00017	-31.86698	22.60332	15.56				59.30					BH	
3122DC00022	-31.86662	22.59498	9.85	90.1			28.50					BH	
3122DC00024	-31.86634	22.59721	3.23	107.0			84.00	12.6000				BH	
3122DC00025	-31.86598	22.59721	3.23				61.00					BH	
3122DC00021	-31.86545	22.59084	4.49				94.00	6.3000				BH	
3122CD00030	-31.85916	22.48273					36.00		Shale (0,0-33,0); Dolerite (33,0-36,0)			BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 CD0 0029	-31.85915	22.48273	13.00				84.00	2.5600	Dolerite (0,0-56,0); Shale (56,0-84,0)			BH	
3122 CD0 0031	-31.85915	22.48274	26.00				39.00	0.1000	Shale (0,0-34,0); Dolerite (34,0-39,0)			BH	
3122 DC0 0020	-31.85312	22.58104	1.64				15.20					BH	
3122 DC0 0018	-31.85126	22.59376	12.20	73.5			76.00				HBH1?	BH	
3122 DC0 0044	-31.84840	22.54651	13.45	86.7			61.00					BH	
3122 DC0 0046	-31.84498	22.53065	26.30				26.80					BH	
3122 DC0 0019	-31.84459	22.60459		50.9								S	
3122 DC0 0045	-31.84023	22.52934					84.20	1.2000	Sand (0,0-2,0); Dolerite (2,0-58,0); Sand (58,0-84,2)			BH	
3122 DC0 0130	-31.83782	22.61342	19.49				59.00					BH	
3122 DC0 0129	-31.83773	22.61318	24.43	115.0			31.00					BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 DC0 0068	-31.83026	22.60876	25.46				36.00				HBH19?	BH	
3122 DC0 0131	-31.82398	22.61501	39.11	164.0			76.00				HBH28?	BH	
3122 DC0 0063	-31.82220	22.57532					0.40					BH	
3122 DC0 0064	-31.82195	22.55059	10.13	102.0			19.00					BH	
3122 DC0 0038	-31.81868	22.50343	10.56	70.5			42.00	20.0			HBH11?	BH	
3122 DC0 0040	-31.81859	22.50051	17.73	115.0			6.00				HBH11?	BH	
3122 DC0 0051	-31.81465	22.50057	10.45	82.0			18.00					BH	
3122 DC0 0052	-31.81458	22.50069	10.17				20.40					BH	
3122 DC0 0053	-31.81437	22.50080	10.00				19.50					BH	
3122 DC0 0107	-31.81298	22.61326	9.39	56.5			25.00				HBH29?	BH	
3122 DC0 0062	-31.81207	22.59054		113.0			36.00				HBH8?	BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 CD0 0044	-31.81082	22.48940	20.50	77.0			26.00				GHbh_7?	BH	
3122 DC0 0058	-31.80998	22.55182	4.57	132.0			40.00					BH	
3122 CD0 0028	-31.80917	22.48273					35.00		Dolerite			BH	
3122 CD0 0026	-31.80916	22.48273					31.00		Dolerite		HBH6?	BH	
3122 CD0 0025	-31.80915	22.48273	0.80				43.00	0.8000	Dolerite (1,0-45,0)			BH	
3122 CD0 0027	-31.80915	22.48274	40.00				115.00		Dolerite			BH	
3122 DC0 0061	-31.80779	22.57311	5.59	81.0			14.00					BH	
3122 DC0 0066	-31.80766	22.52690	3.81				16.00					BH	
3122 DC0 0065	-31.80726	22.52701	3.26				12.00					BH	
3122 DC0 0009	-31.80664	22.52829	18.00				36.00	2.5001	Shale (0,0-14,0); Dolerite (14,0-36,0)			BH	
3122 DC0 0060	-31.80662	22.51818		78.9			25.00				HBH14?	BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 DC0 0059	-31.80645	22.52018	5.97	81.3			33.00					BH	
3122 DC0 0054	-31.80562	22.50315					6.00					BH	
3122 DC0 0057	-31.80495	22.52707		115.0			30.00				HBH16?	BH	
3122 DC0 0056	-31.80409	22.52923	4.56	141.0			10.00				HBH17?	BH	
3122 DC0 0108	-31.80298	22.61440										BH	
3122 DC0 0067	-31.80293	22.54126	2.69	135.0			34.00					BH	
3122 CD0 0048	-31.80270	22.47573	2.44				13.00					BH	
3122 DC0 0109	-31.79370	22.60901	9.18	60.5			26.00				HBH7?	BH	
3122 CD0 0050	-31.79301	22.49590	26.03	104.5			70.00					BH	
3122 DC0 0055	-31.78523	22.51894	4.76	80.0			11.60					BH	
3122 DC0 0112	-31.77993	22.61832	8.50				27.00					BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
3122 DC0 0133	-31.77843	22.56412	7.70				11.00					BH	
HB H1	-31.85067	22.59363	13,9	91	6,7					w	No problems experienced with pump during drought.	BH	Yes
HB H2	-31.89057	22.5473	11,55	150	6,9	750				w		BH	
HB H3	-31.92058	22.49335	-	97	7,4	480				w	Vlak kamp centre.	BH	Yes
HB H4	-31.93025	22.50639	1,8							b	Vlak kamp lande. Broken. Used to have solar pump.	BH	
HB H5	-31.87503	22.57685	2,6	77	7,6	380				w	Ou ooikamp/rammekamp	BH	
HB H6	-31.86756	22.59875	3,95	96	7,6	470				w	Homestead borehole, one of several.	BH	
s1	-31.84398	22.60487	Surface	55	7	270					Piped to reservoir. Less water in drought. Old structures observed in area.	S	
s2	-31.87128	22.53644		58	7,7	280					Duikerskrans. Willows observed in riverbed. Old stone houses observed. Deeper holes in riverbed, apparently remain wet. River was running due to recent rains.	S	
HB H7	-31.79351	22.60873	-	34	6,9	160				w	Equipped to service livestock. Could not use dip meter.	BH	Yes
HB H8	-31.81202	22.59042	-	105	7,1	520				w	Windmill has ~1,5 m diameter rotor.	BH	Yes
HB H9	-31.77453	22.65276		79	7,6	390		3.33		e	Yield ~ 12 000 L/hr. Eskom pump. Field chemistry taken from tap in kitchen.	BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
s3	-31.78978	22.61685									Could not visit spring at this time. Dried up in drought, but has been recharged by rain.	S	
HB H10	-31.774842	22.653253	-	-	-	-				w	Could not visit at this time.	BH	
HB H11	-31.81883	22.50058	7,7							o	Believed to have reasonable yield. Old pump mount nearby. Rabbit or something encountered in the hole using the dip meter; could not measure field chemistry.	BH	
HB H12	-31.81369	22.50126								o	Hole fallen closed.	BH	
HB H13	-31.81393	22.50106	-	74	7,1	360				w	Could not dip.	BH	Yes
HB H14	-31.80642	22.51838								w	Supplies homestead. Could not dip.	BH	
HB H15	-31.82224	22.55053	12,55	77	7,5	380				w	Sulphur smell.	BH	Yes
HB H16	-31.80501	22.52744		156	7,4	780				w	Windmill has ~1,5 m diameter rotor. Fed to JoJo tank and reservoir; sample taken from reservoir. Understood to be a combination of HBH14 and HBH16.	BH	
HB H17	-31.804617	22.531257								w	Understood to have very little water.	BH	
HB H18	-31.80810	22.57414	2,9	66	7,6	320				w		BH	
HB H19	-31.83055	22.60886	22	92	7,3	450				o	Removed pump for unknown reason. Bailed	BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
											field sample. Water dirty - maybe due to borehole sides.		
HBH20	-31.87395	22.51472								w	Could not access borehole at this time.	BH	
HBH21	-31.87492	22.48780	6,4	108	7,5	520				s		BH	
HBH22	-31.876241	22.46594		60	7,8	300				a		BH	Yes
HBH23	-31.876846	22.467721		64	7,7	310				w	Considered to be 'connected' to HBH22 based on anecdotal evidence.	BH	
HBH24	-31.87492	22.45539	2,5							o	Open hole. Broken windpump.	BH	
HBH25	-31.87490	22.45563		68	7,3	340				w	Another windpump between HBH25 and HBH26.	BH	
HBH26	-31.87797	22.43050		119	7,3	590				w	Could not dip.	BH	
HBH27	-31.88645	22.41978	15,1							s	Could not get sample. 36V indicated on electrical box.	BH	
HBH28	-31.82382	22.61482	6,7							w	Dip meter could not get deeper. Appears to have fallen closed.	BH	
HBH29	-31.813	22.61381	12,2	82	6,9	380				w	Rotor some 1,5 m in diameter.	BH	
HBH30	-31.87983	22.62600								w	Could not access borehole at this time.	BH	
GHBh_1	-31.8976739	22.4113211	21.19	120	7.6	530		-		w	Wind pump.	BH	Yes
GHBh_6	-31.8372744	22.4728688	-	142	7.3	720		-		s	Submersible pump equipped, solar power. No access point for WL.	BH	

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	WL (mbgl)	EC (mS /m)	pH	TDS (mg/L)	Depth (m)	Yield (L/s)	Lithology	Equip.	Comment	Type	Sample
GH Bh_7	-31.809971	22.489863	-	-	-	-		-			N/A	BH	
GH Bh_9	-31.793065	22.495642	-	-	-	-		-			N/A	BH	
GH Bh_11	-31.7666882	22.4867328	10.57	110	7.3	520		0.5		w	Wind pump.	BH	
GH Bh_12	-31.806064	22.442732	-	-	-	-		0.4			N/A	BH	
GH Bh_21	-31.8506342	22.4615398	-	120	7.8	580		-		w	Wind pump. No access point for WL.	BH	

Note: w – windpump; s – solar; o – open/no equipment; e – Eskom-powered; b – broken; a – artesian.

16. APPENDIX B: BOREHOLE PHOTOS

ID	Latitude (DD, WGS84)	Longitude (DD, WGS84)	Photo
HBH1	-31.85067	22.59363	
HBH2	-31.89057	22.5473	
HBH3	-31.92058	22.49335	

HBH4	-31.93025	22.50639	
HBH5	-31.87503	22.57685	
HBH6	-31.86756	22.59875	
HBH7	-31.79351	22.60873	

HBH8	-31.81202	22.59042	
HBH9	-31.77453	22.65276	
HBH10	-31.774842	22.653253	
HBH11	-31.81883	22.50058	

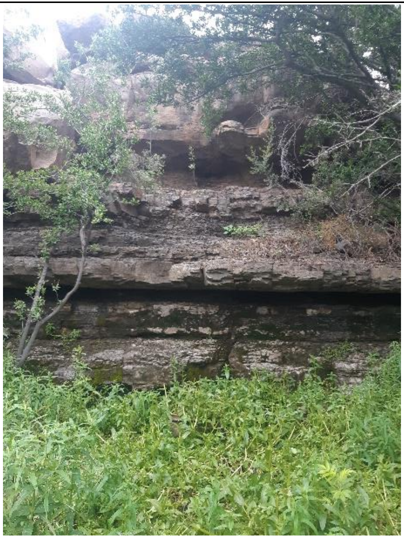
HBH12	-31.81369	22.50126	
HBH13	-31.81393	22.50106	
HBH14	-31.80642	22.51838	
HBH15	-31.82224	22.55053	

HBH16	-31.80501	22.52744	
HBH17	-31.804617	22.531257	
HBH18	-31.80810	22.57414	

HBH19	-31.83055	22.60886	
HBH20	-31.87395	22.51472	No photo available
HBH21	-31.87492	22.48780	
HBH22	-31.876241	22.46594	

HBH23	-31.876846	22.467721	
HBH24	-31.87492	22.45539	
HBH25	-31.87490	22.45563	

HBH26	-31.87797	22.43050	
HBH27	-31.88645	22.41978	
HBH28	-31.82382	22.61482	
HBH29	-31.813	22.61381	

HBH30	-31.87983	22.62600	
S1	-31.84398	22.60487	
S2	-31.87128	22.53644	
S3	-31.78978	22.61685	

17. APPENDIX C: BOREHOLE DATA FROM MR POTGIETER

	Hoogte v. bo	Diepte v gat	mS/m Water kwal
(14) A Koppieskamp in sloot HBH18	5,6 m	14 m	81
B " teen Abrahamsdraai	HBH8		113
(15) Perdeberg HBH19			
(16) Onder Grootkamp 1			
16			
Gansfontein.			
(1) Putskamp 3	7,7m	11 m was 30 m	
(2) Theefontein 3			57
(3) Theefontein (fontein)			53
(4) Huis langs masjienkamer	4,3 m	25 m	
(5) Huiswater langs visdam			96
(6) Lusern			89
(7) By Grootdam	12 m	33,6 m	
(8) Turbine			
(9) Oop dammetjie by boormasjien!			73
(10) Klein groen mono			
(11) Verste van volkshuise	8,3 m	38 m	
(12) By volkshuise sonder wiel	7,1 m	33 m	
(13) " " groentetuin 1	6,4 m	33 m	85
(14) Slagberg - Rietfontein 2			68
(15) Slagberg - Preiskloof 2	39 m	47 m	61
(16) Biesiespoort - sonder kop 2	29,4 m	39,5 m	
(17) Biesiespoort 1	9,8 m	31 m	69
(18) Springbokkamp 2	17,4	55,5 m	
(19) Bontberg. 2	17,3 m	23 m	110
(20) Bontberg Lande oop gat by dam 2	13,2 m	18 m	
(21) " Kraykop	12,9 m		
(22) " Windpomp agter wal	13,6	39 m	
(23) Bontberg pomphuisie	15.9 m	34,6 m	
21			

Leeuwkloof.	Krippe	Hoogte van bo.	Diepte v. gat	mS/m Water kwal.
① Dompelpomp Huis		0.9 m	480 ~~ft~~ 146 m	72
② Huiswater		0.9 m	152 m	75
③ Klein pomp (Bo lande)	1	4.3 m	50.3 m	66
④ Groot pomp (")				
⑤④ Huiskamp	2	8.2 m	25 m	109
⑥ Springbokkamp (Lamerslaagte)	3	24 m	42 m	123
⑦ Sonpomp Springbok		34 m	42 m	86
⑧ Klein Donkerhoek		6.5 m		
⑨ Busstopkamp	1	25,5 m	34 m	73
⑩ Seerplaat	2	9,6 m	27 m	83
⑪ Ou Ooikamp	1	7,7 m	24 m	70 HBH5?
⑫ Vaalkop	2	20 m	49 m	75
⑬ Rapuishang	3	20,8 m	27 m	80
⑭ Sandkamp		6,9 m	26 m	154
⑮ Eldorado	2	12,9 m	21 m	67
⑯ Vaalkopstuk	2	8,2 m	14 m ?	107
	19			
Bultfontein:		~~26,6 m~~	~~67 m~~	~~85~~
① Voor Rapuis	2	26,6 m	67 m	85
② Lande	2	10,6 m	18 m	70
③-5 Bosdam windpomp.	2	10,4 m	18 m	82
④ " Tur (HBH 12)		10,2 m	20,4 m	82
⑤ " oop gat (HBH 11)		10 m	19,5 m	82
⑥ Voor Rapuishang	1	20,5 m	26 m	77
⑦ Springbokhang	3	26 m	70 m	105
⑧ Bo Skuinskop.	2	4,8 m	11,6 m	80
⑨ Huis: Kleinkampie Soppies	1	4,6 m	10 m	141
⑩ Groot Huis				115
⑪ Bo Rivierkamp	2?	4.6 m	40 m	132
⑫ Huiskamp naaste Huis		6 m	33 m	81
⑬ Huiskamp				79

(last page)