TECHNICAL SPECIFICATIONS

Drilling and Commissioning of Two (2) x solar powered - boreholes in the Free State

Phase 1: Water Survey

Specifications Item	**Specifications Details**
Site establishment	Initial preparation of a construction site for borehole drilling
Borehole sitting and geophysical surveys by Geohydrologists ((Use Advanced Electronics Survey Machines)	The survey report must be a detailed analysis of the groundwater potential, and the following must be reflected in the survey report: • **location** of the site to be drilled through the use of Geohydrologist expertise, geological and hydrogeological maps, and advanced geophysical instrumentation. • **The correct drilling method/rig** • **Drilling depth/target** For each borehole, a surveyor must select a suitable line of survey for identification of suitable drill targets. For each borehole siting/survey, a 200 meters long geophysical traverse must be surveyed at 5m spacing, with the use of both Pulse Quick Wavelet Transform (PQWT), and Magnetic method (Proton Magnetometer). These survey techniques must be used interchangeably.

	The hydro-geological report must be signed off by a professional Certified Natural Scientist that is registered with **SACNASP** Note: **Survey report** to be handed to ARC Personnel. The survey report must include the instruments and methods used. No drilling work will be conducted without a professional survey report **If the geohydrologists reports no ground water availability in the farm, then no borehole water drilling work will continue. The service provider will be paid for only survey work.**

Phase 2: Borehole Drilling, Casing and Capping

Borehole drilling	150m borehole (165mm diameter) Drilling work to be conducted according to SANS 10299-: 2003 – Development, Maintenance and Management of Groundwater Resources
Casing	**<u>12m steel casing: Casing 177mm x 3mm,</u>** Steel casings must be welded together one by one while lowering them down the borehole
Concrete collar around a borehole	The Drilling Contractor will construct a **shallow circular concrete collar** around a successfully completed borehole. This collar shall have the dimensions set out in the attached Drawing as seen in **APPENDIX A.1**, yielding a volume approaching 0.08 m^3. **The concrete mixture shall consist of water, Portland cement, stone aggregate (10 mm),** and river sand. Quantities of these

	materials sufficient to make 0.1 m^3 of concrete with the required strength of 30 MPa after 28 days are: (1) 20 litre of water, (2) 42 kg (0.8 bag) of Portland cement, (3) 0.07 m^3 of stone aggregate and (4) 0.07 m^3 of river sand
Cap	The drilling contractor must put a **borehole cap** to prevent any foreign material from entering the borehole
Drilling Machine Requirements	The equipment must be of a suitable size and capacity to deal, on occasion, with: • Deep boreholes (up to 200 m) • Larger than average borehole diameters (up to 254 mm) • Large quantities of groundwater and • Potentially onerous drilling conditions
Borehole drilling report	A driller's log gives details of the construction of the borehole. As a minimum the report must include **Borehole depths and diameters, Casing depths and diameters, Water level, and so on.** A full borehole drilling report must be handed to ARC personnel.
Unsuccessful Borehole	A borehole will be declared unsuccessful at the discretion of the Hydrogeological Consultant who is supervising the borehole drilling. At any time during the course of the work, The Hydrogeological Consultant can order the abandonment of a borehole in progress. When such an unfortunate incidence occurs, ARC will cover only the costs of work done as determined in the bill of quantities (Total costs will be recalculated

	according to costs per item, e.g. costs per meter of casing/drilling).

If soil formation needs less Steel casing, costs must be adjusted accordingly. If soil formation requires more Steel casing, costs can be adjusted to use the contingency amount.

Similarly, cost adjustments must apply if sufficient water is found at less than 150 m or at more than 150 m.

Screening (Steel type can be put under contingency amount should a need arise).

Phase 3: Borehole Yield and Water Tests

48-Hour Borehole Yield Tests-Sustainable yield	Step draw-down and constant discharge tests, and water level recovery tests Determine correct **sustainable yield** according to the South African National Standard for Water Borehole Test Pumping (SANS 10299-4:2003) The borehole yield test serves as a certificate of compliance and as proof that the borehole installation meets the SANS 10299-4:2003 specifications, **thus a <u>Borehole Yield Tests Certificate must be issued</u>** <u>Please see **APPENDIX A.2** for further details</u>
Water tests-Chemical and microbial analysis	Tests must be according to the SANS 241-1: 2015 standards. Test report must be supplied with the conclusion **1. Drinking Water Tests**

	SANS241 Chemistry + Microbiology Testing (Tests to be conducted at SANAS Accredited Laboratory). EC, pH, SAR, Langelier, Ryznar, Turbidity, Colour, Odour, TDS, TSS, Free CI, F, CI, SO_4, NH4-N, NO3-N, NO2-N, Acidity, Alkalinity, Ca, Mg, Na, K, Mn, Fe, Al, HPC Heterotrophic Plate Count, Total coliforms, Faecal Coliforms **2. Irrigation Water Tests** Chemistry & Microbiology Testing (SANS241 Accredited Laboratory) EC, pH, COD, SAR, Langelier, Ryznar, TSS, F, CI, SO4, NH4-N, NO3-N, NO2-N, Alkalinity, CO3, HCO3, Ca, Mg, Na, K, B, Mn, Fe, P, Faecal coliforms, TDS
Registration & Permitting Process	**Registration & Permitting Process before any drilling work** The service provider must check with local municipalities to clarify the registration process. Additionally, all by-laws must be followed before drilling work commences. In summary, a service provider must obtain an approval to conduct drilling work from local municipal or regulatory authorities. Thus, an approval letter for drilling must be submitted to ARC before any drilling work can commence.

Phase 4: Renewable Energy-Solar PV installations and

Solar System

Specifications Item	**Specifications Details**
Monocrystalline Solar modules (3.33kW) **(555W x 6 solar modules)**	Monocrystalline solar modules aligned to face True North Employ the services of a Geomatics Professional (GPr) or Geomatics Technologist (GTg) Optimum tilt angle must be from 20 to 35 degrees **Brands:** Solar modules: Jinko Solar, Canadian Solar, JA solar, RenewSys, Trinasolar , SunPro, Risen ,Haitai Solar, Astroenergy or **Equivalent**
2.2 kW Centrifugal Solar borehole pump and a 2.2kW Solar pump controller with a Built-in MPPT (Maximum Power Point Tracking) technology). Pump must have a non-return valve to ensure water doesn't flow back into the borehole. **Pump pressure head = 243m** **Flow = 4m^3 /hour**	Water pumping at specified depth (Depth as per drilling contractor advice) Use pump data sheets to select the correct pump that fit the required flow and pressure drop
Level sensor for the submersible pump (to be installed in the borehole)	**Dry-run protection**
Float level switches	Installed in the 10000-litre tank for controlling the pump and the level of water in the tank
Protection cabinet	Protect equipment from overload (fuses) Switch off the installation to perform maintenance via a main switch ON / OFF

	Protect the installation from lightning strikes and surges (surge arresters - SPD) **Create a central point of grounding**
Grounding	Equipment and System Grounding **Equipment Grounding:** Connect the solar module frame, solar array mounting structure (Steel support structure), enclosures, metal frames and conduits of the system to a grounding electrode (metal rod or plate buried in the soil). **System Grounding:** Connects the current-carrying conductors/electrical components of the system, to negative/ the neutral, to the grounding electrode/Earth Spike.
Enclosures	All enclosure must have suitable protection against outdoor conditions
Mounting Structure	Solar modules will be mounted on poles (use steel structure, painted, minimum of 4 poles), The steel structure stand for solar modules must be covered with **two layers of paint,** one made with a rust-proof paint and the other made with a thick paint finish or galvanized. **Mount structure height=3.5m** **The structure must be structurally strong to withstand winds**
Supply all cables	Red and black solar cables, pump power supply cable-submersible wire **(10mm^2, 4 core),** grounding wires and other related cables
Sundries	All accessories

All solar pump systems must be grounded via a ground rod. Equipment to connect to the ground network is:

Equipment to be grounded	**Size and type of wire to connect to the ground rod**
Solar panels	Same size as solar panels cables
Solar panel support/stand and metallic frames	16 mm² / Insulated or Bare Copper
Lightning arrestor inside the protection cabinet	16 mm² / Insulated
Metal frame of pump controller or inverter if in a metal frame	16 mm² / Insulated
Pump controller or solar pump inverter	Same size as power supply cables
Submersible pump	Same size as power supply cables

Lightning Protection and Earthing for Solar PV

Apply measures to prevent catastrophic damage and failure of the installed PV system due to lightning. South Africa is in a highly lightning-dense region when compared to the rest of the world. Therefore, lightning strikes can still pose a risk to any electrical system, including solar panels, so **installing lightning protection specific to the installed solar PV system.** Proper grounding, surge protection, and adherence to safety guidelines are crucial to minimizing the potential damage caused by lightning strikes. Grounding involves connecting solar panels and other electrical components to the Earth's surface, creating a path for electrical currents to safely dissipate into the ground. **Use earthing, electrical configurations, and protection products based on standard compliance and protection**.

Note: Only electrical contractor will be allowed to work on electrical installation, thus a registered qualified electrician, either **Installation Electrician (IE)** or a **Master Installation Electrician (MIE)** will be required to submit his/her registration certificate from the Department of Labour to ARC before electrical work commences. IE or NIE must issue a **COC** when electrical work is completed. The **IE or NIE who will be signing off the electrical CoC must be in control on site. He must carry out or supervises the work effectively.**

Further note that a **licenced Single-Phase Tester (SPT)** cannot work with DC and will therefore not sign off on DC installations, which would include PV and any three-phase installations. Therefore, a person with SPT qualification cannot issue a Certificate of Compliance for solar installations.

Fencing-Supply and Installation of Security Fencing around the Borehole and Solar System for 2 sites: Fencing perimeter per site=24m, for 2 sites=48m

Fencing Materials	• 3000mm x 1800mm steel palisade panels • Palisade Fencing Pale 30mm x 30mm x 2mm/40mm x 40mm x 3mm • Steel posts (square tubing):76mm x 76mm x 2 mm with 2.4m height (Includes concrete mix), Dig 600X300X300mm deep for erecting steel posts. • 1800mm x 1000m mm Steel pedestrian gate, hinges and locks • Two layers of paints
Installation	Installation of posts, fencing and paint work

Product Compliance

Solar PV modules must have a Certificate of Compliance with the SANS/ IEC standards. Therefore, the solar modules must conform with the following:

- IEC61215(2016), IEC61730(2016)
- ISO9001:2015: Quality Management System
- ISO14001:2015: Environment Management System
- ISO45001:2018
- Occupational health and safety management systems

The above IEC standards must be reflected in the solar modules data sheets.

All other solar powered system components must comply with IEC/SABS standards, and proof/certificates of compliance will be required for quality assurance.

System Commissioning

Commissioning which includes documentation, inspection, and testing should be carried out in accordance with applicable codes of practice and regulations. Commissioning documentation should include single line diagram, individual component documentation, an O&M manual, and equipment warranty information. Warranties against defective components or poor workmanship must be submitted. Under the defects period, any items that fail, and are not installed to standard, or are damaged, must be corrected on site at cost to the contractor/supplier/installer.

Electrical Installation must be done by a qualified electrical wireman with a valid registration with the Department of Labour. A valid electrical certificate of compliance must be issued once installed, specific to the installation of the solar system. The installation must comply with all warranty claim processes specific to each brand of equipment.

The service provider must submit warranty certificates as guided by the following table:
Warranties Periods:

Component	Warranty Period
Solar modules	12 Year product warranty 25 Years linear power performance Warranty
Pump/motor	Minimum of 1 years
MPPT solar pump controller	Minimum of 1 years
Remaining components	Minimum of 1 year
Workmanship warranty/guarantee for all installations	1 Year
Structural: Solar module structural support	5 years

Contingency Provision

A **contingency amount equal to 10%** of the quoted price must be included. This reserve will be held by the Agricultural Research Council (ARC) to address any unforeseen circumstances. The use of this amount will be subject to prior written agreement between ARC and the appointed Contractor/Service Provider.

Compulsory Requirements

1. Compulsory **Site Briefing**
2. **CIDB** Grading 2CE or above.
3. **Data sheets** for solar modules/panels must be submitted together with all the bidding documents. Solar modules must comply with SANS/IEC standards as stipulated in the specifications, please see details of specific standards required under “Product Compliance” section of the technical specifications document Note: Data sheets must be official documents (In PDF format) from the product manufacturer Data sheets that are copied from the internet and paste into word, then back to PDF will not be allowed. **Solar module/panel data sheets must have the following information printed on them:** A 12 Year product warranty 25 Years linear power performance warranty Applicable IEC or SANS standards
4. **Three reference letters** of completed projects with similar size specifications with traceable contact details. The service providers must have completed projects in borehole drilling and commissioning or bulk water infrastructure installation

Site Briefing:

Location: Maila Creche’ School, Maila Village, Makhado, Ward 19, Limpopo
Coordinates: 23°13'11.4"S 29°57'36.8"E

Date & Time: 29 October 2025 at 11:00

• Note: No latecomers will be permitted.

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The drilling locations (sites)

Province	Site Locations	No. of boreholes
Limpopo	2 Hectare, Maila Creche' School, Maila Village, Makhado Ward 19 23°13'11.4"S 29°57'36.8"E 4 Hectare, Tiyani Secondary School, Makhado 23°17'41.3"S 30°18'39.6"E	**2**

APPENDIX A

A.1 Drawing: Concrete collar around a borehole

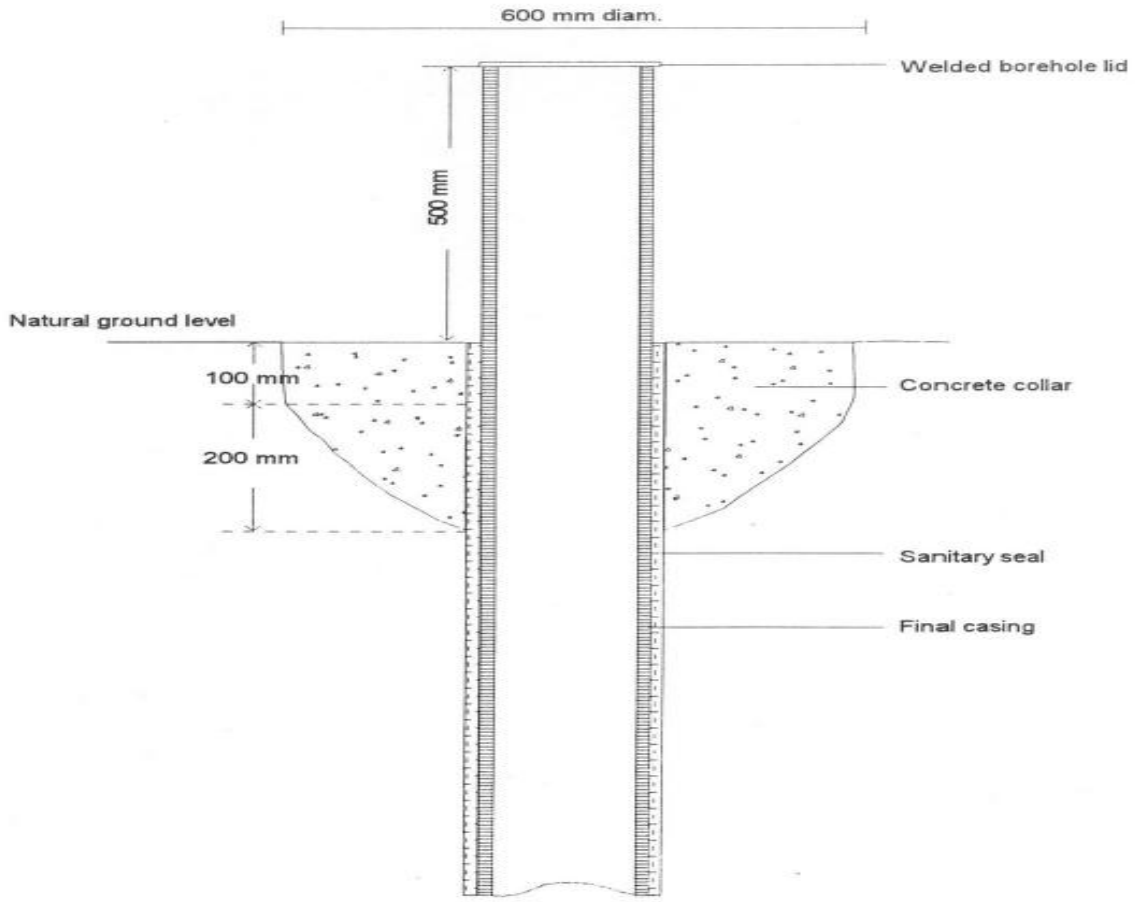

Figure 1 Concrete Collar Dimensions

A.2 Summary of the specifications for test-pumping of boreholes

Step-drawdown Test:

4 to 6 x 1 hour steps, each at a different rate – incrementally increasing. During the last step try to draw the water level down to the pump depth.

The yields to use for the steps are:

- Step1 – One third of the expected yield
- Step2 – two-thirds of the expected yield
- Step3 – equal to the expected yield
- Step4 – one and a half times the expected yield

The planned steps can be adjusted during the test, although the yield during the individual steps must be constant. Yield must be measured at least 3 times during the test to ensure it is constant.

Recovery of the water level after the step test should be monitored till the water level recovers to ~ 1 m hours of the Static water level or for ~ 12 hours.

Constant Discharge Test:

- 24 – 72 hours at a constant rate
- If the water level is drawn down to pump inlet during the test, the pump must be stopped immediately, and recovery of the water level monitored.
- The constancy of the yield is very important, otherwise the data cannot be analysed.
- The water level measurements should be taken and recorded according to the South African National Standard for the test pumping of water boreholes (SANS 10299-4:2003).

Recovery Test:

Immediately after the pump is turned off after the pumping test, start measuring water levels. You need to measure recovery until:

- Water levels recover to less than 5 % of the total drawdown during the constant discharge test.
- At least three readings taken in succession are identical.
- A time equal to the total time taken for the Constant Discharge Test has elapsed.

The data that needs to be collected includes:

- Data and time at commencement of test
- The Static Water level at the start of the test
- The depth of the borehole
- The distance from the borehole to observation boreholes (if applicable)
- Pump installation depth.
- Water strike depths (if known from drilling/landowner)
- Borehole diameter
- Rainfall (if it rains during the test)
- Drawdown of the water level
- Rate of discharge (for Steps and constant Tests)

Pump:

- Pump must have suitable power drive and have the correct pumping capacity. This needs to be managed properly!
- It is VERY IMPORTANT that the pumping rate is CONSTANT during the individual steps and the constant discharge test. The mathematical equations used for analysing the data are only valid if the flow is constant! If the variation in the pump yield exceeds 5 % the test must be stopped, water levels allowed to recover, and the test restarted using suitable equipment! Valves and flow gauges are needed to monitor and control the flow rates as during pumping the change in head results in the pump yield changing.

- Pump inlet must be at the main water strike. If this is not known, install the pump 3 – 5 m from the bottom of the hole.
- Pump must have a non-return valve to ensure water doesn't flow back into the borehole.
- Flow can be measured using:
    - Bucket of known volume and stopwatch (most reliable, and should be used to check other methods)
    - Flow meter (note that if using a flow meter, it will only work when the discharge pipe is full and the flow is not turbulent)
    - Orifice weir
    - V-notch weir

Observation Boreholes:

Boreholes close by should have their water levels monitored during the Test. Boreholes in the area should be rested for at least a day before pumping.