**SCOPE OF WORK (SoW) FOR THE DRILLING OF BOREHOLE, INSTALLATION OF SUBMERSIBLE PUMP, AND SOLAR SYSTEM IN BIYEMTI COMMUNITY, KODOMTI WARD, NUMAN LGA, ADAMAWA STATE**

**1. GENERAL CLAUSES**

* Mercy Corps (MC) Nigeria Mission (herein referred to as the EMPLOYER) is planning to drill one borehole in Biyemti community, Kodomti ward, Numan LGA, Adamawa State.
* Hydro-geological survey has been carried out to identify the exact drilling point.
* MC is seeking for a contractor to provide for proper tools, machinery, materials, and labor necessary for carrying out drilling and construction of the borehole, its development, test pumping, apron and other construction and Installation works as detailed in the technical Specification documents.
* The Contractor shall mobilize to site within two weeks of signing the contract. This should include taking over site, geophysics, and Drilling. The contractor shall take over site in the presence of the Supervisor, and Community.
* Contractor shall provide work schedule within one week after signing of the contract.

### 1.1 Personnel and Equipment

### The contractor shall provide qualified and competent staff to successfully execute the works. The contractor shall be responsible for the hiring of, and the transfer of his personnel as required during the contract period including procurement of entry visas and work permits for expatriates. He shall be responsible for arranging and providing housing and other logistics for his personnel.

### Unless agreed otherwise by the Project Supervisor, the Contractor shall show evidence of the availability of a drilling rig and associated equipment capable of carrying out the same works and which can be mobilized and brought to the site within a period of not more than two weeks such that the contract period is not extended.

### The Contractor shall provide and maintain enough suitable equipment to complete the drilling or rehabilitation works within the period specified in the contract. The equipment should include but not limited to some or all the following essential equipment:

### Drilling Rig

### Air compressor

### Pumping test equipment

### Support vehicles

### Other accessories

**SECTION 1: BOREHOLE CONSTRUCTION**

**1.1 SITE**

### 1.1.1 Drilling Site

Mercy Corps has assessed the location indicating the drilling site and relative distances from the communities where the drilling will be carried out. It should be clear that this information does not hold MC responsible for the locally different conditions at the specific drilling site or for the constraints the contractor may encounter while carrying out this work. The contractor is expected to verify site conditions prior to commencement of drilling works. The contractor will clear all debris of any kind, and move from the site as far as is possible, in the original condition, once the work has been finished, the borehole developed, and test-pumping done, and the borehole installed with the solar pumping system

### 1.1.2 Hydrogeology

Because of the peculiar geological settings of each area, groundwater is expected within the lower aquifer zone whilst the upper subsurface conditions generally consist of clay or sandy clay aquicludes and fine to medium sand. The principal productive layers would generally be the middle and lower aquifers. Drilling conditions are expected to be difficult; therefore, the driller should be prepared to deal with unstable, collapsing water-bearing top formations.

### 1.2 DRILLING

### 1.2.1 Drilling Methodology

The rig to be deployed must be capable of drilling to at least a depth of 25% beyond the anticipated final depth at the final required diameter. Temporary casing may be installed in the borehole to prevent formation heave, collapse or sloughing.

* The anticipated depth of the boreholes has been shown in the annex 1 and if the actual depth of the borehole being drilled justifies any additional depth in the specification, the contractor will request the authorization of Mercy Corps for such changes to be made.
* The Contractor will be required to state the specifications of the drilling equipment that he intends to use.
* The communications will be made in writing and shall be properly recorded by Mercy Corps. In every case, if the actual characteristic of the well differs from those indicated in these terms of reference, and once the changes have been authorized by Mercy Corps, a price adjustment may be made according to the final depth of the well, and the unit price rendered by the contractor in his original proposal.

### Selection of drilling method

### Although the Contractor shall be responsible for selecting the appropriate drilling methods, the boreholes may be drilled by any of the following drilling methods

* The rotary drilling method will be involve using mixture of chemical (drilling fluid) Bentonite, Antisol and or extender as may be needed, the contractor will be required to state the type of polymer to be used and describe how the selected fluid additive will be mixed.
* The Contractor shall immediately after completion of the borehole pump out the drilling mud. The first step shall be the braking up of the mud with polyphosphates (terra sodium pyrophosphate, sodium pyrophosphate, sodium tripolysulphate, sodium hexametaphosphate or sodium heptaphosphate at a dosing rate of approximately 6g/l), surging or air lifting and finally the leaning and test-running with a submersible pump at the highest test pumping rate.

1.2.3 Borehole Construction

(Drawing to be done by the contractor after actual construction based on the approved casing string)

* The exact location of the borehole shall be identified in agreement with the local communities in consultation with the Mercy Corps WASH Team. The site should not be in a place that gets flooded in the rainy season and should be away from the flood plain area of any streams or rivers in the locality. Special care must be taken to ensure that the sites chosen are at least 50 meters away from toilet pits or any other sources of pollution such as graveyard, stagnant pools of dirty water or animal pens and should always be up the gradient (i.e., at upper level than the contamination source).
* At least two alternative (2) sites shall be identified at each location, which the contractor can move to in the event of the first site borehole being considered dry; Mercy Corps shall approve movement to the alternative site and meet relative additional mobilization costs incurred for that location.
* Boreholes shall be drilled to such depths as to penetrate below the shallow water table aquifers and tap the potential deeper aquifer or aquifers in confined/semi-confined conditions The depth to be drilled should be at least six (6) meters below the main aquifer to allow for open space during well construction
* The outer surface casing shall terminate not less than 0.1 meter above original ground level.
* Dry boreholes are defined as:
* A borehole having no water bearing zones/aquifers.
* A Borehole that has insufficient discharge.
* A borehole that has failed verticality test (See 3.4 below)
* It will be the duty of Mercy Corps to inform the Local community members at least 48 hrs in advance as to when the commencement of the drilling will be.

1.3 CASINGS AND DIAMETERS.

* The drilling of the borehole will be carried out according to the characteristics specified in this SoW and appendix of the specifications (BoQ), using the proper drilling tools, drive pipes (Drilling Rods), casing pipes, gravel packs and sanitary protection (seals) should isolate the aquifers from other formations, which are considered improper for the exploitation of wholesome water.

**1.3.1 Screen Casing**

* The Contractor will use; Stainless steel JSS screen 150mm Diameter, the slot size and screen length depending on the aquifer materials and aquifer thickness. The Contractor will take sole responsibility of designing the well assembly and placing screen and casing at appropriate depths (Casing Tally) to match the positioning of the aquifer(s) which will be approved by Mercy Corps. Depending on the aquifer, the Contractor may choose an appropriate slot width other than 0.8 mm.

**1.3.2 Plain Casing**

* Casing pipe should be of API type. The joints are properly cleaned with the cleaning fluids and or brush wire and welder (connected) horizontally in the drilled hole.

**1.3.3 Permanent Casing**

* Outer permanent surface Casing pipe should be of API type, standard lengths, nominal inside diameter of 6 inches casing, The boreholes will be fully cased up to bottom of the borehole except for open hole
* The Contractor will take all necessary precautions during the transportation and storage of casing pipes up to drilling site to prevent distortions, bending or deformation of the pipe that could result in eccentricity along the length of the pipe.
* The borehole construction design including casing string will be authorized by Mercy Corps WaSH Team before the plain casing; screen casings and gravel pack are introduced into the borehole.

1.4. GRAVEL PACKING, DEVELOPMENT AND TEST PUMPING.

1.4.1 Development.

* On completion of drilling, the Contractor will choose a suitable and appropriate borehole development method. The borehole shall be developed for a period of at least ten (10) hours to obtain a maximum yield of water that is free of suspended matter. Developing shall be carried out by airlift pumping and surging, jetting and block surging, or other techniques the contractor feels is more appropriate and efficient to suit the hydro-geological and drilling conditions prevailing in that borehole. Development will be considered complete only when less than 15 ppm of suspended solids remains in the water. It is recommended that flushing be done for a minimum of 10 hours. The boreholes shall be presented for testing free of any bridging or obstruction to the total depth.

**1.4.2 Gravel Packing**

* The contractor shall supply and install filter pack/formation stabilizer. The material shall be 2- 4mm diameter, clean well rounded siliceous gravel with no more than 5% non-siliceous material. The pack must be approved by Mercy Corps prior to installation. Installation of filter pack/formation stabilizer may be water wash down or reverse circulation methods. In the latter case a pump set, or airlift string shall be installed in the borehole to encourage material settlement. The filter pack shall terminate not less than 3m above the uppermost screen when stabilized, or as otherwise directed by Mercy Corps. The Contractor shall provide a means by which this level may be measured.
* The gravel shall be rounded (not crushed) quarzitic types and the selection of the gravel shall be based on the results of grain size analysis of the borehole at the level of the aquifer. The recommended grain size for slot 20, if used, shall be 2-4mm and for slot 10, it shall be 1-3mm. The maximum percentage of permissible undersize is 3%. Samples of gravel shall be tested by the Contractor and test results and samples shall be submitted to the Supervisor for approval.
* Backfill material shall comprise fine or clayey drill cuttings and shall be installed from the top of the filter pack to 6m below ground level unless otherwise directed by Mercy Corps. The installation method must ensure that no bridging occurs within the annular space. The Contractor shall measure the depth to the top of the backfill and provide how this level may be measured.
* Any casing and/or screen damage during installation, gravel packing and well development shall be the responsibility of the CONTRACTOR, who shall make the necessary corrections/repairs without additional cost to the Mercy Corps. When well development is completed, the gravel packing will be topped up if it is found settling below the required depth.

**1.4.3 Test Pumping and Recovery**

* Borehole yield tests shall be carried out in accordance with BS ISO 14686:2003 using pump sets provided by the Contractor. The tests are to be undertaken by the Contractor under the supervision of Mercy Corps or his authorized representative. The discharge, after measurement, shall be led away from the site to a suitable out fall. The Supervisor shall be informed a minimum of one week before the starting of the test.

The test shall be carried out to explore and determine:

* The aquifer characteristics.
* The maximum possible safe yield of the borehole.

The Contractor shall supply two submersible pumps for this purpose, one operating and one standby.

Drawdown shall be measured by an electrical probe accurate to one centimeter, or other methods proposed by the Contractor and approved by the supervisor. A temporary probe-across tube shall be installed down the borehole, if required. The Contractor shall record water levels at the appropriate intervals for subsequent plotting by the Contractor on logarithmic paper with a particular emphasis on the accuracy of early readings. During the test pumping of the borehole, water level measurements shall be carried out to specifications.

Water levels shall be recorded at the following intervals, or at other intervals approved by the Supervisor.

* Immediately before discharge is started.
* Every 30 seconds for the first 10 minutes.
* Every 15 minutes thereafter until the completion of 1 hour or pumping.
* Every 15 minutes thereafter until the completion of 4 hours or pumping.
* Every 30 minutes thereafter until the completion of 8 hours of pumping.
* Every hour thereafter until the completion of 24 hours of pumping.

The means used to measure time shall be accurate to the nearest second. During the first 10 minutes of the test, an error in time-keeping greater than 3 seconds should be avoided. Timing devices should be synchronized prior to the start of the test. The start and completion of events should be recorded in local time; the test should be started on the stroke of the hour.

The approximate discharge rate of each of the steps shall be determined by the Contractor and agreed with the Supervisor prior to the start of the test. The discharge rate shall be approximately adjusted to the following rates:

1. 30% of the agreed rate.

2. 60% of the agreed rates.

3. 90% of the agreed rate.

4. 120% of the agreed rate.

The degree to which the control valve shall be opened to establish the initial discharge rate shall be determined from pressure gauge readings or from the number of turns on the control valve.

The discharge rate shall be held as near constant as possible throughout the period of each step and, unless it is grossly at variance with the intended rate, no major adjustments need be made. If major adjustments are necessary, they shall be made during the first few minutes, or the test must be started again after full recovery of the ground-water level.

* Pumping test will be for twenty-four (24) hours, of which 8 hours is a step draw down test and 16 hours of continuous test. A pumping test is required on a routine basis for each borehole. The Contractor will estimate the discharge from the air lifting rates during borehole development. Based on the estimated discharge, the Contractor will certify the borehole as either "productive" or "abortive".
* The recovery shall be tested with the recovery test. The recovery test shall commence immediately upon the end of each step of the pumping test. The discharge shall be stopped at the designated moment by stopping the pump. The ground water level shall be measured in the borehole at the intervals stated above, commencing at the time discharge ceases. The recovery test shall be continued until a stable water level has been achieved. The pump test data and the results of pump test is presented in the standard form attached (Annex 1, 2,3)
* Readings of flow and water level shall be taken at the intervals defined on the test pumping form. For accurate measurement, an electrical/ sonic water level indicator with graduated tape for taking water level readings. Recovery readings shall be taken until attest 80% recovery is attained, during which period airlifting or pumping equipment shall not be removed from the borehole.
* The Contractor can also use any other method approved by the Supervisor to measure the exact quantity of water pumped.

1.4.4 Other specifications.

The contractor will evacuate all pumped water in such a way that no impoundments are produced at distances less than 200 meters from the borehole. The contractor will provide all necessary elements for this purpose which include provision of all necessary implements and pumping equipment i.e., weirs, pipes, gauges etc. for the proper measurement of discharge rates and water levels and disposal of extracts.

1.5 WELL PLUMPNESS AND ALIGNMENT.

### 1.5.1 Tests.

The borehole should be tested for plumpness and alignment by means of a 12 meter long, and perfectly straight, steel pipe that should be introduced along the whole borehole. The external diameter of this should, at most, be 13 mm less than the well casing inside diameter. This pipe will be supplied by the contractor.

1.5.2 Minimum Requirements.

Such a test pipe, as described above should easily move through the whole borehole. The loss of plumpness of the well’s axis should never be more than 2/3 of the smaller inside diameter of the casing. If these minimum requirements are not met by the well, the contractor will be required to correct the defects, otherwise Mercy Corps will reject the borehole and no payments will be made for its drilling and completion. This test should normally be done before pump testing the well in the presence of the agent appointed by Mercy Corps.

1.6 PROTECTION OF WATER QUALITY, DISINFECTIONS AND SAMPLING.

1.6.1 Borehole Protection.

The contractor will take maximum care to avoid the physical, chemical, or bacteriological contamination of the borehole water, during the construction and after construction operations. In any case, where water is polluted due to the contractor’s neglect, he will be obliged to carry out all the necessary operations, at his own cost, to rectify such pollution of the borehole.

### 1.6.2 Well sterilization.

Once the well has been completed and tested, disinfection will be undertaken by introducing granular Calcium Hypochlorite, Sodium Hypochlorite into the annular space along with the gravel pack material at a concentration of 500 grams per cubic meter of pack. This will initiate the process of sterilizing the Borehole and the chlorine solution should stay in the well for at least four hours, at the specified concentration.

### 1.6.3 Samples.

* The contractor will take at least one sample every three meters of drilling, unless a change in formation is encountered by the driller. In such cases, additional samples should be taken. The minimum weight of each sample should be 100grams.
* The contractor will keep a complete record of the samples taken from the cuttings during the drilling operation, in properly packed and identified sample bags, and all will be made available to Mercy Corps upon request.
* The contractor will supply a detailed borehole geo-log data, in which all the relevant information and drilling velocity, well casing and other well construction operations will be recorded. The contractor will also annotate all information pertaining to the appearance of water filtrations and aquifer, types of rock found and sampling details (lithological data).
* The contractor will be required to complete the log forms for the borehole. (Ref Annex 4
* The contractor will provide the Borehole Completion Record immediately upon completion of the drilling work. (Annex 4) The Borehole Completion Record will also be accompanied by Water quality certificates capturing, chemical and physical water qualities
* For each rock sample that has not been taken the contractor will be fined a penalty amounting to 1 per cent of the total value of the well and this will be deducted from the final payment. If the total amount of samples not taken is more than 15% of the specified number, the well should be started again, and Mercy Corps will not make any payments for this additional work.

1.6.4 Water samples.

A minimum of 2 liters each for chemical and bacteriological analysis shall be collected by the contractor in the presence of the Supervisor or his representative (2) liter samples in a clean plastic bottle from the borehole for reference to a Water Testing Authority recognized and authorized by Mercy Corps for laboratory analysis, after completion of test pumping. One sample will be used for each of these tests; physical and chemical analysis, which should be collected in clean, sterilized properly sealed and protected plastic containers. The samples so collected should reach the authorized water testing laboratories (MWR and NAFDAC), within 6 hours from the time of collection from the borehole unless otherwise. Specific parameters to be measured shall include.

* **Physical Parameters** – Colour, Odour, Taste, Turbidity, pH Value, Electrical Conductivity, Temperature
* **Chemical Parameters** – Nitrate, Nitrite, Total Hardness, Fluoride, Chloride, Sulphate, Copper, Manganese, TDS, Total Iron, Arsenic
* **Biological Parameters** – Faecal Coli form Counts

### 1.6.5 Particle Content in Pumped Water.

The water drawn out of the well will be acceptable if it has a sand particle content of less than 5 milligrams per cubic meter. In case this allowed maximum limit is not met, the contractor will make all necessary adjustments to the well structure, at his own expense, to meet these specifications.

### 1.7 FINISHING WORKS AND REPORTS

1.7.1 Temporary Lid.

The contractor will pay close attention to the due protection of the aperture of the borehole against the entrance of water or any other pollutants while drilling or after the completion of the borehole. For this purpose, the contractor will provide a lid to be placed on the entrance of the well at any time the drilling rig is not in operation.

1.7.2 Sanitary Protection Seal **and Well Head Construction**

* The top of the casing shall be a minimum of 200mm above the original ground level and there shall be a flange for connection of the wellhead assembly. Around the casing, there shall be a 1m x 1m concrete slab. The slab shall be slightly cambered away from the borehole.
* After completion of the pumping test, removal of the test pumping unit and after the last water level recovery observations have been made, the level of the gravel pack will again be checked to see if there is any settlement below the required depth. If it is found below the required depth, it will be topped up to the appropriate level. Based on the actual situation, the annular space between the well and the permanent casing will be cement grouted down to at least 6m from the surface in order to prevent contamination of the borehole by surface run-off water
* The surface/outer permanent casing must protrude 0.1 meters above the ground label
* Specifications related with wellhead construction, installation of pumps have been indicated in the specifications and bill of quantities Part.

1.7.3 Abandoned Borehole.

* If the contractor is not able to finish the drilling or must abandon the borehole due to loss of tools, accidents or any unforeseeable circumstances, the contractor should remove the casings or drive pipes already in the hole and refill it with clay or concrete. All materials extracted from the hole, after refilling it will be the property of the contractor.
* In case a situation described above occurs, Mercy Corps will not pay for any of the work carried out and will authorize in advance the drilling of a new hole, at a site near the abandoned one, if need be, at the contractor’s expenses.

**1.7.4 Report Compilation**

On successful completion of the borehole, three hard copies of detailed completion report and an electronic copy shall be submitted to the Employer. The report shall comprise but not limited to the following:

* Project completion summary sheet (as provided)
* Drilling method
* Driller’s log
* Rate of penetration
* Drilling bit diameter
* Lithological log
* Mud/additives used
* Materials installed
* Details of geophysical well logging (where applicable)
* Details of borehole design (composite log)
* Pumping test result
* Water quality result
* Pump installation details
* Incidents and accidents of any kind

**SECTION 2**

**2.1 WATER STORAGE** **TANKS AND SUPPORT**

**2.1.1 Steel Support**

* The Contractor shall supply and erect PVC tanks and Steel towers in accordance with the Mercy Corps drawings and BoQ.
* All structural steel work shall conform to BS 4 and all sections shall be at least equivalent to those shown in BS 5950 unless otherwise shown on the drawings or indicated in the BoQ.
* The Steel support structure shall be as specified in the drawing and BoQ complete with ladder to the top of catwalk and all nuts, bolts, washers as necessary for site erection. The tank steel support structure shall be painted with one coat of red oxide primer and one coat of aluminum paint before dispatch, and one coat of aluminum paint after installation
* Provision will be made for 450 mm wide catwalk complete with hand railing around the perimeter of the tank and 450 mm wide valve-operating platform with hand railing approximately 3 meters below the tank base.
* Supply, deliver and install all pipe work necessary to operate tank, inlet, outlet, washout, overflow, and other fittings as shown on the drawings.
* Ends of beams and joints, including other members, shall be cut to exact lengths true and square and shall be cleaned of burrs or rough edges. Drilled or punched holes shall not be greater than 1/16” more than the bolt diameter and they shall be cleaned of burrs and rough edges.
* All fillet welds and gussets plates should not be less than 6mm thick unless otherwise stated. Holes on angles and gusset plates to be 18mm diameter. All welding is to be deslagged and wire brushed. All bolts should be to be M16 (grade 4.6).
* Foundation bolts are to be properly levelled before casting. All nuts’ heads are to be covered to avoid cement setting on threads. Gravel should be crushed and not exceeding 19mm (0.75 inch)
* Reinforcement bars should be free from rust and of the correct type and size for concrete construction work (typically a characteristic yield stress of at least 210 N/mm²).
* 6m standard steel stanchion consisting of six numbers 200 x 100 x 4mm steel I-section braced with 50mm angle section.

**2.1.2 Support Foundation**

* Excavate foundation trench to a depth not below 2000mm at 4200 x 4200mm for footing as specified in drawings.
* Trim and level off surface of excavated surfaces under surface beds
* As preparation to receive foundation base and column, place a surface blinding of 50mm thickness with a concrete mix ratio of 1:2:4.
* Place reinforcement basket for column base on surface blinding. Basket should be of high yield steel diameter 16mm with a mesh of 150mm c/c in top and bottom as specified in drawing. Allow for column reinforcement of steel diameter 20mm centralized on footing basket and firmly secure with binding wire. Column dimension shall be 400 x 400mm and will be 1950mm high. Column links shall be spaced at 150mm using 6mm diameter stirrups.
* Supply materials, prepare and cast concrete Grade 20/19mm aggregates as footings, 3600 x 3600 x 500mm deep for each footing.
* Formwork to vertical strutting shall be provided for casting of columns and shall remain in position until the newly constructed work is due for curing.
* Cast concrete grade 20/19mm aggregates as column. Column dimension shall be 400 x 400mm and will be 1450mm high from footing as specified in drawing
* Concrete cover of 50mm should be used for all RC casting
* Allow at least 72 hours for curing before removing formworks
* Backfill to trench and compact
* Prepare and cast oversite concrete 3600 x 3600mm and 150mm thick using mix ratio 1:6.

**2.1.3 Access Ladders**

* Supply and fix 50 x 50 x 2mm flat bar as balustrade (ladder)
* An outside tank caged ladder shall be furnished and installed as shown in drawings.
* An interior ladder shall be furnished and installed as shown in drawings.
* Ladders shall be fabricated of hot-dipped galvanized carbon steel.
* Safety cage as well as intermediate and top step–off platforms shall be fabricated of hot-dipped galvanized carbon steel.

**2.2 DISINFECTION**

* Provide for the disinfection of the tanks after installation.
* Fill the tanks a quarter full of clean water. Sprinkle 80 grams of granular high-strength calcium hypochlorite HSCH into the tank for every 1000 liters total capacity of the tank. Fill the tank completely with clean water, close the lid and leave to stand for 24 hours.
* Completely empty the tank and carefully dispose of the disinfecting water as it will contain a high concentration of chlorine. Fill the tank with drinking water; allow standing for about an hour then empty the tank again.
* Care must be taken when disposing of all liquids used for cleaning and disinfecting the tanks. Sudden discharge of water will cause localized erosion or flooding. Make sure the water follows a channel to its final disposal point.
* Liquid waste should not be disposed of in rivers and ponds as the organic materials and high chlorine levels may kill fish and plant life.

**SECTION THREE**

**3.1 SOLAR SYSTEM**

* The Contractor shall provide 10 pieces 240V photovoltaic systems. All the solar panels shall be made of crystalline silicon solar cells. All systems shall be fully operational turnkey installations. Contractor shall make their own assessment of the sites and suggest a suitable location for installation of the PV systems on the ground. The location chosen for system installation for each site shall be approved by MC Supervisor.
* According to the Supervisor’s technical assessment of the water points, all the facilities have adequate unshaded space. The Contractor shall make own assessments for enough space available for unshaded array: The array will be installed where shading is avoided from 6am – 6pm “solar time” each day of the year. This will be verified during the pre-installation and the acceptance test.
* The installed system must meet applicable national standards and codes. Plastic laminated safety signage placards should be provided for each installation. Contractor shall install the same at designated locations as per instructions.
* For each water point, PV modules must be procured for same make (manufacture) and same wattage rating.
* Contractor shall supply and install circuit breaker (DC disconnect) 16A 100v and change over switch 50A 415V

**3.1.1 PV System Mechanical Design Specifications**

* The installed system shall include all hardware required for assembling the photovoltaic array, balance of system components, and structural attachments to mounting frames
* The PV array shall be installed on the mounting frame with a slope which is approximately 20 degrees, and an eastern orientation within northeast to southeast +/-15 degrees of true south.
* The PV array mounting structure, including modules, and balance of system components shall be designed to withstand wind loads of at least 60 mph.
* Adequate spacing, about 4 to 6 inches, between the ground surface and PV mount frame shall be maintained to allow air circulation to cool the module back sheet.
* Array mounting frames supplied shall be compatible with the site considerations and environment.
* Mounting frames shall be made of 50mm-by-50mm angle iron of 2mm thickness.
* Mounting frames for ground-based PV modules should be placed on 2” GI pipe stanchion buried 50mm below ground level in concrete of mix ratio 1:3:6. Concrete mould should be 50mm above ground level for each stanchion. Stanchions should be spaced at 3460mm spacing horizontally while allowing 300mm hangover at both sides and 1600mm vertically.
* Special attention shall be paid to minimizing the risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. All potentially hazardous hardware shall be protected or shielded for safety.
* Mechanical hardware, conduit, and other equipment shall be concealed beneath and/or behind the array. Contractor shall provide combiner boxes if required
* The array layout shall be consistent with the ordering (and labeling) of source circuits in the array combiner boxes. Accessibility to perform array troubleshooting and maintenance is required by allowing access to the back of the array.
* The PV systems will be installed in communities; therefore, population safety is critical. Contractor must minimize the risk of vandalism, theft and personal injury in the installation and operation of the system.

**3.1.2 PV System Electrical Design Specifications**

* A grounding electrode shall be installed for the arrays.
* All inverters shall be commercially available models and must include ground-fault protection with a visible indicator. The inverter size shall be 3KW RSI
* Inverter/Charger shall be installed at the same location or within proximity.
* All outdoor wiring must be listed to a temperature rating of 90°C in wet locations, and it shall be listed as sunlight resistant where run outdoors and outside of conduit. All AC wiring shall be ducted in metal conduits. DC wiring can be ducted in PVC conduits.
* Outdoor-rated, visible-break lockable disconnects shall be installed on each set of current carrying conductors entering or leaving the array area.
* The wiring shall be sized appropriately to avoid more than 1% voltage drop.

**3.2 SYSTEM WARRANTIES AND MAINTENANCE**

* The supplier/Contractor must provide warranties to Mercy Corps on both the complete system and individual components. The methods for implementing and terms of the warranty provisions must be clearly established and handled by the system supplier/Contractor as the single point-of contact for warranty service with the end-user.
* At a minimum, the following warranties are required:
  + One (1) year complete system-level warranty and service contract for no-cost replacement of any defective component required for safe and as-specified system operation.
  + Inverter must have a minimum five (5) year warranty.

**3.3 OTHER REQUIREMENTS**

**3.3.1 Inspections and Acceptance Testing**

* Contractor shall ensure that all project specifications have been met. MC will verify compliance through a site inspection and acceptance tests. The contractor shall be available and present for the acceptance tests, which will be scheduled with reasonable advance notice (notwithstanding delays due to weather). Acceptance testing will verify that the system and equipment specified in the bid was installed in a safe and code-compliant manner and is operating properly under all conditions.
* All charges incurred because of non-compliance on the part of the Contractor shall be borne entirely by the Contractor and shall be deducted from the final payment.
* Acceptance testing forms will be made available to the contractor as early as possible after award but no later than before system construction begins.

**SECTION FOUR:**

**4.1 TAP STANDS**

* From the overhead tank a 2” GI pipe, with an approximate length of 10m will be installed to reach the ground.
* A 2” flow meter will be installed in a box for protection.
* On the ground a 2” UPVC 10 bars resistance pipe of 40m will be laid into a trench (same trench as the supply trench).
* To protect the pipes in the runoff drainage channel, the supply and the distribution pipes will be protected in a bigger GI pipe.
* A connection box will be installed. Two 1\*1/4” GI valves will be installed, and two lines will be created.
* Two lines on 1\*1/4” UPVC 10 bars resistance will be laid to each water point, the total length of the two lines will be 1000m.
* The foundation for the tap stands will be done with two layers of 6” sandcrete, with a dimension of 1.6 x 3.5 m (5.6m2) and will be laid on a blinding of 50mm using mix ratio of 1:6 cement to sand.
* Medium mortar (300Kg of cement /m3) will be used for joints.
* Two layers of sandcrete will be line up to realize the slab (surface).
* A layer of one sandcrete will be laid on the edge to realize a curbstone. To facilitate the access and formalize the entrance and the exit two sandcretes will be remove of the edge one at the front the other at the back.
* The floor of the drinking water point will be plastered with a mix ratio of 1:4 with a thickness between 0.010m and 0.08m
* A slop toward the outlet will be realized to evacuate runoff water
* Steps will be realized with sandcrete to facilitate the access to the infrastructure.
* A valve box will be installed at the entrance of infrastructure with a dimension of 1\*1/4”
* A GI 1\*1/4” pipe embedded into concrete will be installed on the structure.
* Six (6) standpipes of 1”1/4 will be connected to the embedded piped and reduced by ¾”.
* The six standS pipes will be protected by a 4” UPVC pipe filled with concrete with a ration of 300Kg/m3 minimum.
* A 3/4” GI heavy duty tape will be connected to the 6 standpipes

**4.2 SOAK PIT**

* The excavation of the pit will have to reach the layer of sand (approximately 3m deep)
* The soak pit will be done by lining sandcrete block 9’’ with a dimension of 1500x1500x1500mm on purpose to facilitate the infiltration. Depth of the soak pit is subject to change by MC supervisor.
* Sandcretes will be perforated, with 2” UPVC pipe tilted to facilitated infiltration of water and reduce the sand to come into the soak-pit. UPVC pipe will be installed only on the sandy layer spaced by 0.25m.
* The sandcrete will be laid on a blinding of 50mm using mix ratio of 1:6 cement to sand.
* Cast soak pit cover of dimensions 1450x1450mm and cure for 48hours before placing on soak pit. Slab thickness should not exceed 100mm with 10mm diameter iron bar spaced at 200mm center to center top and bottom. Concrete grade 20 of mix 1:2:4 – 20mm coarse aggregate). The cast soak pit will be seal to his base.
* Backfilling around the soak pit will be done with sand to increase the infiltration capacity by increasing the contact surface.

**4.3 ANIMAL TROUGH**

* Dimensions: 2.5m x 4m x 0.9m deep
* The animal trough will be constructed using 9” sandcrete block wall finished with 1:6 mortar mix ratio.
* The animal trough will be linked to the fetching point at 50m apart and piped with 6” UPVC pipe to collect wastewater during and after fetching. This distance is subject to change by MC supervisor.
* The UPVC pipes shall be installed at a convenient gradient to ensure easy flow of water from the fetching point to into the animal trough.
* Provide 50mm blinding to the base to disallow infiltration of water beneath the ground.

**SECTION FIVE:**

**FENCING AND LANDSCAPPING**

* 1.8m high by 14-gauge chain link tied to stretching wire at 3- steps through the post
* Chain link Mesh wire fencing 1800mm high overall fixed to 3 No strands of galvanized straining wire spaced at 500mm spacing.
* Tension wire to run in a straight line in each line of fence between corner posts.
* The chain link is tied with stretching wire.
* All wire clips to be secured so that pointed or jagged ends do not protrude from fencing
* Construct and install metal gate with overall width of 3m and with 1.8m height
* The gate shall be constructed with rectangular section G.I pipe complete with locking devices.
* Gates to be of overall standard widths and heights unless otherwise noted on drawings. The vertical members for the gate should not exceed 1.8m with rectangular section metal of 80mmx40mm. While the bracing members should not be less than 40mm x 40mm rectangular section with galvanized malleable iron hinges, latch and all necessary hardware attached.
* Apply 3 coats of white paint to all the constructed work
* Spray zinc oxide as first coat and second coats of silver paint to protect the poles from corrosion.
* Level perimeter area to receive one layer of 20mm nominal size gravel
* Spread and level gravel all over perimeter

**ANNEXES**

### A; If the contractor wishes to use a reporting format different from the templates annexed below; authority will have to be sought from MC for review before use

**Annex 1 Test Pumping; Step Draw Down**

|  |  |  |  |
| --- | --- | --- | --- |
| **PUMP TEST - STEP DRAW DOWN TEST REPORT** | | | |
| **Camp;** | **Coordinate: N………… E…………** | |  |
| **STEP 1 :** | **Discharge set at ( Liters/Second):** | |  |
| **TIME ELAPSED (In Minutes)** | **DEPTH TO WATER LEVEL (Meters)** | **DRAWDOWN (In meters)** | **REMARKS** |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |
| 9 |  |  |  |
| 10 |  |  |  |
| 15 |  |  |  |
| 20 |  |  |  |
| 25 |  |  |  |
| 30 |  |  |  |
| 40 |  |  |  |
| 50 |  |  |  |
| 60 |  |  |  |
| **STEP 2:** | **Discharge set at ( Liters/Second):** | |  |
| **TIME ELAPSED (In Minutes)** | **DEPTH TO WATER LEVEL (Meters)** | **DRAWDOWN (In meters)** | **REMARKS** |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |
| 9 |  |  |  |
| 10 |  |  |  |
| 15 |  |  |  |
| 20 |  |  |  |
| 25 |  |  |  |
| 30 |  |  |  |
| 40 |  |  |  |
| 50 |  |  |  |
| 60 |  |  |  |
| **STEP 3 :** | **Discharge set at ( Liters/Second):** | |  |
| **TIME ELAPSED (In Minutes)** | **DEPTH TO WATER LEVEL (Meters)** | **DRAWDOWN (In meters)** | **REMARKS** |
| ( 20 MINUTES) |  |  |  |
|  |  |  |  |
| 0 |  |  |  |
| 1 |  |  |  |
| 2 |  |  |  |
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| 20 |  |  |  |
| 25 |  |  |  |
| 30 |  |  |  |
| 40 |  |  |  |
| 50 |  |  |  |
| 60 |  |  |  |
| **Pump Supervisor Sign** | **Drilling Supervisor Sign** |  | **Drilling Manager Sign** |
|  |  |  |  |

**Annex 2 Test Pumping; Constant Discharge**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PUMP TEST - 4 HOURS AQUIFER TEST** | | | | |
| **Coordinate: N……………… E …………….** | | | **Camp:** | **Date: ……………………**  **Start Time……………. End Time……………** |
| **S.NO** | **TIME ELAPSED IN MINUTES** | **DRAWDOWN (METERS)** | **YIELD ( LTR / SEC)** | **REMARKS** |
| 1 | 0 |  |  |  |
| 2 | 1 |  |  |  |
| 3 | 2 |  |  |  |
| 4 | 3 |  |  |  |
| 5 | 4 |  |  |  |
| 6 | 5 |  |  |  |
| 7 | 6 |  |  |  |
| 8 | 7 |  |  |  |
| 9 | 8 |  |  |  |
| 10 | 9 |  |  |  |
| 11 | 10 |  |  |  |
| 12 | 15 |  |  |  |
| 13 | 20 |  |  |  |
| 14 | 25 |  |  |  |
| 15 | 30 |  |  |  |
| 16 | 35 |  |  |  |
| 17 | 40 |  |  |  |
| 18 | 50 |  |  |  |
| 19 | 60 |  |  |  |
| 20 | 70 |  |  |  |
| 21 | 80 |  |  |  |
| 22 | 90 |  |  |  |
| 23 | 105 |  |  |  |
| 24 | 120 |  |  |  |
| 25 | 135 |  |  |  |
| 26 | 150 |  |  |  |
| 27 | 165 |  |  |  |
| 28 | 180 |  |  |  |
| 29 | 195 |  |  |  |
| 30 | 210 |  |  |  |
| 31 | 225 |  |  |  |
| 32 | 240 |  |  |  |
| 33 | 260 |  |  |  |
| 34 | 280 |  |  |  |
| 35 | 300 |  |  |  |
| 36 | 330 |  |  |  |
| 37 | 360 |  |  |  |
| 38 | 390 |  |  |  |
| 39 | 420 |  |  |  |
| 40 | 450 |  |  |  |
| 41 | 480 |  |  |  |
| 42 | 510 |  |  |  |
| 43 | 540 |  |  |  |
| 44 | 600 |  |  |  |
| 45 | 660 |  |  |  |
| 46 | 720 |  |  |  |
| 47 | 780 |  |  |  |
| 48 | 840 |  |  |  |
| 49 | 900 |  |  |  |
| 50 | 960 |  |  |  |
| **Pump Supervisor Sign** | | **Drilling Supervisor Sign** | | **Drilling Manager Sign** |
|  | |  | |  |

**Annex 3 Recovery Measurements**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BOREHOLE - RECOVERY TEST** | | | | |
| **Coordinate: N……………… E …………….** | | | **Camp:** | **Date…**  **Start Time……………. End Time……………** |
| **S.NO** | **TIME ELAPSED IN MINUTES** | **DRAWDOWN (METERS)** | **YIELD ( LTR / SEC)** | **REMARKS** |
| 1 | 0 |  |  |  |
| 2 | 1 |  |  |  |
| 3 | 2 |  |  |  |
| 4 | 3 |  |  |  |
| 5 | 4 |  |  |  |
| 6 | 5 |  |  |  |
| 7 | 6 |  |  |  |
| 8 | 7 |  |  |  |
| 9 | 8 |  |  |  |
| 10 | 9 |  |  |  |
| 11 | 10 |  |  |  |
| 12 | 15 |  |  |  |
| 13 | 20 |  |  |  |
| 14 | 25 |  |  |  |
| 15 | 30 |  |  |  |
| 16 | 35 |  |  |  |
| 17 | 40 |  |  |  |
| 18 | 45 |  |  |  |
| 19 | 50 |  |  |  |
| 20 | 55 |  |  |  |
| 21 | 60 |  |  |  |
| 22 | 70 |  |  |  |
| 23 | 80 |  |  |  |
| 24 | 90 |  |  |  |
| 25 | 100 |  |  |  |
| 26 | 120 |  |  |  |
| 27 | 140 |  |  |  |
| 28 | 160 |  |  |  |
| 29 | 180 |  |  |  |
| 30 | 240 |  |  |  |
|  | **Pump Supervisor** |  | **Drilling Supervisor** | **Drilling Manager** |
|  |  |  |  |  |

**Annex 4: Borehole Log Sheet**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Borehole Litho log and drill time log with water strike zones** | | | | | | | | | | | | | |
| **Drilling Company:** | | | | | | | | | | | | | |
| **Camp** |  | | | | **Borehole Number** | | | | | |  | | |
| **GPS Coordinate** |  | | | | **Dates Start and End :** | | | | | |  | | |
| **Water**  **strikes** | **Litho-logical Log**  **Ground Surface** | | **Depth in Meters** | |  | **Drill Time Log** | | | | | | | |
| **BOREHOLE** |
| **Minutes per meter drilled** | | | | | | | |
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|  |  |  |  |  | **BOREHOLE** |  |  |  |  |  |  |  |  |
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**Annex 5 Borehole Completion Record**

Borehole No……………………………………………………..

Borehole Name………………………………………………….

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. Community………………………………, Ward ……………………………………..

Coordinates; ………………E, ………………N, Elevation …………………..ASL

LGA………………………………………..

2. Owner…………………………………….; Address……………………………………

Locality ……………………………; L.R No…………………………………….

Intended Use; Public W.S; Irrigation; Domestic; Livestock; Other……………………...

……………………………………………………………………………………………

3. Contactor/Driller………………………………………… Address…………………….

…………………………………………………………………………………………

4. Type of Borehole; Drilled; Driven; Bored; Jetted; Other………………………………

…………………………………………………………………………………………..

Type & Make of the drilling Rig………………………………………………………...

5. Borehole Design & Construction (Sketch to accompany)

Drilling Started…………………………; Drilling Completed………………………….

All work completed………………………………………………………………………

Total Depth: Reported………m; Measured…….m; Final (Backfilled) Depth;……..m

Hole Diameter………………mm. From ……….m to……………….m

……………….mm From ……….m to……………….m

……………….mm From ……….m to……………….m

……………….mm From ……….m to……………….m

Permanent Casing:

Plain:

Type………..; Dia……..mm; Length………m; From………m to……….m

Type………..; Dia……..mm; Length………m; From………m to……….m

Type………..; Dia……..mm; Length………m; From………m to……….m

Type………..; Dia……..mm; Length………m; From………m to……….m

Screen:

Type & Make………………………………………………………………………………

Diameter………mm; Length……….m Set from…….m to……………m

Gravel Pack:

Size of grains…………mm, Roundness (Good, Fair, Poor)………………………..

Volume inserted to the annular space………cu.m, from………….m to…………..m

6. Aquifer: 1st Water Struck at ……………….m.; Water rest level………………………….m

Main Aquifer struck at …………...m. ; Water rest level…………………………m

Water bearing material…………………………, from……..m to………………..m

Other Aquifers, Remark etc……………………………………………………………………...

…………………………………………………………………………………………………….

………………………………………………………………………………………………

7. Yield: SWL………m.; DWL……….m. below GL; Discharge………………………..….Ltrs/min

after pumping ……………..Hrs; Recovered to SWL in …………….Minutes;

Recommended production discharge………….Ltrs/Hr, with pump set at …………..m below GL

8. Borehole Development Start……………. Finish …………… Hrs…………………

9. Pumping Test Record in summary (Attach detailed test records – Test pumping & BH recovery tests) – All depth measurements to be in Metres below GL

|  |  |
| --- | --- |
| **Description** |  |
| Date of Test (Day, Month, Year) |  |
| Depth of BH at time of test (m) |  |
| Static Water Level (SWL) before test (m) |  |
| Type of Pump used |  |
| Depth of Pump Intake (m) |  |
| Discharge (Ltrs/Minute) |  |
| Dynamic/Pumping water level (m) |  |
| After Pumping continuously for (Hrs) |  |
| Time of recovery to original SWL (Minutes) |  |
| Rate of Recovery – WL after 5 Minutes (m) |  |
| WL after 20 Minutes (m) |  |
| WL after 60 Minutes (m) |  |
| WL after 180 Minutes (m) |  |
| WL after 360 Minutes (m) |  |

Additional pumping tests to be mentioned in Remarks

10. Quality of Water: (Water Quality Test Certificates to accompany)

Sample (Yes/No) collected at …………………………. Hour on …………………….. (Date)

Sediment………………………….., Taste ……………………….., Odour…………………….

Colour………………………………; Specific conductivity……………….μmho/cu. m; Temperature……...oC

11. Remarks: (Drilling difficulties, gravel pack details, all pertinent information about drilling and completion of the Borehole)

…………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………….

12. Sketch of Borehole Construction

(Sketch to include depth, & changes of hole diameter; casing positions, manner of casings (if different diameters), connections, and casing connection to the screen; depths of screen, how casing is closed at the bottom, formation caving zones and any other pertinent information)