

TECHNICAL SPECIFICATION

SECTION 01015 TECHNICAL SPECIFICATIONS

1. WATER WELLS

Construct water well(s) as specified in section 01010 Scope of Work, to provide sufficient supply for the population of the facility. The well construction and water well capacity shall be based on the allowable safe yield of the new well determined by a well pump test as described in the USACE-AED Well Design Guide and Water Well Guide Specification, latest version. The new well site shall be at a location approved by the Government. The new well site shall be no closer than 60 m from any existing wells.

The Contractor shall submit all required information listed in Section 7.0 of the USACE-AED Well Design Guide to the government for review and conduct:

1. Well Construction and Well Test Plan - Must be submitted PRIOR to any well drilling activities and must include procedures for decommissioning dry wells in the event water is not encountered,
2. Obtain Approval of Well Construction and Test Plan - Well construction cannot start until government approval of well construction and test plan,
3. Drill Well - after approval of the well construction and test plan by the government, drill a well,
4. Pumping Test - Capacity test of well yield,
5. Water Quality Testing - sample and test the quality of the test well water,
6. Design Well - design a permanent well based upon initial testing of well based upon lithology and groundwater data, and
7. Submit Water Well Test and Permanent Well Design Report - provide water quality lab results, pump test results, drillers log, lithology log, and submit a well construction design for approval PRIOR to the start of final well construction (submit prior to installing any permanent well features), and
8. Obtain Approval - Final well construction cannot start until government approval of Water Well Test Report and Permanent Well Design with proposed construction details, and
9. Construct Well - Build final well in accordance with approved well construction detail and contract specifications. The final well construction details must be provided in the post-construction as-builts.

It is acknowledged that water may not be available at the site despite Contractor good faith efforts to find it.

Well construction shall be in accordance with AED Design Requirements - Well Pumps & Well Design/Specifications, latest version - which includes, but is not limited to, requirements for well screen, casing, gravel pack, well pump, disinfection, water meters and testing requirements. All design requirements, material specifications, and testing contained in this document shall be used and submittals shall be made promptly in accordance with Section 01335. Failure to follow the construction and submittal procedures outlined may, at AED's discretion, result in rejection of the well and the Contractor having to remove the well casing and screen, re-drill the well, and reinstall the proper features per an AED approved design.

Well Construction and Well Test Plan: Prior to the start of well drilling activities at the site, the contractor must submit a well construction test plan that describes:

- Type of drill method to be used (mud rotary, or air rotary),
- GPS location and target depth of the test well,
- Qualifications of the rig geologist,
- Test borehole diameter for unconsolidated sediment and hard bedrock,
- Type and diameter of temporary casing,
- Description of pumping test procedures,
- Abandonment procedures and methods in the event of a dry hole,
- Water quality sampling and testing including identifying certified analytical laboratory to be used, and
- Other details as required under the AED Design Requirements - Well Pumps & Well Design/Specifications, latest version.

Well Testing: After the Government approves the Well Construction and Testing Plan and before permanent well construction, at least one well of a diameter meeting specifications listed in section 01010 and to the contracted minimum depth requirements shall be drilled into the water bearing stratum or bedrock. The test well to be

constructed shall be located as shown on the drawings, or where directed by the Contracting Officer (CO) or his representative (COR).

A GPS instrument will be used to determine the geographic coordinates of the well. This information shall meet requirements of the World Geodetic System 1984 (WGS 84 and the correct UTM Zone – 41, 42, or 43) in decimal degrees. The initial borehole shall be used to determine the location and character of the water bearing strata and to obtain samples of the various formations.

The contractor must collect samples of drilling cuttings. The samples shall be taken at every change of strata and at depth intervals not to exceed 2.0 meters. A driller's log shall be made based on the cuttings obtained. The drill cuttings shall be divided, put into suitable containers and labeled. These samples shall be approximately half a liter each. If the test hole fails to indicate the presence of water bearing strata or is abandoned for any other reason, the test hole shall be abandoned and plugged in conformance to UFGS-33 20 00 (April, 2008) Section 1.3.2. At the completion of the test hole, a drillers log shall be prepared containing the following information:

- Depth of static water depth and water bearing strata;
- Lithology log with type, thickness, and depth of different material strata contacts;
- Color, size, and soil description of cuttings; and
- Proposed well construction details based upon lithology and water bearing strata found and contract specifications.

The drillers log must be submitted as part of the Water Well Test and Permanent Well Design Report.

Permanent Well Depth. The well shall be drilled to a minimum depth as described in the 01010 Scope of Work in an attempt to find potable water meeting WHO water quality requirements. The depth of the test and permanent well shall take into consideration the drawdown depth, screen depth and pump submergence as described in the AED Design Requirements document. If water cannot be found at a sufficient yield after drilling to that linear depth, the contractor will be responsible for properly decommissioning the well under the contract, and then the Contractor will be considered to have fulfilled the terms of the contract and will be entitled to the full price of the contract CLIN for Well. However, the Contractor must still furnish all other parts of the water distribution system as described in the specifications.

Well Pumping Test: To determine the expected yield from the test well and to assure acceptable water quality, a pumping test shall be performed in the well. As described in AED Design Requirements - Well Pumps & Well Design/Specifications, latest version, three types of tests can be performed including 1) Step-drawdown Test; 2) Specific Capacity Test; and 3) Pumping test. The results of the pumping test must be submitted as part of the Water Well Test and Permanent Well Design Report and must include data table, graphs, and pumping test descriptions.

Water Well Test Report - PRIOR to the start of final well construction, the contractor must provide the government a water well test report that includes water quality lab results, pump test results, drillers log, lithology log, and a permanent well construction design for approval. The Water Well Test and Permanent Well Design Report must be submitted and approved by the government prior to installing any permanent well features.

The Water Well Test and Permanent Well Design Report shall include:

- water quality lab results,
- pump test results,
- drillers log,
- lithology log, and
- permanent well construction design that must include-
 - (a) Location in decimal degrees.
 - (b) Number of screens and depth of screen settings in the well.
 - (c) Size of well screen inside and outside diameters and length.
 - (d) Pipe material (material schedule and specification).
 - (e) Standard screen slot opening, mm and spacing.
 - (f) Effective open area of screen (sq cm per meter).
 - (g) Transmitting capacity (liters/meter).
 - (h) Sieve analysis of the material to be screened.

- (i) A graphic showing screen and casing with adjacent lithology types.
- (j) Calculations supporting screen slot size.
- (k) Photo of screen slot pattern.
- (l) Results of Gravel Pack selection analysis.

After approval of the Water Well Test and Permanent Well Design Report, the contractor may start construction of the well.

Permanent Well Casing. The allowable casing and screen material is specified in section 01010 Scope of Work. In unconsolidated material, casing shall extend to the top of the well screen. In suitable rock formations (drilled wells) with low collapse properties, the hole may be left open in the rock formation/bedrock portion of the borehole (i.e., filter pack and well screen may not be required) with casing extending at least 3 m into the rock formation. All wells will be cased 0.5 meters above grade (i.e., base of pit, ground surface, etc.) and be fitted with a lockable cap with air gap (vacuum relief during pumping). Each section of casing will be joined with standard couplings and full-threaded joints, or by proper welding, so that all joints are sound and watertight. Well casing alignment shall not interfere with the proper installation and operation of the pump. The bottom of the casing shall be fitted with a metal well screen that will permit maximum transmission of water without clogging. The minimum length of screen shall be at least 3 m.

Permanent Well Screen. The casing will be fitted with a well screen that will permit optimal transmission of water without clogging. Screen shall only be placed in the interval of the aquifer targeted. To prevent flow of sewage, bacteria, and other contaminants typically found at the groundwater surface, wells must be screened below the confining specified above. The material of construction, opening requirements, minimum lengths and placement shall be per the AED Design Requirements document.

Filter Pack - The width of the filter pack must be larger than the casing by at least 6-inches (150 mm), meaning 3 inches (75 mm) of space or annulus on each side of the casing. Above the filter pack, the annular space between the casing and the borehole will be filled with gravel, overburden, or concrete as follows:

- 1) The annular space between the well screen and borehole shall be filled with material that will form a filter to minimize production of fines and not clog the slots in the screen (e.g., washed, well-graded silica sand). A uniformity coefficient of 2.5 for the filter pack is required, and
- 2) The filter pack must extend 3 m above the top of the topmost screen interval.

Sealing: Above the filter pack, the annular space between the casing and the borehole must be filled with grout or a neat cement as follows:

- 1) The annular space above the filter pack up must be sealed with at least 3 m of bentonite installed approximately 5 meters above the topmost well screen .
- 2) A neat cement grout seal must be placed from the top of the bentonite to within 3 m beneath the ground surface. The grout shall be placed in one continuous mass and shall be impermeable.
- 3) All aggregate shall contain less than 5 percent of shale, clay lumps, coal, lignite, soft or unfragmented stone, or other deleterious materials.

The neat cement grout seal shall be proportioned of Portland Cement conforming to ASTM Specification C150, Type I or II and bentonite (either sodium bentonite or calcium type montmorillonite or opalite). The cement-bentonite mix shall be proportioned, by weight, as follows; 6.6 : 1 : 0.4 (water : portland cement : bentonite). The water-cement (w/c) ratio shall not exceed 7.

Well Development- After construction is complete; the well shall be thoroughly developed. The developing equipment shall be of sufficient capacity to remove all drilling fluids, sand, rock cuttings or any other foreign matter. The wells shall be thoroughly cleaned from top to bottom before beginning the well tests. Overpumping for well development is NOT approved for this project. Only well development methods that involve surging and removal of sediment from the casing/screen will be approved. Mechanical surging, air-surging, and high velocity jetting may be used to develop the well. Development shall continue until turbidity of the water meets WHO turbidity standards.

Performance Testing: Upon completion of the permanent production well, the Driller shall conduct a continuous 6-hour pumping test at the designed flow rate. Drawdown will be recorded from time-zero at the following time intervals:

First 5 minutes—every 30 seconds
Next 5 minutes – every minute
Next 50 minutes—every 10 minutes
Next 2 hours—every 20 minutes
Next 2 hours—every 40 minutes
Last hour—one sample at end

If water levels are recorded digitally with a transducer, smaller time intervals are often programmed into the software. This is acceptable. The above guidance serves as minimum time intervals. Recovery data will also be recorded at intervals described above. Recovery data will be recorded until drawdown reaches 90% of pre-pumping levels.

Well Disinfection. The well shall be disinfected to remove bacteriological contamination that may cause the well-water supply to be unsafe for human consumption. The chlorine solution used for disinfecting the well shall be of such volume and strength and shall be so applied that a concentration of at least 50 mg/L of available chlorine shall be obtained for the entire water depth of the well, and this solution shall remain in the well for a period of at least 12 hr. If the samples collected after disinfection show bacteriological contamination, the contractor shall prepare and apply to the entire depth of the well a total volume of the chlorine solution of at least 100 mg/L of available chlorine equal to at least four times the volume of water in the well. The contractor shall allow this solution to remain in the well for a period of at least 24 hr.

Source protection - Surface drainage within 30 m of wellhead shall ensure no ponding, flooding or collection of runoff adjacent to the well. This can be accomplished through surface grading or use of gravel drains to modify site drainage in the vicinity of the well. Identify all sources of contamination and ensure the proposed well site meets minimum standoff distances as indicated below:

- a. Sewage storage areas (outhouses, tanks, individual sewage pits, lagoons, and WWTP) – 30 m
- b. Septic fields (infiltration galleries) – 30 m
- c. Fuel storage, engine maintenance/repair – 30 m

Well Pump – A submersible, centrifugal pump shall be installed inside the casing either slightly above the highest screen interval or between screen sets. Pumps must not be installed adjacent to screens and shall not be installed at the bottom of the well. Control of the pump shall be by means of a Hand-Off-Auto (HOA) switch. In the “Auto” position, the pump shall be started and stopped automatically by water levels in the water storage tank. Pump shall start at low level and shall stop at high level. Level controls shall be adjustable. Manual start shall be the Hand position. Specification section 01010 Scope of Work may have requirements for both an electrical submersible and a hand pump in the same well. Well pump testing and water clarity testing after well development shall be per the requirements in AED Design Requirements - Well Pumps & Well Design/Specifications, latest version or most recent version.

Backflow Prevention – An appropriate backflow prevention device and shut-off valve (downstream of the backflow device) must be placed on the above-ground well discharge piping to prevent water from flowing back down the well.

Well Tank – Provide bladder style pressure tank for well pump to minimize pressure surges and water hammer effects. The well pressure tanks shall be located downstream of the pump to provide a constant pressure to the system and reduce the well pump cycles, see the below paragraph on Hydropneumatic tanks for the sizing and the number of acceptable pump cycles per hour.

2. WATER QUALITY SAMPLING AND ANALYSIS

The Contractor shall perform water quality sampling and testing at the source. The Contractor shall utilize well-qualified and equipped testing capability in the project site area, if available. If professional testing services are not available in the area, the Contractor will submit an alternative practical testing source for approval.

Details on laboratory analyses are presented in USACE-AED Well Pumps & Well Design February 2012 version, Section 5.2 (also see DOD TB MED 577, 2005, TM 5-813-3, and UFC 3 230 08a Water Supply Water Treatment, January 2004).

Physical and Biological Characteristics:
• Turbidity
• Conductivity
• Total Dissolved Solids
• pH
• Total/fecal coliform
• Total Hardness (as CaCO ₃)
Chemical Characteristics (Expressed as mg/L)
• Arsenic
• Chromium ⁺⁶
• Lead
• Cadmium
• Selenium
• Copper
• Sodium
• Potassium
• Magnesium
• Fluoride as F
• Manganese as Mn (Dissolved and total)
• Iron as Fe (Dissolved and total)
• Sulphates as SO ₄
• Chlorides as Cl
• Nitrites as NO ₂
• Nitrates as NO ₃
• Ammonia
• Bicarbonate
• Carbonate