

SECTION 02734.2

WATER WELL DRILLING, CASING & TESTING (CUSTOM MULTI-PORT NESTED WELLS)

This Custom supplement to Detailed Provision Section 02734 - Water Well Drilling, Casing & Testing, summarizes Contract-specific requirements referenced by each sub-section in the original provision. Sub-sections with no Contract-specific changes or additions are so indicated.

Requirements specified here shall be used in conjunction with those specified in Section P (Standard and Construction Drawings), Special Conditions, and Bidding Sheets. This specification is for the Mountain Avenue West Replenishment Basin Project groundwater monitoring multi-port nested wells.

In accordance with the Scope of Work presented in the Special Conditions, this supplement defines requirements for each multi-port nested monitoring well. Sheet C-2 Drawing D-56999 to Section P – Contract Drawings shows the multi-port nested monitoring well locations, while Sheet C-22 Drawing D-57048 to Section P – Contract Drawings show construction schematics for the multi-port nested monitoring wells.

Work items completed at the option of the District are indicated below.

PART 1 - GENERAL

1.01 DESCRIPTION

Provide all labor, equipment, materials, and forces necessary to provide the District with three new, complete and fully developed multi-port nested groundwater monitoring wells at the locations shown in Sheet C-2 Drawing D-56999 to Section P – Contract Drawings. The monitoring wells shall be drilled using the reverse circulation rotary drilling method where the circulating fluid maintains the borehole at all times during drilling, testing and well construction. For bidding purposes, the wells shall be constructed as shown in Sheet C-22 Drawing D-57048 to Section P – Contract Drawings. However, the final well design will be prepared and submitted to the Contractor by the District upon review of the borehole lithologic log and sieve analyses of lithologic samples from the borehole.

1.02 WELL CONSTRUCTION STANDARDS

The new wells shall be constructed in compliance with (1) the latest edition or supplement(s) of: *State of California Water Well Standards, Bulletin 74-81* dated December 1981 and *Bulletin No. 74-90* dated June 1991, (2) local modifications to these Standards, (3) Sections 13800 through 13806 of the California Water Code, and (4) American Water Works Association (AWWA) Standard for Water Wells (AWWA A100-87 or later).

1.03 WELL CONSTRUCTION SUMMARY

Except as noted in the provision supplement(s), the general work required for well construction, development, and testing shall include, but may not be limited to the following:

- A. Move on and off the well sites and complete permit application prior to start of work.
- B. Install temporary security fencing around all construction, material storage, and temporary water disposal areas.
- C. Setup and maintain a temporary field office, electrical, and telephone (cellular is acceptable) service and sanitary facilities.
- D. Provide at least two temporary tanks for settlement of solids from development water prior to discharge to the point of discharge.
- E. Provide temporary pipeline and appurtenances required to convey well development water to the point of discharge.
- F. Install sanitary seal in upper 50 feet for the well.
- G. Drill and sample pilot borehole.
- H. Conduct down hole geophysical surveys in the pilot borehole.
- I. Ream the pilot boreholes to the specified final diameters and depths.
- J. Complete a caliper survey on final reamed borehole.
- K. Install blank and screened well casing, gravel pack, and annular seals in accordance with the Plans and Specifications and final well design specified by the District.
- L. Complete initial well development by air-lift swabbing (mechanical development).
- M. Complete well development by pumping and surging, may require added water.
- N. Conduct a well alignment test by gyroscopic methods.
- O. Construct the well pad with standpipe to protect well and bollards around pad per specifications.
- P. Complete final site cleanup and restoration to the satisfaction of the District.
- Q. Provide all records required by the specifications and requested by the District.

1.04 CONTRACTOR EQUIPMENT

- A. General

1. The contractor shall supply all equipment, tools, supplies, materials, power, services and personnel required to complete the work.
2. The contractor shall provide fencing for the sites as needed to secure the well site and work area used for material storage and drilling operations including areas occupied by the field office, construction equipment, engines, motors, and other equipment. The Contractor shall supply provide a temporary field office and sanitary facilities as described in the Special Conditions.

B. Drilling Equipment

1. The multi-port nested wells shall be drilled using reverse circulation rotary drilling method in which the uncased wall of the drill borehole is held in place at all times with a circulating fluid. The multi-completion well will be constructed from bottom to top using Contractor supplied tremie pipe to insert gravel pack, sand pack, annular seals and bentonite/grout seal.
2. Contractor will use spacers to ensure that the four (4) steel risers are kept apart while using centralizers to keep the 4 wells evenly spaced from the borehole walls. The Contractor will provide a complete drilling unit, all tools, accessories, power, lighting, water, supplies and materials, and other equipment and experienced personnel necessary to conduct efficient drilling operations at the site.
3. The drilling equipment shall be in good condition and of sufficient mast capacity to drill the boreholes required by these specifications to a depth specified in Sheet C-22 Drawing D-57048 to Section P – Contract Drawings. All drilling equipment including mast, draw-works, air compressors, bits, drilling fluid pumps, drill pipe, etc., must be of requisite size, sufficient capacity and in suitable condition to drill and set casing to the anticipated depths in the well (as specified for depth requirements). The mast and all running gear (hoists, cables, etc.) shall have sufficient and demonstrated capacity to lift two (2) times the buoyant weight of either the drill rig string or the blank and screened well casing assembly or auger flights (whichever is greater). The drill rig utilized must have the ability to fully lift and land the anticipated casing loads without the use of cranes, float plugs, or other similar devices.
4. The contractor shall submit, upon request, detailed information documenting the capacity of the various components of the rig used including, but not limited to: derrick/mast capacity, drill pipe type and rating, all line and hook load capacities, air compressor rating, mud pump capacity, etc. All drill pipes must utilize threaded flush or upset tool joints, or equal, as approved by the District.

Drilling equipment shall be disinfected on site prior to use and between wells. The methods, chemicals, and dosages employed shall be approved by the District.

- C. **Mud Tanks**
Excavated mud pits will not be allowed. Portable tanks are required which allow the drill cuttings to settle. The tanks will have a minimum of three chambers and have sufficient capacity to allow for proper settling of drill cuttings as approved by the District. The tanks will be cleaned periodically to ensure that the drilling fluid remains clean prior to its re-entry into the borehole. At no time shall the height of the material settled in the tank exceed two feet. Drilling fluid re-circulated to the borehole shall not contain in excess of 5 percent sand. Drilling mud materials cleaned from the tanks shall be hauled to a site designated by the District for disposal at the Contractor's expense.
- D. **Water Storage Tanks**
The Contractor shall provide sufficient water storage capacity ("Baker Tanks" or equivalent) for retention of fluids generated during the course of the work, prior to their disposal. The tanks shall be joined in series such that water flows between the tanks to maximize settling time and minimize disturbance of settled materials. Water storage and clarification facilities utilized shall be sufficient to meet water discharge requirements of the District's NPDES permit. Pipelines or hoses used to link the water storage tanks and convey clarified water to the point of discharge shall be of a capacity sufficient to handle the maximum quantity of water that can be produced from the well during mechanical and pumping development as required.
- E. **Discharge Piping**
The Contractor shall provide temporary discharge piping of adequate capacity and length to convey water pumped during well development to the point of water discharge specified in the Special Conditions.

1.05 CONTRACTOR RESPONSIBILITIES

- A. The Contractor is solely responsible for making all necessary provisions for mobilizing onto and demobilizing from the well site with their equipment, tools, supplies, materials, and personnel.
- B. The Contractor shall spread drill cuttings on the well site area at the direction of the District. Drilling mud will be disposed at a site identified by the District.
- C. The Contractor shall convey all water discharged during development in a closed pipe to a suitable discharge point specified by the District representative. All water discharged shall meet the requirements in the District's NPDES permit.
- D. The Contractor will submit all required reports, well certification, and data to the District and other appropriate agencies.
- E. The Contractor is responsible to have inspected the well site prior to submitting a bid and commencing construction activities (Note Mandatory Pre Bid Meeting Attendance requirement).

- F. The Contractor shall keep the District and the District's Representative continuously informed of the on-site work schedule so that drilling, construction, and testing activities can be monitored as required by the District.
- G. The Contractor is responsible for any damage to properties adjacent to the well site caused by the Contractor activities associated with the work described herein and shall restore these properties to their original condition.

1.06 QUALIFICATIONS AND QUALITY ASSURANCE

- A. The Contractor shall have been engaged in the business of well construction using the reverse circulation and hollow stem drilling methods, well completion with a depth, diameter, and capacity equivalent to those anticipated for the new well for a period of at least fifteen (15) years.
- B. The Contractor shall submit a list of the last three (3) monitoring well owners for whom the Contractor has drilled equivalent monitoring wells (including multi-completion nested wells). The list of references shall include (as applicable) the owner's name and address, casing diameter, type, depth, monitoring well depth, installed equipment (transducers, dedicated pumps, etc.), sanitary seal, screen interval, and other relevant data including drilling methods.

1.07 RECORDS

- A. The Contractor shall keep a daily log and progress record at the site readily available for inspection during drilling of the pilot borehole, reaming, down-hole testing, well construction, and development of the new well. Scans of the daily reports should be transmitted to the District representative at the end of each days work.
- B. Specific records associated with each on-site activity are listed in Part 2.0 – Construction (Technical Provisions) of this detailed provision. In general, the Contractor shall keep records providing the following information:
 - 1. Drillers description of formation materials penetrated at 10-foot intervals and at each major change of formation (from both the conductor casing borehole and pilot borehole).
 - 2. A log of drill bit types, diameters, and changes to drilling equipment, and drill rate.
 - 3. Drilling fluid properties at 4-hour intervals including mud weight, Marsh funnel viscosity, sand content, solids content, water additions, and mud additives used.
 - 4. Collection of one (1) set of representative formation samples from the conductor casing borehole and pilot borehole. Samples shall be collected over a 10-foot interval and at each major change in formation from the ground surface to the full depth of the borehole (Not required for continuous core boreholes where core is recovered). The method of sample collection shall be approved by the District. ***Samples collected off a shaker screen are not acceptable unless specifically approved by the District.*** Samples will be collected from the mud return at the borehole.

Samples shall be preserved in one-gallon size, heavy (freezer) weight, zip-lock type, plastic bags labeled with the well name, date, time, and depth interval.

5. Results of sieve analysis of formation samples requested by the District and completed by the Contractor. See Section 02734.2 2.04 for number of sieve analyses required.
6. Results of down hole geophysical surveys completed in the pilot borehole.
7. Documentation of borehole reaming activities.
8. Results of caliper survey of the final reamed borehole.
9. Results of sieve analyses completed by the Contractor of representative samples of gravel pack materials delivered onsite prior to screen and casing installation. See Section 02734.2 2.11 for number of samples.
10. Well construction activities including final schedule and diagram of installed blank and screened well casing, gravel pack, fine sand, and annular seal intervals; and sanitary seal interval.
11. Cross-sectional diagram illustrating the as built well construction.
12. Records of well development for each screened interval including development method (swabbing, air lift pumping, added water, jetting, surging) and development through pumping methods. Records shall include a development log showing static water level, pumping rates, drawdown, volume pumped, and water quality parameters (pH, conductivity, turbidity, temperature) and other information requested by the District.
13. Setup and results of well alignment and deviation surveys.
14. Schedule of well destruction if applicable.
15. Final as built of well including screen intervals, gravel pack, sand pack, annular seal, riser interval, sanitary seal, and surface completion including well head completion.

1.08 SUBMITTALS

All submittals shall be delivered to the District in both hard copy and District approved electronic format. All records shall be legible, typed as appropriate, and submitted to the District on 8.5" x 11" paper. Required submittal schedules are summarized in Table 02734.2.

1.09 GUARANTEE

A. General

For a period of three (3) years after acceptance of the well by the District, the Contractor shall make the following guarantees and accept the following responsibilities concerning their work:

1. The well casing and screen shall remain intact throughout its entire length.
2. Plumbness and alignment of the well shall remain within the tolerances set forth in these specifications.

- B. Demonstration of Compliance
 - 1. To demonstrate compliance with the above, the Contractor shall perform one yearly inspection of the well under the Districts supervision.
 - 2. Should the sampling program indicate an issue with the well the drillers will budget for one gyroscopic inspection of the well under the Districts oversight. A report of the finding will be submitted to the District.

1.10 SUPERVISION AND COOPERATION

- A. The Contractor shall provide a qualified and experienced foreman and drilling superintendent, one of who shall be constantly in attendance throughout drilling and construction of the new well.
- B. In addition to directing all well drilling and construction (including down hole testing), the foreman shall be capable of coordinating the work with all personnel, subcontractors, and the District so that the overall project is safely and successfully executed and completed without undue conflicts or delays.

PART 2 - CONSTRUCTION (TECHNICAL PROVISIONS)

General requirements, materials, and execution for construction of District monitoring wells are presented in the following sections. Contract-specific requirements are presented in the provision supplements. Well locations, and standard and construction drawings are shown on Sheet C-2 Drawing D-56999 and Sheet C-22 Drawing D-57048 to Section P – Contract Drawings.

2.01 MOBILIZATION/DEMobilIZATION

- A. GENERAL
 - 1. Description
 - Mobilization/demobilization will include: 1) preparatory utility clearance of each site and sign off on the respective permit documents and clear/grade access road to site; 2) transportation of personnel, equipment, and operating supplies to and from the well site; 3) establishment of temporary fencing, field office, power and telephone service (cell is acceptable), noise barrier as directed by the District (per specifications), and portable sanitary facilities, 4) obtaining an adequate source of fresh water from the District; 5) setup of temporary water storage tanks, discharge line and appurtenances, and 6) other preparatory work required to complete construction of a new well including equipment, cleanup and return of site to match original surrounding grade and materials, removal of all equipment, materials, supplies, trash, and well head completion.
 - 2. Related Work Specified Elsewhere
 - a. General Conditions, Section F-42, Measurement and Payment
 - b. Mandatory Pre-Bid Walk Through – Special Conditions
 - c. Pre-construction Conference – Special Conditions

3. Submittals
 - a. Well Drillers Permit from Riverside County Department of Environmental Health Services.

4. Measurement and Payment

A specific lump sum line-item is provided for mobilization/demob. The contractor shall incorporate the costs for mob/demob into the well cost as specified.

B. MATERIALS

Requirements for Contractor equipment are specified in Section 1.04.

C. EXECUTION

1. The Contractor shall install appropriate fencing around the well construction area including the well, materials storage and temporary water disposal areas. Fencing shall be adequate to ensure the safety and security of the equipment, materials, on-site personnel, and local residents.
2. Temporary water service for construction services will be supplied by the District in accordance with the procedures described in the Special Conditions and established at the Mandatory Pre-bid Walk Through.
3. The Contractor shall provide a work station and portable sanitary facilities for use by all personnel connected with this well project. At the District's direction the driller will install noise barriers at the drill site per the specifications (02734.2 2.02).
4. The Contractor shall keep the well site free from accumulations of waste materials, rubbish, and other debris resulting from the work. At completion of the work, the Contractor shall remove all waste materials, rubbish, and debris from and about the well site as well as all tools, construction equipment, fuel tanks, drums, machinery, temporary structures, and surplus materials. The Contractor shall leave the site clean and ready for use by the District with access to the well head for future sampling and data downloads. The Contractor shall restore all temporary work areas at the site to their original condition.
5. The Contractor shall prevent damage to the well site, adjacent facilities and properties associated with pumping water during drilling and development, or due to interruption or diversion of storm or wastewater during execution of the work (proper BMPs will be employed to address storm-water at the site).
6. Dirt and sediment shall be kept out of water disposal/drain lines at all times. The Contractor shall properly dispose of all drilling, waste, and nuisance water.
7. Well development and testing water shall be conveyed to the discharge location specified in Section SC – Special Conditions (Section 00100). Water discharges shall be conducted under and in compliance with the District's NPDES permit (Section H).
8. Drill cuttings and drilling fluids shall be removed from the well site and properly disposed by the Contractor as directed by EMWD representative.

2.02 NOISE CONTROL

A. GENERAL

1. Description

This section covers the installation of noise control barrier walls and other measures required to meet specified noise limits. Project-specific requirements are summarized in the provision supplement(s) and will be discussed at the Pre-bid Walk Through.

2. Measurement and Payment

Payment for installation and removal of noise control barrier walls shall be at the price per lineal foot bid.

B. MATERIALS AND EQUIPMENT

1. Equipment and materials employed for noise suppression shall include, but are not limited to, equipping all internal combustion engines with critical residential silencers (mufflers), installing sound blankets over equipment (or equivalent barriers), shielding noise-producing equipment and installing noise control barrier walls.

2. If required, barrier walls installed shall consist of fiberglass-filled curtains and shall have adequate transmission loss and a minimum wall height of 20 feet. Noise control barrier walls shall be designed by a registered civil engineer. The design shall preclude structural failure due to such factors as winds, shear, shallow soil failure, earthquakes, and erosion. The length, height, and location of noise control barrier walls shall be adequate to assure proper acoustical performance.

C. EXECUTION

1. Noise suppression shall be practiced at all times to minimize disturbance to persons living or working nearby, and to the general public. Noise control measures shall be installed to direct the greatest noise emissions away from these receptors. Operations shall be conducted in a manner to minimize noise generation consistent with the execution of the contract in a timely and economic manner.

2. Noise control barrier walls and equipment shall be installed as needed to achieve a noise level of 65 db or less at the property lines. Noise levels in excess of 65 db shall be allowed only during critical operations for brief periods of time. Contractor shall make every reasonable effort to minimize noise levels during nighttime operations.

2.03 CONDUCTOR BOREHOLE, CASING AND SANITARY SEAL

A. GENERAL

1. Description

a. The conductor casing at the monitoring well shall be constructed to a minimum depth of 50 feet bgs.

This item includes drilling a conductor borehole, installation of a conductor casing, and installation of a cement grout sanitary seal in the annulus between the borehole and the conductor casing to the minimum depth specified in the provision supplement.

- b. The sanitary seal installed shall meet the requirements of California Department of Water Resources Bulletins 74-81 and 74-90 and all requirements of the County of Riverside Department of Environmental Health Services (DOHS).

2. Submittals and Notifications

- a. Certified test reports to show compliance with both the physical and chemical properties of the steel.
- b. Cement weigh or batch tickets
- c. The Contractor shall notify the District at least 24 hours in advance of commencing drilling. The Contractor shall notify the District and Riverside County DOHS at least 48 hours in advance of setting the conductor casing and cement grout sanitary seal around the conductor casing. Unless pre-approved, installation shall not proceed without District and DOHS inspectors on site.

B. MATERIALS

1. Conductor Casing

Conductor casing shall have the following specifications:

- a. 32-inch diameter hole
- b. Minimum 50 feet depth
- c. 28-inch O.D, minimum 3/8-inch wall thickness
- d. Mild steel, ASTM A 139, Grade B without copper, or approved equal
- e. The conductor casing shall not be fabricated in less than 40-foot lengths. All spiral or longitudinal and circumferential seams shall be butt-welded with shielded arc electrodes to assure full fusion with the parent metal and complete penetration. All welding will be performed in accordance with American Welding Society Standards. All casing materials shall be new.

2. Sand-Cement Grout

- a. The grout used to fill the annulus between the conductor borehole and the conductor casing shall be sand-cement mix specified in the provision supplement. The mix shall not be more than two parts sand (by weight) to one part cement (by weight). The water cement ratio shall be about 7 gallons per 94 pound sack of cement (standard brand Portland cement, ASTM C150, Type II).

- b. Water used for cement and grout mixtures shall be clean and of potable quality.
- c. Materials used as additives for Portland cement mixtures in the field shall meet the requirements and latest revisions thereof, ASTM-C494, Standard Specifications for Chemical Admixtures for Concrete.
- d. Special quick-setting cement, retardants to setting, and other additives, including hydrated lime to make the mix fluid (up to 10 percent of the volume of cement), and bentonite (up to 5 percent) to make the mix more fluid and to reduce shrinkage, may be used.

C. EXECUTION

1. Conductor Casing Borehole

- a. The borehole shall be drilled at a location confirmed in the field with the District. Drilling shall not commence without the District or District's Representative on-site unless previously agreed by the District.
- b. During drilling, the Contractor shall collect and preserve representative samples of formation materials at 10-foot intervals and each major change in formation, in accordance with sampling procedures specified in Section 2.04 - Pilot Borehole.**
- c. Upon completion of drilling, the Contractor shall condition the borehole and take whatever steps are necessary to maintain and prevent collapse of the borehole prior to and during placement of the conductor casing and cement grout sanitary seal.

2. Installation of Conductor Casing

The conductor casings shall be constructed to a minimum depth of 50 feet.

- a. When the drilling operation has been completed to the satisfaction of the District, the conductor casing shall be installed. The MINIMUM length of the conductor casing installed below the ground surface shall be as specified in the provision supplement(s). The final length shall be approved by the District. The conductor casing shall extend to the ground surface, be held in plumb position and shall be placed on the bottom of the borehole.
- b. All field joints shall be properly butt-welded to assure complete penetration during welding with a minimum of two passes. All joints shall be watertight. Special care shall be exercised to ensure that the casing is straight. All field welding shall be performed in accordance with American Welding Society Standards by a certified welder.
- c. Centering guides shall be securely welded (or equivalently secured) to the conductor casing with a minimum of two sets of guides installed (one near the bottom and one near the top). Each set shall consist of three guides equally spaced circumferentially.

3. Installation of the Grout Seal

The grout seal at the well shall be constructed to a minimum depth of 50 feet.

- a. After the conductor casing is installed and aligned, the annular space between the conductor casing and the conductor casing borehole shall be filled with cement grout from the bottom of the borehole to the ground surface. **The MINIMUM depth of the grout seal shall be as specified in the provision supplement(s).** Prior to grouting, the Contractor shall fill the inside of the conductor casing with water to balance the hydrostatic pressure between the inside and outside of the casing during placement of the grout.
- b. The grout shall be pumped into the annular space through a tremie pipe installed to the bottom of the borehole. The bottom of the tremie pipe shall remain submerged in the grout throughout the placement of the grout. The placement procedure shall be approved by the District prior to installation of the grout seal. The Contractor shall take all precautions to prevent the collapse of the conductor casing and borehole during placement of the grout.
- c. The grout seal shall be placed in one continuous pour.
- d. **The Contractor shall not operate any equipment on-site during the 24-hour period immediately after the grout has been placed.**
- e. In the event the borehole or part of the borehole collapses prior to completion of grouting, the Contractor shall take whatever steps are necessary to reopen the borehole, reset the casing and place the grout as required. Any such remedial action shall be conducted at the Contractor's expense.

2.04 PILOT BOREHOLE

A. GENERAL

1. Description
This item includes drilling a pilot borehole (minimum 17.5-inch diameter) by the approved drilling method to the depth specified by the District.
2. Related Work Specified Elsewhere
 - a. Drilling Fluid - Section 2.05.
3. Submittals
 - a. Daily activity report.
 - b. Samples of formation materials.
 - c. Results of sieve analysis of formation samples (2 per screen interval).
 - d. Lithologic log.
 - e. Drilling rate log.

4. Measurement and Payment

Payment for pilot borehole drilling will be based on measurement of vertical feet of pilot borehole drilled from below the bottom of the conductor casing to the bottom of the borehole (as verified by the down hole geophysical logs). Payment shall include all materials, labor, tools, and equipment required to drill the pilot borehole, collect formation samples, conduct sieve analysis of formation samples, maintain circulation, and protect the pilot borehole from collapse.

B. MATERIALS

1. Drilling Fluid

The Contractor shall maintain controlled drilling fluid characteristics during the entire drilling operation as specified in Section 2.05, Drilling Fluids.

2. Borehole

a. Minimum 17.5-inch diameter

b. Depth: 50 feet to 1,100 feet (or as specified by the District)

C. EXECUTION

1. Pilot Borehole Drilling

a. The pilot borehole shall be drilled from the bottom of the conductor casing to the specified depth and diameter. The final depth of the pilot borehole will be determined by the District as drilling proceeds. The Contractor shall drill below the specified depth only if requested to do so in writing by the District. The Contractor shall take all measures necessary to protect the borehole from caving or raveling.

b. The Contractor shall maintain a record showing any variation in the addition and amount of approved clays or chemical products or water required during drilling. The depths at which such changes are required shall be shown in the daily reports.

2. Formation Sampling

a. The Contractor shall collect, preserve and label one (1) set of representative samples of drill cuttings at 10-foot intervals and at each major change in formation as drilling proceeds to the full depth of the pilot borehole. The method of collection shall be discussed with and approved by the District at the Pre-construction Conference. **Samples collected off a shaker screen are not acceptable unless specifically approved by the District.** Samples shall be placed in one-gallon size, heavy (freezer) weight, zip-lock type, plastic bags and shall be labeled to indicate the well name, date, time and depth interval. Collected samples shall be stored in a manner to prevent breakage or loss.

b. Upon completion of the pilot borehole, down hole geophysical logs shall be run.

3. Sieve Analysis
 - a. The Contractor shall conduct sieve analysis of samples of formation materials selected by the District. The numbers of analyses required are specified in the provision supplement(s).
 - b. Sieve analysis shall be conducted by a firm acceptable to the District using a set of sieve sizes previously approved by the District.
 - c. Up to six (6) samples per well borehole (selected by the District)

2.05 DRILLING FLUID

A. GENERAL

1. Description
This section describes requirements for fluid used during drilling.
2. Submittals
Concurrently with contract submittals, the Contractor shall provide a description of the drilling method and fluids to be used. The drilling fluid program described shall include: (1) information regarding the types of fluid to be used, (2) intended fluid weights, viscosities, sand and solids contents, (3) name of the supplier of the drilling fluid additives, and (4) name and qualifications of the mud engineer the Contractor would intend to use, if required.

B. MATERIALS

1. Drilling Fluid
 - a. Only fresh water shall be used in the drilling fluid whether employed alone or in combination with drilling additives. All water used during drilling shall meet California State Department of Health standards for safe drinking water. Only high grade approved commercial clays or commercial chemical products in common usage in Riverside County for water well drilling shall be used in the make-up of any drilling fluid. **Organic drilling additives shall not be used unless previously approved by the District.** Drilling with a mixture of water and unprocessed mud, clay or other material will not be permitted.
 - b. The drilling fluid shall possess such characteristics as are required to (a) adequately maintain the walls of the borehole to prevent caving, (b) permit recovery of representative samples of drill cuttings, (c) prevent the swelling of clay zones, (d) prevent loss of shear strength or other borehole stability problems, and (e) allow the fluid and mud cake to be readily removed from the borehole and borehole wall during placement of the gravel pack and development of the well. All drilling fluid test equipment and procedures shall be equal to those used in the oil well drilling industry.

- c. The drilling fluid shall have the following properties in accordance with API Code RP 13B (or recent modification), "Recommended Standard Procedure for Testing Drilling Fluids." In the event the Contractor cannot attain these properties, drilling shall be halted and the mud replaced.
- (1) Weight - a maximum to 80 pounds per cubic foot (10.7 pounds per gallon) during pilot borehole drilling, a maximum of 75 pounds per cubic foot (10.0 pounds per gallon) during pilot borehole reaming, and 70 pounds per cubic foot (9.4 pounds per gallon) during well completions and gravel packing.
 - (2) Marsh funnel viscosity - a maximum to 50 seconds during pilot borehole drilling, a maximum of 45 seconds during pilot borehole reaming, and a maximum of 40 seconds during well completion and gravel packing.
 - (3) Sand content of mud entering the pump - a maximum of five (5) percent by volume during all stages of drilling.

C. EXECUTION

1. The Contractor shall provide adequate baffled above ground tanks with solids control equipment, for the collection and removal of drill cuttings/solids from the fluid before re-circulation to the borehole. The mud tank capacity shall be sufficient to effectively separate drill cuttings from the fluid and keep sand and solids contents below the specified amounts. Sediment shall be removed periodically from the tank in order to maintain tank volume and keep drilling fluid properties within specifications.
2. The Contractor shall maintain controlled drilling fluid characteristics during the entire operation of well construction. If proper control of the drilling fluid is not maintained to the satisfaction of the District, the Contractor shall be required to retain at the Contractor's own expense a qualified drilling fluid engineer during all operations to supervise and maintain drilling fluid properties.
3. The Contractor shall maintain the minimum viscosity of the drilling fluid that will raise cuttings and adequately condition the wall of the borehole. The Contractor shall remove all mud cake on the wall of the borehole during the development of the well or placing of the gravel.
4. The sand content of the drilling fluid shall be measured and recorded a minimum of every four (4) hours during drilling or circulation. The sand content of the fluid returning to the borehole shall be maintained at five (5) percent (by volume), or less, at all times.
5. In the event that drilling additives are used, the Contractor shall maintain careful mud control. Procedures must be adopted to ensure removal of these additives during the development process. The Contractor shall maintain a continuous log of mud weight, funnel viscosity, 30-minute water loss, wall cake thickness, pH and sand content. Fluid checks shall be taken at a minimum of every four (4) hours during drilling, whenever conditions appear to have changed, or if difficulties arise.

6. The Contractor shall provide a District-approved device or system for collection of whole representative samples of formation materials drilled. **Samples collected off a shaker screen are not acceptable unless previously approved by the District.**
7. All drilling cuttings and drilling mud shall be properly disposed by the Contractor outside the limits of work site in accordance with applicable ordinances and regulations of governmental agencies having jurisdiction. No additional compensation will be paid to the Contractor for fluid disposal or treatment prior to disposal.
8. After the borehole has been reamed, and before the caliper survey is run, the drilling fluid shall be appropriately thinned in preparation for installation of the well casing and gravel pack.

2.06 DOWNHOLE GEOPHYSICAL SURVEYS

A. GENERAL

1. Description

Down hole geophysical logs will only be collected for pilot boreholes. This item includes completion of down hole geophysical logs conducted in the pilot borehole by a logging firm retained by the Contractor and approved by the District. Geophysical surveys to be completed in the pilot borehole shall be as specified in the provision supplement(s).

Required Logs shall include:

- a. Resistivity (including curves for spontaneous potential, point resistance, 16-inch normal resistivity, 64-inch normal resistivity, and focused guard resistivity)
 - b. Natural Gamma-ray Log
- #### 2. Submittals
- a. Within ten (10) days of Notice of Award, the Contractor shall submit to the District the name and qualifications of the firm proposed for completing geophysical surveys.
 - b. The Contractor shall provide five (5) field copies of the surveys to the District for interpretation upon completion. Within one week of log completion and at no additional cost, the Contractor shall provide the District with ten (10) final copies of each survey, one mylar original of each survey, and a compact disk or 3.5-inch floppy disk(s) containing survey results in a digital format(s) approved by the District.

- c. Payment for geophysical surveys will be based on the lump sum price bid. Payment shall include full compensation for fluid circulation, removal of drill string, operation of the drilling rig and other equipment, furnishing and operating geophysical surveying equipment as specified, field and final copies of the surveys, digital copies of the surveys, and providing whatever assistance may be required to complete the surveys.
 - d. There will be no additional payment for rig time and idle time while waiting for the surveying firm to arrive or while the surveys are being conducted.
 - e. Upon receipt of copies of geophysical surveys and results of sieve analysis, the District may require an evaluation period up to the duration specified in the provision supplement(s) to interpret the data and prepare schedules for a final well design, as applicable. No standby time will be paid during the evaluation period. Standby time will be paid for each hour after the specified evaluation period for which the Contractor waits to receive instructions.
3. Evaluation Period
 - a. Up to 120 hours, excluding weekends and holidays, to develop final requirements for final well design, as applicable.
 - b. Evaluation period begins after receipt of geophysical logs, Contractor's lithologic log of drill cuttings and sieve analyses of drill cuttings.
 - c. No accrued standby time during the evaluation period.
- B. MATERIALS
1. Log Scales
 - a. Vertical Scale: 50 feet per inch
 - b. Horizontal Scale: appropriate to log type and subsurface conditions encountered (or District preference)
- C. EXECUTION
1. Upon completion of the pilot borehole, down hole geophysical surveys shall be conducted. Before conducting geophysical surveys, the Contractor shall cease drilling and circulate fluid for not less than one (1) hour.
 2. The geophysical surveys shall be conducted in the presence of the District. The surveys shall become the property of the District at the time the surveys are completed.
 3. The logging speed for all surveys shall be 40 feet per minute, unless otherwise approved by the District.
 4. If a survey probe fails to descend to the completed depth of the borehole, the Contractor shall at the Contractor's own expense, re-condition the borehole to permit the probe to descend to the maximum depth drilled or other depth approved by the District. No additional payment will be made for time required to clean or condition the borehole for logging.

5. The Contractor shall provide whatever assistance may be necessary to complete the geophysical surveys.
6. The Contractor shall ensure the stability of the pilot borehole during the analysis period following completion of the geophysical surveys.
7. If available information indicates well completion is not warranted, the District reserves the right to terminate further work under the contract. In this event, the borehole will be destroyed in accordance with Section 2.19 of the Technical Provisions.

2.07 BOREHOLE SEAL

A. GENERAL

1. Description
 - a. This work item includes installing a grout seal, at the District's option in the lower (bottom) portion of the borehole.
 - b. **Requirements will vary by Contract. The work item status and tentative seal depth are shown on Sheet C-22 Drawing D-57048 to Section P – Contract Drawings.** The final seal depth and thickness will be specified in the final well design submitted to the Contractor by the District after evaluation of the lithologic log and geophysical surveys, as applicable.

Requirements

- (1) One (1) seal at bottom of the borehole (District option)
 - (2) Seal depth to be specified by the District in the final well design.
 - (3) This line is left intentionally blank
2. Submittals
 - a. Daily activity logs.
 - b. Cement weigh tickets.
 - c. Record of actual depth and thickness of seal installed.

B. MATERIALS

1. Seal
Cement grout used for the borehole seal shall be a non-shrinking cement mixture approved by the District. The grout shall be supplied by a qualified subcontractor.

C. EXECUTION

1. The borehole seal may be installed in the pilot borehole after completion of the geophysical surveys or following completion of reaming operations. If installed after reaming, the Contractor shall re-enter the borehole with the pilot hole bit to clean out that portion of the borehole to be sealed.

2. Cement grout shall be pumped in the borehole using a tremie pipe. The bottom of the tremie pipe shall remain submerged during the entire grouting operation.

2.08 FINAL REAMED BOREHOLE

A. GENERAL

1. Description
This item includes reaming the pilot borehole to the final borehole diameter(s) and depth(s) specified by the District in the final well design.

Requirements

- a. For multi-port nested monitoring wells the minimum Reamed Borehole: 24-inch diameter.
 - b. See Sheet C-22 Drawing D-57048 to Section P – Contract Drawings for tentative depths and quantities. Final depths will be specified in final well design provided by the District after completion of the down hole geophysical surveys, as applicable to the Contract.
2. Related Work Specified Elsewhere
 - a. Drilling Fluid - Section 2.05.
 - b. Contractor Equipment - Section 1.04 (this provision) and Special Conditions.
 3. Submittals
 - a. Daily activity reports.

B. MATERIALS

1. Drilling Fluid

The Contractor shall maintain controlled drilling fluid characteristics during the entire reaming operation as specified in Section 2.05.

C. EXECUTION

1. Upon receipt of a written final well design from the District, the Contractor shall ream the pilot borehole to the depths and maximum diameters specified.
2. A record shall be kept showing any variation in the addition and amount of drilling fluid or water required during the drilling operation. The depths at which such changes are required shall be shown in the daily reports.
3. Upon completion of the reaming operations, a caliper survey shall be run to verify the final diameters and depths reamed.

2.09 CALIPER SURVEY

A. GENERAL

1. Description

This item includes a caliper survey to be conducted by a firm retained by the Contractor and approved by the District. The caliper survey shall accurately measure the final diameter(s) of the reamed borehole.

Required Survey

- a. 1 three-arm caliper survey for final reamed borehole only.

2. Submittals

- a. Within ten (10) days of the Notice of Award, the Contractor shall submit to the District, the name and qualifications of the firm proposed to conduct the caliper survey.
- b. The Contractor shall provide five (5) field copies of the caliper survey to the District for interpretation upon completion. Within one (1) week of survey completion, the Contractor shall provide the District with ten (10) final copies of the caliper survey, one mylar original, and survey results in a District-approved digital format on either compact disk or 3.5-inch floppy disk.
- c. Based upon an examination of caliper survey results, the Contractor shall estimate and report to the District the volumes of gravel pack and other annular fill materials required to complete the final well design.

3. Measurement and Payment

- a. Payment for the caliper survey will be based on the lump sum price bid. Payment shall include full compensation for fluid circulation, removal of the drill string, operation of the drilling rig and other equipment, furnishing and operating caliper survey equipment as specified, and providing whatever assistance may be required to complete the caliper survey.
- b. Upon receipt of field copies of the caliper survey, the District may require an evaluation period, up to the time specified in the provision supplement(s), to review and approve survey results. No standby time will be paid during this evaluation period. Standby time will be paid for each hour after the initial evaluation period for which the Contractor waits for District approval of caliper survey results.

4. Evaluation Period (for review and approval of survey results)

- a. Up to 48 hours, excluding weekends and holidays, to review and approve survey results
- b. No accrued standby time during the evaluation period

B. MATERIALS

1. Survey Scales

- a. Vertical Scale: 50 feet of depth per inch of plot
- b. Horizontal scale: 4 inches of borehole diameter per inch of plot

C. EXECUTION

1. Upon completion of reaming, and prior to setting the bottom pilot borehole grout seal if required, the caliper survey shall be conducted. Before starting the survey, the Contractor shall ensure the borehole is free of loose drill cuttings by circulating the drilling fluid for a period of at least one (1) hour.
2. The caliper survey shall become the property of the District at the time the survey is completed. The survey will be conducted in the presence of the District.
3. The logging speed for the caliper survey shall be 40 feet per minute, unless approved otherwise by the District.
4. If the caliper survey shows the reamed borehole to be less than the specified diameter(s) at any point or the final borehole is less than the specified depth, the borehole shall be re-reamed or re-drilled and re-surveyed at the Contractor's expense.
5. The Contractor shall provide whatever assistance may be necessary to complete the caliper survey.
6. During the evaluation period following completion of the caliper survey, the Contractor shall remain continuously responsible for the integrity of the final reamed borehole. The Contractor shall take all steps necessary to stabilize and preserve the borehole.

2.10 WELL CASING

A. GENERAL

1. Description

- a. This item includes the supply and installation of blank and screened well casing and end cap required by the final well design. Well construction materials are specified in the provision supplement(s). For bidding purposes, tentative schedules of completion for Contract wells are provided in the provision supplement(s), and shown on Sheet C-22 Drawing D-57048 to Section P – Contract Drawings.
- b. A final schedule of well casing will be prepared by the District and submitted to the Contractor upon completion of analyses of a lithologic log, sieve analyses of drill cuttings, and down hole geophysical surveys.

2. Submittals

The Contractor shall submit certified test reports and other documentation necessary to demonstrate compliance with (1) the physical and chemical properties of the steel used in the manufacture of blank and screened well casing delivered on-site, and (2) diameter, wall thickness and slot dimensions (as applicable) of blank and screened well casing (steel) specified in the final well design.

B. MATERIALS

1. Blank Well Casing

- a. 4-inch I.D., minimum 0.337-inch wall. 316L stainless steel casing
- b. ASTM 778, Stainless Steel (Type 316L)
- c. All casing materials shall be new.
- d. The blank well casing shall have the same I.D., thickness, physical and chemical properties as the screened well casing.

2. Screened Well Casing

- a. Roscoe Moss Continuous Wire Wrap Screen
- b. 4-inch I.D., minimum 0.337-inch wall
- c. ASTM 778, Stainless Steel (Type 316L)
- d. All well screen materials shall be new.
- e. The screened well casing shall be the wire wrap type (if available) with openings that are horizontal to the axis of the casing with an aperture facing downward. **The wire wrap screen shall be Roscoe Moss Continuous Wire Wrap Screen (or equivalent) if available in size and material.**
- f. For bidding purposes, the aperture size of the well screen is specified in the provision supplement(s). **The final aperture size will be selected after examination of the lithologic log and sieve analyses of drill cuttings and the down hole geophysical surveys and will be specified in the final well design prepared by the District.**
- g. The well screen shall be factory assembled in 10-feet, 20-feet or 40-feet lengths as specified by the District.

3. Casing Centralizers and Bottom End Cap

Centralizers will be provided every 40 feet such that the wells riser and screen maintain separation to the ground surface. The centralizers will position the well in the center of the borehole, the spacers will evenly separate the casings and screen from the other risers and screen and will be fixed in place so that they stay in position. Casing centralizers and bottom end cap shall be provided as shown on the plans. The centralizers and bottom end cap shall be of the same physical and chemical properties as the well casing.

4. Sounding Tube(s)
Not required
5. Air Vent Tube
Not Required
6. Permanent Gravel Feed Tube
Not Required
7. Welding Electrodes

The following electrodes shall be used for welding various casing materials:

Mild Steel	E-6011 or E-7018
Copper-bearing Steel	E-6011 or E-7018
Low Alloy Steel (ASTM A 242 or equivalent)	E-7018
Stainless Steel (Type 304L)	E-308L-16
Stainless Steel (Type 316L)	E-316L-16

Depending on the wall thickness, the following electrode sizes shall apply:

<u>Wall Thickness</u>	<u>Electrode Size</u>
1/8-inch	1/8-inch
3/16- to 1/4-inch	5/32- to 3/16-inch
Over 1/4-inch	3/16- to 1/4-inch

C. EXECUTION

1. General
 - a. Installation of well casing and screen shall commence upon completion of a District-approved caliper survey of the reamed borehole and after all well construction materials delivered on site have been examined and approved by the District for compliance with the final well design.
 - b. The final arrangement of the temporary tremie pipe around the well casing shall be approved by the District prior to installation of well casing.
2. Joints
3. **All risers and screen will be designed as collared couplings.** Centralizers
 - a. The centralizers will be placed on the screen and risers at 40 foot intervals and will be situated such that they space the well evenly within the borehole.
 - b. The centralizers will be started 20 feet from the bottom of each screened interval to the next screened interval above. Spacers will be used between the four 4-inch diameter steel risers and screen to keep the wells evenly spaced within the borehole.

- c. The centralizers will be continued to the surface along with the spacers.
4. Construction Tremie Pipe
 - a. A temporary construction tremie pipe shall be installed in the reamed borehole prior to installation of well casing.
 - b. The tremie pipe shall be used to install gravel pack, annular seal and sanitary seal materials in the annulus between the well casing and borehole.
 - c. The tremie pipe shall be completely removed after placement of the upper annular seal.
 5. Blank and Screened Well Casing
 - a. Prior to casing installation, the Contractor shall inspect for and remove any tags, labels or other deleterious material attached to the interior or exterior of the blank and screened well casing.
 - b. The well casing string assembled shall be suspended in tension from the surface by means of an appropriate hanger or clamp. **Steel bars (clamp anchors) pre-welded to the casing to hold the casing clamp in place during casing installation, shall be removed prior to lowering a new casing section into the borehole.** The use of float plugs to land and set casing will not be permitted. The casing string shall be plumb and centered in the borehole. The bottom of the casing shall not rest on the bottom of the borehole.
 - c. If for any reason the casing cannot be landed in the correct position, or at a depth acceptable to the District, the Contractor shall rectify the situation by either removing the casing, re-reaming the borehole and re-installing the casing, or constructing another well in accordance with the specifications, plans and final well design at a location immediately adjacent to the original well. All such remedial work shall be at no additional cost to the District. The borehole of the abandoned well shall be properly destroyed at the Contractor's expense in accordance with Section 2.19.
 - d. If any of the casings should collapse or be damaged prior to well completion, they shall be withdrawn and replaced at the Contractor's expense.
 - e. All work required to be repeated, and all additional materials, labor and equipment required, shall be furnished at the expense of the Contractor and no claim for additional compensation shall be made or be allowed therefore, except as specifically provided herein.
 - f. **Alignment spacers between the four casings will be installed in conjunction with the centralizers to maintain the wells evenly within the borehole.**
 - g. The top of the well casing string shall extend approximately 18-24 inches above the ground surface.

- h. The well will be constructed so that there is adequate room in the protective standpipe for the cables, bladder pump discharge lines and airlines, and data logger materials.
- i. Following casing installation, the top of the well casing shall be covered with a protective steel plate (or other equivalent to limit access to the borehole during well construction) at all times when personnel are not on the site.

2.11 GRAVEL PACK

A. GENERAL

- 1. Description
This item covers the supply and installation of gravel pack materials in the annulus adjacent to the blank and screened well casing.
- 2. Submittals
 - a. Initial description and recent certified sieve analysis of gravel pack materials to be used for well construction. The sieve analysis shall be submitted to the District for approval at least three (3) days prior to the anticipated date of gravel shipment from the supplier.
 - b. Copies of weigh tickets for gravel delivered on-site.
 - c. Measurement of the total volume of gravel installed in the well annulus.

B. MATERIALS

- 1. Gravel Pack
 - a. For bidding purposes assume 8 x 16 gradations, TACNA or District approved equal. The final gravel gradation will be specified in the final well design provided by the District after evaluation of the geophysical surveys and/or sieve test results for lithologic samples, as applicable.
 - b. Gravel shall be delivered to and contained on-site in appropriate size bags ("super sacks").
 - c. At the District's request, Contractor shall complete up to three (3) sieve analyses of gravel pack materials delivered on-site. Gravel re-delivered or re-mixed to replace any rejected material shall be sampled and tested at the District's request and Contractor's expense.
 - d. All gravel or coarse-grained sand for packing shall be hard, water-worn, and washed clean of silt, fine sand, dirt, and foreign matter. Crushed gravel will not be accepted. The gravel shall be well-rounded and graded, and subject to the approval of the District.
 - e. **The gravel shall be delivered on-site as specified in 2.11 and shall be protected and kept free of all foreign matter.**

C. EXECUTION

1. Prior to placement of the gravel pack, the drilling fluid shall be thinned with clean water (fresh water down the tremie pipe).
2. Muddy borehole fluid displaced during gravel packing shall be conveyed to the on-site BakerTanks (or equivalent) for clarification prior to discharge.
3. Baker Tanks (or equivalent) used for fluid clarification shall be setup prior to commencing well construction.
4. Contractor shall provide gravel tremie pipe in lengths sufficient to ensure the drop during placement of the gravel is acceptable to the District. Five and ten foot lengths of pipe shall be available as needed.
5. The gravel pack shall be installed in the annular space between the reamed borehole and well casing through a construction tremie pipe from the bottom of the borehole. A circulating system with one or more positive displacement pumps utilizing fresh water shall be used for the purpose of introducing the gravel into the annulus. Under no circumstances will the gravel pack be allowed to "free-fall" down into the annular space.
6. A device approved by the District shall be used to sound the level of the gravel during its placement.
7. **During placement, the gravel quantities will be monitored as specified in the provision supplement(s). Gravel pack shall include a 5-foot thick fine sand layer at the top of the gravel pack.**
8. After the gravel pack has been placed to the depth specified by the District, all rock, sand, gravel, and foreign materials shall be removed from the casing by bailing and/or pumping.
9. **The Contractor shall record the volume of gravel installed.** The volume shall not be less than the calculated volume of the annular space between the casing and the borehole wall based on the caliper survey. A significant discrepancy may be grounds for rejection of the well by the District.
10. This line left intentionally blank

2.12 ANNULAR SEALS

A. GENERAL

1. Description
 - a. Number of seals: 1 seal at top of each well screen (District option)
 - b. Length of seal: Specified in final well design but plan for a minimum of 25 feet
 - c. Seal depth: Specified in final well design
 - d. Additional Seal between each screen interval (specified in final design).

- e. This item includes placement of annular seals adjacent to blank sections of the well casing. Seals will be installed at the option of the District as specified in the final well design.
 - f. For bidding purposes, tentative seal requirements are shown on Sheet C-22 Drawing D-57048 to Section P – Contract Drawings.
2. Submittals
- a. Daily activity logs.
 - b. Material certification reports.
 - c. Record of actual depth(s) of placement and volume(s) of annular seal materials placed in the annulus.

B. MATERIALS

Annular seals shall consist of a mixture of 1/8 to 1/4-inch bentonite chips (Baroid Benseal or approved equal) and gravel. The gravel used in the mixture shall be the same gravel specified for the gravel pack or other approved material. Bentonite chips and gravel shall be pre-mixed dry prior to tremie placement in the annulus.

C. EXECUTION

- 1. A seal shall be installed by pumping the seal mixture through a tremie pipe. The pipe shall extend from the ground surface to the bottom of the interval to be sealed. The seal shall be pumped in place from the bottom of the interval to the top in a continuous operation. The Contractor shall sound the annulus to verify the starting and ending depths of a seal after each load of seal mixture has been pumped.
- 2. The Contractor shall keep a record of the volume of seal mixture used. The volume shall not be less than the calculated volume of the annular space between the reamed borehole and the well casing.

2.13 UPPER ANNULAR GROUT SEAL

A. GENERAL

- 1. Description
 - a. This item includes placement of annular seals adjacent to blank sections of the well casing. Seals will be installed at the option of the District as specified in the final well design. An upper annular seal from 20 ft bgs to ground surface will be required for the borehole.
 - b. For bidding purposes, tentative seal requirements are shown on Sheet C-22 Drawing D-57048 to Section P – Contract Drawings.
- 2. Submittals
 - a. Daily activity logs
 - b. Material certification reports.

- c. Record of actual depth(s) of placement and volume(s) of annular seal materials placed in the annulus.

B. MATERIALS

1. Cement used for the seal shall be a standard brand Portland cement (or equivalent) conforming to ASTM C150, Type II.
2. The grout shall be a sack sand-cement mix. There shall be not more than two parts by weight of sand to one part by weight of cement. The water-cement ratio shall be about 7 gallons per sack of cement (94 pounds). All on-site water additions shall be metered. Up to 5 percent bentonite gel may be added.
3. Clean medium-grained sand shall be used to separate the gravel pack from the annular seal.

C. EXECUTION

1. A seal shall be installed by pumping the seal mixture through a tremie pipe. The pipe shall extend from the ground surface to the bottom of the interval to be sealed. The seal shall be pumped in place from the bottom of the interval to the top in a continuous operation. The Contractor shall sound the annulus to verify the starting and ending depths of a seal after each load of seal mixture has been pumped.
2. The Contractor shall keep a record of the volume of seal mixture used. The volume shall not be less than the calculated volume of the annular space between the reamed borehole and the well casing.
3. The Contractor shall provide grout (tremie) pipe sections in incremental lengths sufficient to ensure the discharge end of the pipe remains continuously submerged in the grout at all depths during placement as required by the Riverside County Department of Environmental Services.
4. The Contractor shall be responsible for determining the collapse potential of the well casing during grouting and shall take whatever precautions are necessary to prevent casing collapse. In the event the casing collapses prior to completion of seal installation, the Contractor shall take whatever steps are necessary to reopen the well and place the seal as required by the final well design. Any such remedial action shall be conducted at the Contractor's expense.
5. The Contractor shall keep a record of the actual depth and volume of grout installed. The volume shall not be less than the calculated volume of the annular space between the conductor casing or reamed borehole.
6. The Contractor shall not operate any heavy equipment on-site during a 24-hour period immediately following placement of the seal.

2.14 MECHANICAL WELL DEVELOPMENT

A. GENERAL

1. Description

Mechanical development shall proceed until purged water turbidity value of 10 NTU is reached and District concurs that the well is sufficiently developed as specified in Section 02734.2 2.14 on a schedule approved by the District.

2. Submittals

The Contractor shall maintain a **daily** record of development activities. The record shall include: (1) depth interval and time developed, (2) volume of sediment bailed from the bottom of the well, (3) static water level, (4) approximate well discharge during air-lifting, and total hours developed daily.

B. MATERIALS

1. Swab

a. Swabbing of the well shall be done with close fitting single and double swabs whose outside diameter of the surge blocks shall not be more than 1/8-inch smaller than the inside diameter of the screen section, unless approved otherwise by the District.

2. Water Storage Tanks and Discharge Piping

a. The Contractor shall provide storage tanks (described in Section 1.04) for clarification of development water prior to discharge to the point specified in the Special Conditions.

b. The Contractor shall provide temporary discharge piping as needed to convey clarified development water to the point of discharge.

3. Air Compressor

a. The Contractor shall provide an air compressor of adequate capacity in both volume (CFM) and pressure (PSI) to maintain air-lifting efficiency at all depths during mechanical development.

C. EXECUTION

1. Contractor shall not commence development until solids settlement, discharge and sound control facilities are installed to the satisfaction of the District.

2. Mechanical development by simultaneous airlifting and swabbing shall commence within 24 hours after completion of the idle period following placement of the upper annular grout seal. Development shall be completed in two stages as described below. For the upper zone potable water may be added to help develop the well, Contractor will measure the flow rate to calculate the quantity of water added during development.

Stage One - Initial Development with Single Swab

- a. Initial mechanical development shall be completed with an open-ended single swab attached to the end of the drill pipe.
- b. Swabbing shall be completed to remove sediment and heavy fluids from the well casing.
- c. The tool shall be moved up and down three to four times in a section of well screen while airlifting. After working the tool to the bottom of the well, airlifting shall continue until all sediment is removed.

Stage Two - Development with a Double Swab

- a. Development with a double swab shall commence immediately following completion of development with a single swab.
- b. The double swab tool shall consist of a perforated steel pipe, 10 to 20 feet in length, fitted with rubber packer assemblies at the top and bottom. The bottom of the perforated pipe shall be capped.
- c. Simultaneous airlifting and swabbing using the double-swab tool shall commence in the upper-most screened interval and proceed to the lower-most screened interval. Each screened interval shall be swabbed and airlifted in 20-foot increments until the discharge water becomes substantially clear as determined by the District. Approximately 2 1/2 to 3 hours are anticipated for each 20-foot increment of screened well casing.
- d. Development in each 10- to 20-foot increment of screened well casing shall include raising and lowering the double swab tool three to four times or more in a shorter section of the screened well casing as needed to produce sediment-filled discharge water while airlifting continues. Air-lift swabbing shall be followed by a period of airlifting without swabbing until the discharge water clears. This process shall be repeated until water produced from the 10- to 20-foot section of screened well casing becomes substantially clear and no additional settlement of the gravel pack is observed. Upon completion, the dual-swab tool shall be moved to the next 10- to 20-foot section of screened well casing and the process repeated until all screened intervals have been fully developed.
- e. Upon completion of mechanical development, the well shall be accurately sounded in the presence of the District to determine the level of accumulated sediment in the well. The sediment level shall be recorded on the Driller's daily activity log. All accumulated sediment shall be bailed from the well prior to installing the temporary test pump.

2.15 CHEMICAL DEVELOPMENT

A. GENERAL

If directed by the District chemical development may be carried out on the wells.

1. Description
 - a. This item includes introduction of chemicals to augment initial (mechanical) development of the well (Section 2.14). A chlorine solution and clay dispersing agent shall be introduced and swabbed into the well and gravel pack in successive stages.
 - b. Chemical development will be completed, in whole or in part, at the option of the District.
 - c. This item applies to wells constructed using bentonite-based drilling fluids only.
 2. Submittals
 - a. Daily activity log.
 - b. Descriptions and quantities of chemicals added to the well during development.
- B. MATERIALS
1. Chlorine Solution
See provision supplement(s) for assumed quantity and concentration of chlorine solution per 20 feet of well screen.
 2. NW-220
See provision supplement(s) for assumed quantity of NW-220 solution required per 20 feet of well screen. (NW-220™ AQUA Clear™ PFD or equivalent)
- C. EXECUTION
1. If completed, chemical development shall be conducted in two stages and shall be integrated with mechanical well development.
 2. Stage One - Chlorination
 - a. At the option of the District, a 10 percent chlorine solution shall be introduced into the well upon completion of stage one of mechanical development using a double-swab tool.
 - b. A pre-mixed solution of chlorine and water shall be swabbed into the screened intervals of the well from the bottom of the well to the top.
 - c. The chlorine solution shall remain in the well for a minimum period of 12 hours, or as approved by the District. Following the idle period, the Contractor shall use the double-swab tool to remove the chlorine solution from the well by airlifting.
 3. Stage Two - Introduction of Clay-dispersing Agent (NW-220)
 - a. At the option of the District, introduction of NW-220 shall commence immediately upon completion of removal of the chlorine solution from the well.

NW-220 shall be introduced and swabbed into each 10-foot section of well screen for a period of 30 minutes (or other period approved by the District) using a double-swab tool. Upon completion of swabbing, the NW-220 shall be allowed to stand in the well for a period of 24 hours, or other period approved by the District.

- b. After the idle period, mechanical well development using a double-swab tool shall continue in accordance with Section 2.14.

2.16 PUMPING DEVELOPMENT

A. GENERAL

1. Description
This item includes development of the well by surge pumping using an airlift pump (or equivalent).
2. Submittals
Daily log of pumping development including static water level, well discharges, pumping water levels, description of water discharged and hours pumped.
3. Measurement and Payment
 - a. The time required for well development will be recorded by the hour with 15-minute intervals as the smallest unit of recorded time. The time recorded for payment shall commence when the equipment installed in the well is placed in operation and shall end when pumping is stopped.
 - b. No payment will be made for delays resulting from: (a) equipment stuck in the borehole, (b) equipment breakdown, (c) arranging major drilling, pumping or testing apparatus, or (d) failure to conduct the operations in a diligent and workmanlike manner by which the desired results could ordinarily be expected.
 - c. No additional payment shall be made for gravel added to the annulus as the gravel pack settles during development.

B. MATERIALS

Requirements for the test pump, discharge line, and other equipment for pumping development are described in this Section.

C. EXECUTION

1. **Well development using the test pump shall commence after completion of initial development by air-lift swabbing and pumping, within the time period specified in the provision supplement(s). Once started, development pumping shall proceed on a continuous basis at a daily work schedule approved by the District.**
2. The well shall be developed by intermittent pumping and surging at an initial rate approved by the District and continued until the water is clear.

Surging shall allow water to flow back through the bowls with free backspin and through the casing perforations. The pump shall then be started and stopped several times and then pumped at the current rate until the water is clear. The procedure shall be repeated at District approved discharge increments up to the maximum pump or well capacity, as specified by the District.

3. During initial pumping development, water clarification may be required in on-site water storage tanks to allow for settling of sediment prior to conveying the water to the specified point of discharge (see Special Conditions).
4. Development records shall be maintained on at least a half-hour basis showing production rate, pumping level, drawdown, and all other pertinent information concerning well development. A representative static water level shall be measured and recorded at least once a day.
5. The rate of sand production shall be measured using the centrifugal sand separating meter. The results of all sand production tests shall be expressed in parts per million at 5-minute intervals and shall be provided to the District immediately. The final sand production test shall be conducted in the presence of the District.
6. Clean water shall be added continuously down the tremie pipe during development.
7. If during development operations the gravel pack settles, more gravel shall be added as needed and the quantity recorded and reported to the District.
8. Development shall continue at each discharge rate until the following conditions have been met:
 - a. No further settlement of gravel pack.
 - b. Sand content meets requirements specified in the provision supplement(s).
9. **The duration of development pumping shall not exceed the bid amount without prior District authorization.**
10. Upon completion of development pumping, the Contractor shall (in the presence of the District) measure the depth of the well to determine the amount of sediment deposited in the bottom. If the sediment level extends into the screened interval of the well, the Contractor shall pull the pump, clean the well of all accumulated sediment and foreign material.

2.17 ALIGNMENT/DEVIATION TESTS

A. GENERAL

1. Description
The multi-port nested wells will be evaluated for alignment per the specifications. The Contractor shall conduct alignment/deviation tests, using a gyroscopic tool, to determine the plumbness and straightness of the well casing. For bidding purposes, the casing interval to be tested is specified in the provision supplement(s).

Alignment tests may be performed any time after the down hole color video surveys have been completed.

2. Submittals
 - a. Within ten (10) days of Notice of Award, the Contractor shall submit to the District the name and qualifications of the firm proposed for completing the alignment/deviation tests.
 - b. Report of deviation and directional survey measurements and interpretation of well plumbness and alignment.

B. MATERIALS

1. Gyroscopic Tool
The deviation and direction survey shall be performed with a gyroscopic-type tool or a similar type tool as approved by the District.

C. EXECUTION

1. Alignment/deviation testing shall be conducted in the presence of the District.
2. Alignment criteria are specified in the provision supplement(s).

2.18 STANDBY TIME

A. GENERAL

1. Description
During the progress of well construction, it may be necessary for the District to perform work that will require the drilling crew and equipment to stand idle. In such event, the District will request in writing the Contractor cease operations and will state the anticipated extent or duration of the idle period. The Contractor shall promptly cease operations.
 - a. District review of caliper survey results: up to 48 hours (excluding weekends and holidays).
 - b. Idle period following placement of upper annular grout seal: 24 hours.
 - c. Grout and bentonite seal set up time during well construction.
2. Submittals
 - a. Daily log summarizing idle resources (description, basis of claim and hours).
 - b. Written claim for standby time.

**B. MATERIAL
(Not used)**

**C. PART 3 – EXECUTION
(Not used)**

2.19 DESTRUCTION OF NEW WELL

A. GENERAL

1. Description
This item includes destruction of the borehole or casing for the new well. Destruction may be initiated due to actions of the Contractor or at the request of the District.
2. Submittals
 - a. Daily activity log.
 - b. Final schedule of destruction.
3. Measurement and Payment
 - a. No payment will be made for destruction required due to actions of the Contractor.

B. MATERIALS

1. Sealing Materials
Acceptable impervious sealing materials that may be employed in the destruction of the borehole or well include neat cement or sand-cement grout.
 - a. A neat cement mixture shall be composed of one 94-pound sack of Portland cement and 5 to 6 gallons of clean water. Bentonite may be used to a total of 5 percent of the volume of cement to make the mix more fluid and reduce shrinkage.
 - b. Sand-cement grout shall be composed of not more than 188 pounds of sand and one 94-pound sack of Portland cement (2 parts sand to 1 part cement by weight) to about 7 gallons of clean water. This is equivalent to a 10.3 sack mix. Bentonite, to make the mixture more fluid and reduce shrinkage, may be used to a total of 5 percent of the volume of cement.
 - c. Quick setting cement, retardants to setting, hydrated lime and additives to make the mix more fluid may be used up to a total of 10 percent of the volume of the cement. Bentonite, to make the mix more fluid and reduce shrinkage, may be used to a total of 5 percent of the volume of cement.
2. Filler Material
Suitable filler materials include clay, silt, sand, gravel, crushed stone and those described in the previous section. Material containing organic matter shall not be used.

C. EXECUTION

1. Destruction Prior to Installation of Casing

a. Destruction Due to Actions of the Contractor. If destruction of the borehole is by reason of any actions of the Contractor, including but not limited to such causes as losing tools, damaging the well, misalignment, or any other cause attributed to careless or poor workmanship, the borehole shall be completely filled with bentonite, cement or other impervious earth materials in accordance with applicable State and County Standards. No payment will be made for drilling and filling the borehole so destroyed or for mobilization and demobilization of this procedure. The Contractor shall drill a new borehole as specified in the Plans within fifty (50) feet of the original location, or as specified by the District.

b. Destruction at Request of the District. If destruction of the drilled borehole is specifically requested by the District in writing, including but not limited such causes a total lack of potential aquifers, insufficient number of potential aquifers, or unacceptable quality, the borehole shall be filled completely with bentonite, cement, or other impervious materials in accordance with applicable State and County Standards. In this event, the Contractor will be paid for mobilization and demobilization at the site, as well as for the footage of drilling completed.

The Contractor may then be requested to re-mobilize at a second site selected by the District. No payment for standby time will be made while awaiting a second site.

Destruction hereunder also shall include payment for destruction of any remaining or unused portion of the pilot borehole that is not being used for final well completion.

Payment for destruction of the borehole, if required and specifically requested by the District as set forth above, shall be made on a unit price per foot and shall be considered full compensation for all time, materials, and equipment required to complete the destruction.

2. Destruction During or After Installation of Casing and/or Well Screen

Necessity to destroy the cased borehole shall be deemed caused by the actions of the Contractor or the Contractor's negligence. In the event the borehole is destroyed after installation of casing or screen, the Contractor shall at their discretion, pull or leave the installed casing sections in place. In either case, the borehole shall be destroyed in accordance with State law by backfilling the casing and/or borehole with bentonite, cement or other impervious material.

No payment shall be made for lost or damaged casings and/or their installation in a well destroyed by reason of any action of the Contractor. The Contractor shall be required to drill a new well as shown on the Plans within 50 feet of the original site.

2.20 INSTALLATION OF DATA LOGGERS AND BLADDER PUMPS

A. GENERAL

1. Description
Contractor will purchase, supply, and install a total of 9 In-Situ Level Troll 500 Data Loggers (or District approved equivalent) with appropriate cables, large desiccant, and wiring to reach the required depths. The Contractor will also purchase, supply, and install 4 air bladder pumps in the screen intervals (no direct air lift contact), cables, tubing, airlines, and controller equipment for each screened interval (submit selection prior to purchase for District approval). Bladder pump will be QED Well Wizard™ System L bladder pump (model ST1102M or equivalent) with ¼ inch discharge line and a MP 10UH, 500-psi controller module.
2. Submittals
Provide the District the manufacturer specifications and equipment list prior to purchase for District approval. Provide all manufacturer documentation, operations manuals, and ancillary equipment to the District. Provide documentation of training of District staff (sign in sheet, course outline, meeting agenda, etc.).
3. Measurement and Payment
Payment will be made upon documentation of submittal of equipment maintenance materials, controller system for bladder pumps, and documentation of training of District staff on bladder controller unit. Also provide documentation of transducer test results (from supplied water for shallow wells) and the pump rate tests for the bladder pumps.

B. MATERIALS

1. Data logger will be In-Situ Level Troll 500 transducer with cable and wiring sized for placement at the respective depths in each well.
2. District has requested large desiccant package for each transducer.
3. Items will be new in original factory packaging when delivered to the site.
4. Air bladder pumps will not allow air contact with sample water and will be QED Well Wizard™ system L bladder pump (or equivalent with District approval).
5. Air bladder pumps controller, valving, and connectors will be supplied to the District for subsequent operation. District staff will be trained on how to operate the bladder pump controller and pumps.

C. EXECUTION

The Contractor shall provide equipment, staff, training, and materials for placing the transducer and bladder pump within each specified screen interval at the specified depth (District will determine the final depth for each transducer and bladder pump unit). For the multi-port nested 4-inch wells the transducer and pump will be placed as one unit to minimize binding within the well. Once the transducers and pumps have been placed the contractor will test that each unit is working in accordance with the manufacturer's specifications and provide training to District staff on bladder pump operation.

TABLE 02734.2

SUMMARY OF SUBMITTALS* DETAIL PROVISION SECTION 02734.2

Work Phase	Submittal	Specification	Submittal Schedule
Notice of Award	List of Proposed Subcontractors (downhole geophysical logs, caliper log, alignment logs)	2.06, 2.09, 2.11, 2.12, 2.13 and 2.21	Submit names of subcontractors within 10 days of Notice of Award
Pre-Construction Conference	Drilling Fluid Program	2.05	Deliver/discuss at conference
All	Daily Activity Reports	All Phases of Work	Daily reports grouped and submitted weekly
Mobilization	Well Driller's Permit from Riverside County Department of Environmental Health	2.01	Due prior to mobilization
Conductor Casing	Material Certification Reports (casing)	2.03	Due upon delivery of casing on-site
Sanitary Seal	Cement Weigh Tickets	2.03	Due upon delivery of material on-site
Pilot Borehole	Formation Samples	2.04	Due in the field as sampled
	Lithologic Log and Drilling Rate log	2.04	Due in the field each day
	Gradation (Sieve) Analyses of Formation Samples	2.04	Due upon completion of geophysical logs
	Downhole Geophysical Surveys	2.06	Five (5) field copies each survey due upon completion; ten (1) final copies, one (1) mylar original, and one (1) ASCII digital copy each survey due within one (1) week of completion
	Bottom Seal, Cement Weigh Tickets and final Depth Interval	2.07	Due upon delivery of material on site and completion of seal installation

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Borehole Reaming	Caliper Survey	2.09	Five (5) field copies of survey due upon completion; ten (1) final copies, one (1) mylar original, and one (1) ASCII digital copy of survey due within one (1) week of completion
Casing and Fill Installation	Certified Test Reports and other Documents for Blank and Screened Well Casing, and Cross-Sectional Diagram illustrating the design of the well.	2.10	Due upon delivery of materials on-site and prior to start of casing installation
	Gradation (Sieve) Analyses of Gravel Pack Materials	2.11	Approved sieve analysis prior to shipping; up to three (3) sieve analyses of materials delivered on site due prior to start of casing installation
	Material Certification Reports and Cement Weigh Tickets, as applicable, for Annular Seals and Upper Annular Grout Seal	2.12 & 2.13	Due upon delivery of materials on-site and prior to seal installation
	Schedule and Diagram of installed well casing, tubing, gravel pack, and annular seals	2.12 & 2.13	Due within 2 weeks of completion of construction
Mechanical Well Development	Daily Development Summary (depth intervals developed, total hours, gravel settlement/additions, and volume of sediment bailed from well)	2.14	Daily reports grouped and submitted weekly
Chemical Well Development	Daily Development Summary (Descriptions and quantities of chemicals added to the well during development))	2.15	Daily reports grouped and submitted weekly
Pumping Development	Pump Installation Summary (type, diameter, capacity range, intake depth)	2.16	Due upon completion of pump installation
Pumping Development	Daily Development Summary (hours pumped, surging	2.16	Daily reports grouped and submitted weekly

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Alignment/Deviation Tests	Results of Alignment and Deviation Surveys	2.17	Five (5) field copies of survey due upon completion; ten (1) final copies, one (1) mylar original, and one (1) ASCII digital copy of survey due within one (1) week of completion
Standby Time	Daily logs summarizing idle resources and written claim for standby time	2.18	Due upon completion of each idle period for which standby time is claimed
Well Destruction	Final Schedule of Destruction and Materials (if required)	2.19	Cement weigh tickets due upon material delivery on site; destruction summary due within one week of completion
Transducer Bladder Pump Installation	Record of installation, manufacturer specs and warranties.	2.20	Due within 2 weeks of completion of installation and testing

** Submittals shall be delivered to the District Representative identified in the Pre-construction meeting*