



CALAMBA WATER DISTRICT

Lakeview Subd., Malang, Calamba City
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24/7 Public Service

Project Description:

The work includes the furnishing of all labor, materials, supplies, equipment, tools, transportation, recommendations, testing, services, and appurtenances unless hereinafter specifically excepted, necessary to move-in, move-out, disinfect and clean-up; satisfactorily complete rotary drilled pilot boreholes, log, secure pilot boreholes; rotary drilled gravel packed wells including but not limited to drill, construct, disinfect, test, maintain/test drilling fluid, gravel pack, develop, clean pump, test pump, check casing, plumbness and alignment, perform final borehole caliper survey, obtain and analyze water samples as specified, place sounder pipe and gravel pack make up pipes and caps, and well cap; and submittals of logs and test results.

SPECIAL PROVISIONS

GENERAL

a. Scope

The work includes the drilling of exploratory/ production well for Calamba Water District.

b. Water Level Sounding

The Contractor shall provide a functioning and accurate water sounding instrument acceptable to the Engineer to measure the water level during all drilling, development and testing of the well. Failure to provide such will subject the Contractor to penalty of P 200.00 per day

WELL DRILLING

a. No Special Provisions

Equipment

The Contractor shall provide and operate one exploratory drilling including all auxiliary equipment necessary to complete the work within the contract period.

Drilling Method

All drilling shall be performed with rotary drilling method

GEOPHYSICAL LOGGING

Scope

The work includes geophysical logging (electric resistivity and self potential).

WELL CASING

Casing Material

All permanent casings to be installed shall be spiral welded steel casing with minimum wall thickness of 6 mm and should be of new stock and complies with ASTM A 139 Grade B.

WELL SCREEN

Type of Screen

The screens shall be stainless steel continuous slot wedge wire wound, with slot size 1.5 mm (slot size), 3 meters length per piece and of new stock with a minimum 30% open area. The well screen and attached end fittings shall be fabricated from corrosion-resistant type 316 stainless steel. The slot size shall not vary by more than +/- 10% as measured by wire gages.

The ends of the screens and blank casing shall be beveled for welding and shall meet the same standard as the beveled ends of the blank casing.

The contractor shall be responsible for ensuring that the materials utilized will be adequate for the actual conditions encountered.

End fittings shall be welded to the screen body with electrical insulation provided between stainless steel and other metallic materials. Insulation joints shall be provided between screen and casing as required by screen placement.

The screen length and wire shape shall be chosen so that the maximum velocity of the water entering the screen shall not exceed 0.1 foot per second at the desired yield. The screen shall be selected by the contractor and submitted with supporting calculations for approval by the CWD.

FORMATION STABILIZER/GRAVEL PACK

Scope

The Contractor shall provide and install uniform pea size gravel packed materials. It shall composed of siliceous materials and well rounded particles as approved in the Final Well Design

WELL DEVELOPMENT

Well development for the exploratory/production well drilled method shall consist of but not necessarily limited to, work items as listed and described in Quotation Form.

The series of development activity shall involved removal of the mud cake formed during the drilling at the wall of the borehole, removal of fine formation materials and rearrangement of the gravel packed materials for a stable permeable envelop is developed around the well intake zones(screens).

Expected Yield

The exploratory/production well is expected to yield 25-30 lps.

WELL TESTING

Measurement of time of start, stop and interval measurements must be made with reasonable accuracy(+/- 6 seconds). Any irregular events (e.g. pump failure and restart occurring during the test cycle must be noted and their times recorded. Should this event occur, the CWd must be notified and decisions made as to validity of the test. If the pumping test is interrupted due to contractors equipment malfunction, the test shall be re run at the contractors expense. Pumping rate shall not vary by more than 5%(+/-).

Water Level measurements should be accurate to within 2cm and carried out with the following frequency.

- Every minute for the first 10 minutes
- Every 2 minutes for the next 20 minutes
- Every 3 minutes for the next 30 minutes
- Every 10 minutes for the next 1 hour
- Every 20 minutes for the next 2 hours
- Every 30 minutes for the next three hours
- Every hour thereafter until completion of test

As soon as pump is stopped, recovery measurements should commence immediately using the same frequency of measurement as above.

CEMENT GROUTING

The annular space around the casing shall be filled with a cement slurry ground mixed in the following proportions by volume.

1-part cement; 1-1/2 parts sharp, clean sand and 6/10-part water.

The addition of any additives to prevent shrinkage shall be approved by CWD. The water shall be potable and the sand free of clay, silt, organics or other deleterious matter. The grout shall be undisturbed for a period of not less than 48 hours.

WELL DISINFECTION AND CLEANING

The work includes disinfection with a chlorine solution.

GENERAL TECHNICAL SPECIFICATIONS

1. GENERAL

1.1 Technical Definitions

The following definitions shall apply:

- a. Borehole – means any drilled section of boring before completion as defined in well below.
- b. Casing – means unslotted or non-perforated lining tubes.
- c. Development Equipment – means high velocity jetting tool, airlift equipment, surge plunger and all other equipment needed to develop the well.
- d. Diameters – means nominal diameters unless otherwise stated.
- e. Drilling Rig – means the drilling equipment and the auxiliary equipment for its operation.
- f. Drilling Unit – as defined in Clause 2.2.
- g. Final Well Design – means the drawing and description prepared by the Engineer upon completion of drilling specifying the final well construction.
- h. Lining Materials – means any casing, screen, slotted lining or perforated lining tube whether permanently or temporarily installed in the borehole.
- i. Pumping Unit – as defined in Clause 8.7.
- j. Screens – means continuous wire wound stainless or low carbon steel screens, or slotted or perforated lining tube.
- k. Tentative Well Design – means the contract drawing showing the estimated quantities of the work.
- l. Well – means any completed hole in which all lining material has been set, all grouting completed and all temporary lining removed.

1.2 Technical Standards

All materials or workmanship shall comply with the specifications. Other standards equal or superior to those enumerated in this specification, shall be acceptable, subject to the approval of the Engineer. The opinion of the Engineer must be obtained prior to utilizing such materials or workmanship on or off the site.

1.3 Water Supply and Illumination

In the absence of adequate quantities of water or illumination required for drilling at the drilling site, the Contractor shall make such arrangements including the provision for mobile tanks or fixed tanks as may be necessary to ensure a supply of water and illumination sufficient for drilling operations.

1.4 Electrical Power Supply

The Contractor will make arrangements as may be necessary for the connection of or supply of power to the site.

Payment for the provision of electrical power supplies as specified in subclause 1.4 (1) shall be deemed to be included in the rates entered in the Bid Form for setting up equipment at the site, drilling rates and rates entered for operation of pumping unit.

1.5 Storage of Inflammables

The Contractor shall comply with all local authority regulations applicable to the use and storage of diesel oils, petrol, paraffin and other inflammable fuels used by him on the site, and shall ensure that adequate precautions are taken against fire.

1.6 Boundaries of Work

The Owner shall provide land or rights-of-way for the work specified in this Contract and make suitable provisions for ingress and egress, and Contractor shall not enter or occupy with men, tools, equipment or material, any ground outside the property of the Owner without the written consent of the Owner of such property. Other Contractors and employees or agents of CWD and/or the Owner may, for all necessary purposes, enter upon the work and premises used by the Contractor, and the Contractor shall conduct his work so as not to impede unnecessarily any work being done by others on or adjacent to the site.

1.7 Access Roads

Construction or improvement of access roads to the wells shall, unless otherwise agreed, be done by the Contractor at his own cost, which is deemed to be included in the contract sum. The access road shall be kept in proper condition during the entire construction period.

1.8 Protection of site

Excepting as otherwise provided herein, the Contractor shall protect all structures, walks, pipelines, tress, shrubberies, lawns, etc., during the progress of his work, shall remove from the site all drill cuttings, debris, and unused materials, and shall upon the completion of the work restore the site as nearly as possible to its original condition, including removal of access tracks and the replacement, at the Contractor's sole expense, of any facility or landscaping which has been damaged beyond restoration to its original condition all to the satisfaction of the Engineer.

Water pumped from the well shall be conducted to a place approved by the Engineer where it will be possible to dispose the water without damage to property or creation of a nuisance.

1.9 Site to be kept Tidy

The Contractor shall at all times keep the site and all working areas in a tidy and workmanship condition and free from rubbish and waste materials.

1.10 Temporary Buildings for Use by Contractor

The Contractor shall provide at the site of the works such temporary buildings, tanks, workshops, etc. as may be necessary and proper for his general use in connection with the works, and for the use of persons employed by him. The nature of the buildings, tanks, etc. and the positioning of them shall be subject to the prior approval of the Engineer and the relevant authorities.

1.11 Shop Drawings

The Contractor shall if requested by the Engineer prior to start of each operation, produce for the Engineer's approval shop drawings showing details of technical operations such as test of plumbness and alignment, the method of the slotted casing production, if so required, the methods of placement of formation stabilizer and/or cement grout, the arrangement for well testing, the method for well development and all other drawings pertinent to the well drilling, well construction operations and well development as requested by the Engineer.

Shop drawings shall be completed with respect to dimensions, design criteria, materials, methods of constructions and the like to enable the Engineer to review the information as required.

1.12 Well Head Protection

At all times during the progress of the work, the Contractor shall protect the well in such manner as to effectively prevent either tampering with the well or the entrance of foreign matter into it, and upon its completion he shall provide and install a well head cap satisfactory to the Engineer.

In the event that the well becomes contaminated or that water having undesirable physical or chemical characteristics has entered the well due to the negligence of the Contractor, he shall at his own expense perform such work or supply casings, seals sterilizing agents or other materials as may be necessary to eliminate the contamination or to exclude any undesirable water in the well.

1.13 Transport of Personnel and Equipment

The Contractor shall supply and operate all transport required for transporting his employees, materials and equipment.

The cost of movement of personnel, materials and equipment shall be included in the rates given for drilling, development and pump operation.

1.14 Site Preparation and Reinstatement

The Contractor shall prepare the site, provide all necessary tanks and pits and make all necessary arrangements for erecting and dismantling the drilling unit and shall reinstate the site on completion of such phase of work to the satisfaction of the Engineer.

Payment shall be deemed to be included in the items entered in the Bid Form for erection and dismantling of drilling rigs.

1.15 Standing Time

Standing time will be paid only when drilling is suspended on the written instruction of the Engineer.

2.0

WELL DRILLING

2.1 Scope

The Contractor shall provide and operate one or more mobile Drilling Units required to complete the works within the contract period

The Contractor shall provide all auxiliary equipment, lubricants, fuels and spares necessary to keep the drilling rig(s) in continuous operation.

2.2 Equipment

The drilling rig(s) together with all auxiliary equipment and personnel shall be defined as the Drilling Unit(s).

All rigs shall have sufficient capacity to drill the specified borehole(s) in the diameters specified in the tentative well design(s) to a depth which is min. 25% higher than indicated in the Contract Drawings

Payment for drilling will be by the linear meter to borehole as measured after removal of drill string. The rates set against drilling items in the Bid Form shall be deemed to include all equipment, personnel, fuels and lubricants and the accessories required for operation of the Drilling Unit.

When the Drilling Unit is being used for a purpose other than drilling, then the rates for that purpose entered in the Bid Form shall be deemed to include the running costs of the Drilling Unit.

2.3 Drilling Method

All drilling shall, unless otherwise specified in the Special Provisions, be performed with the rotary or the percussion drilling method.

The Contractor shall drill the hole to such depth and with such a diameter which shall enable an easy installation of casing and screen and placement of gravel envelope with a uniform thickness as specified, if required. During drilling of the hole, the Contractor shall ensure that the natural permeability of the yielding strata near the well bore is not irreversibly reduced due to the drilling method employed.

2.4 Strata Sampling

Strata samples shall be taken at 1 meter intervals or more frequent if the formation penetrated changes. Samples shall be placed in plastic or other appropriate bags on which or in which the sampling depth and the date of sampling is written in such a manner that it is permanently readable.

The sampling procedure must provide that all the fractions of the penetrated strata are present in the sample.

Each sample shall be placed in a wooden box with space for storage of one sample and the sampling depth shall be written on the box.

A record of samples taken with the details describe above, shall be submitted to the Engineer everyday.

Payment for sampling shall be deemed to be included in the rates entered for drilling in the Bid form

The failure on the part of the Contractor to obtain, preserve and deliver samples or records, satisfactory to the Engineer, shall be considered as actual damage to the Owner. Such a failure shall authorize the Engineer to retain from money due or to become due the Contractor. Liquidated damages for each sample that the Contractor shall fail to obtain, preserve or deliver, or for each length of pipe not properly measured and recorded in the order in which it was placed in the well. In the event that, in the opinion of the Engineer, the failure of the Contractor to take and preserve the samples may affect the proper design of the well, the Contractor may be required to perform such work as the Engineer deems necessary to remedy such failure at no cost to the Owner. It is understood that the liquidated damages herein provided are fixed, agreed and not by way of penalty; and that the Owner shall not be required to prove that he has incurred actual damages.

2.5 Drilling Mud

Bentonite, if used, shall be of premium quality in accordance with API Standard 13A with 150 kg/cum of make-up water yielding a mud with a viscosity of between 35 and 40 seconds using a Marsh Funnel and a mud weight of less than 1.10 kg/l (9.2 lbs/US gal.).

Make-up water shall be treated with caustic soda (soda ash) to maintain the pH between 8.0 and 9.0 prior to mixing mud.

During drilling with mud the Contractor shall perform hourly measurements of the following mud characteristics:

- pH value
- Funnel viscosity
- Specific gravity
- Sand content
- Filtration loss
- Filter cake thickness

The recorded mud characteristics shall not exceed the following values, without the prior approval of the engineer:

- Specific gravity : 9.5 lb/gal.
- Sand content : 4%

- Filtration loss : 10 ml
- Filter cake : 1.5 mm

2.6 Working Hours

All work from start of drilling of the borehole until completion of well development shall, if the rotary drilling method is applied, be on a round the clock basis.

3.0

GEOPHYSICAL LOGGING

3.1 Scope

The contractor shall, if specified in the Special Provisions, perform geophysical logging as specified in the Special Provisions.

3.2 Equipment

The geophysical logs may be recorded either by automatic recording on a chart strip or by manual reading of recorded values. In case the logs are recorded by the manual method, readings shall be taken per min. 0.33 m of borehole length.

The recorded logs shall be submitted to the Engineer immediately upon completion of logging as plots of recorded characteristics versus depth for his approval. In case of disapproval the Engineer, the logs shall be repeated immediately.

3.3 Logs

Geophysical logging shall, unless otherwise specified in the Special Provisions, comprise the following logs:

- Caliper log
- Resistivity log (16" and 64")
- Gamma ray log
- Self-potential log (SP)

4.0

WELL CASING

4.1 Scope

The Contractor shall provide and install the well casing specified in the Contract Drawings and any temporary casing required during the work, unless otherwise specified in the Special Provisions.

4.2 Casing Material

The contractor shall, before commencement of work, submit for the approval of the Engineer the following details of all casing:

- Type of material
- Internal and external diameters

Wall thickness
Method of jointing

All permanent casing material shall be seamless and of new stock. The casing shall be factory assembled in not less than six meter sections. There shall be no burrs or protrusions into the casing I.D.

For field assembly welding, ends of sections may be either belled or furnished with collars in accordance with the following standards:

a). Plain Ends Fitted With Collars. Collars shall be of the same thickness and have the same chemical and physical properties as the corresponding casing section, shall be 150mm in width, shall be rolled to fit the outside diameter and shall be welded to the casing section. Longitudinal welds on the plain end shall be ground to plate surface a sufficient distance from the end. The inside edge of the collars and the outside edge of the adjacent casing length shall be ground or sufficiently scrapped to remove sharp edges or burrs. Section ends shall be machined flat perpendicular to the axis of the casing and shall be machined flat perpendicular to the axis of the casing and shall not vary than 0.010 inch at any point from a true plane at right angles to the axis of the casing.

Three 1 inch by 3/8 inch alignment holes shall be provided in each Collar to insure proper matching of the sections. The casing gap shall be welded full double pass within the holes as well as hole edges.

b) Bell ends. The inside diameter of the bell shall be 1/32 2/32 inch greater than the outside diameter of the plain end. The ends of each section shall not vary more than 0.010 inch in any point from a true plane at right angles to the axis of the casing.

c) Butt welded joints shall be per AWWA C-206

The Contractor shall assume responsibility for any casing failure and shall correct, as approved by the Engineer, any casing failure at no cost to the Owner. In the event that the Contractor cannot correct a casing failure, the Contractor shall replace the casing with material complying with the specifications, or if necessary, better casing as approved by the Engineer at no extra cost.

4.3 Temporary Casing

The Contractor shall provide such temporary casing as may be necessary to prevent the collapse of any formation during the drilling operation to allow the well to be sunk to the specified depth and to allow the insertion of permanent lining material as required. The Contractor shall remove the temporary casing before completing the well, unless otherwise specified in these documents.

4.4 Lining Installation

Lining material shall be assembled and located in the well at the required depth in a continuous operation. The lining material shall be set concentric within the borehole by centralizing bars unless otherwise agreed with the Engineer.

If the lining jams or is lost before it is set to the specified depth, the Contractor shall endeavor to remove the lining material from the well or, if unable to effect removal, shall re-drill the well and replace the lining material at his own expense.

4.5 Lining Material Accessories

The Contractor shall provide as necessary the following accessories to set the lining material to the required depth:

Centralizers to be affixed to the lining material at intervals of 10 m to locate the lining material in the center of the drill hole:

- Supporting clamps, equipment and tools;
- Reducing ones and connecting pieces;
- Casing hangers
- All other necessary equipment.

Except where expressly provided, all accessories shall be deemed to be included in the Bid Form for the provision and insertion of lining material.

4.6 Testing for Plumbness and Alignment

All boreholes shall be constructed, plumb and true to line as defined herein. To demonstrate the compliance of his work with this requirement, the Contractor shall furnish all labor, tools and equipment and shall provide the detailed drawings and the description of the tests to the satisfaction of the Engineer.

Test for plumbness and alignment must be made after the complete construction of the well and before its acceptance. Additional tests, however, may be made by the Contractor during the performance of the work. No specific payments shall be made for making these tests.

Should the results of the tests for plumbness and alignment show that the plumb bob or dummy fails to move freely throughout the length of the lining or borehole to a depth of the lowest anticipated pump setting and should the well vary from the vertical in excess of two-thirds of the smallest inside diameter of that part of the well being tested or beyond the limitations of this test, the plumbness and alignment of the well shall be corrected by the Contractor at his own expense. Should the Contractor fail to correct such faulty alignment or plumbness, the Engineer may refuse to accept the well and the Contractor shall drill a new well without charge to the Owner.

WELL SCREENS

5.1 Scope

The Contractor shall provide and install the well screens specified in the Contract Drawings, unless otherwise specified in the Special Provisions.

5.2 Type of Screens

The type of screens shall be as specified in the tentative well design and the Special Provisions.

Slotted screens, if specified for installation, shall be so fabricated as to ensure the maximum yield of the well and to prevent clogging and incrustation and shall be free from jagged edges and irregularities that may accelerate clogging or corrosion.

5.3 Responsibility for Malfunction

The Contractor shall assume full responsibility for any malfunction of the screen caused by the inadequate installation procedure and shall undertake any correction as approved by the Engineer at no extra cost for the Owner.

The screen must have no change of alignment at any of its joints after installation. If requested by the Engineer, the Contractor shall submit for approval by the Engineer the design and method of construction and installation of the screen.

In the event that the Contractor cannot correct a screen failure, the Contractor shall replace the screen with material complying with the specifications of this Contract at no extra cost for the Owner.

5.4 Screen Strength

The screens shall have adequate strength to resist the external forces that may be applied during and after installation.

5.5 Screen Accessories

All fittings, packers, couplings, joints, plugs and seals used during installation of well screen together with the installation procedure, shall be to the approval of the Engineer.

FORMATION STABILIZER/GRAVEL PACK

6.1 Scope

The Contractor shall provide and install formation stabilizer, or gravel pack if specified in the Contract Drawings and the Special Provisions.

6.2 Material

The formation stabilizer/gravel pack material shall consist of well rounded, water-worn siliceous grains. Angular chippings or road stone must under no circumstances be used as formation stabilizer/gravel pack material.

The Contractor shall, during the mobilization period, submit to the Engineer for his approval, samples of the formation stabilizer he proposes to use, stating the source of the formation stabilizer, quantities available, rate of delivery and any other information requested by the Engineer.

6.3 Method of Installation

The method of placing the formation stabilizer/gravel pack in the annulus shall be such that separation of the gravel and bridging is avoided.

The formation stabilizer/gravel pack shall immediately upon completion of lining installation, be placed in the annulus between the borehole and the lining, in the screened section(s) of the lining, as specified in the Final Well Design.

If the borehole was drilled by the rotary method, installation of formation stabilizer/gravel pack shall be done by circulation of the drilling mud.

7

WELL DEVELOPMENT

7.1 Scope

The Contractor shall furnish compressors, surge plungers, jetting tools, electric generators, chemicals and any other equipment required for satisfactory well development and shall undertake the development as directed by the Engineer.

Development shall, if the percussion drilling method is applied, comprise surging with plunger and development by airlifting unless otherwise specified in the Special Provisions.

Development shall, if the rotary method is applied, comprise deflocculation, removal of the mud cake formed during the drilling at the wall of the borehole, removal of fine formation materials and rearrangement of the gravel packed high velocity jetting in continuous slot screens, surging with plunger in slotted screens and development by airlifting by compressor and over pumping, unless otherwise specified in the Special Provisions.

7.2 Expected Yield

The Contractor shall develop the well to its maximum expected yield, as specified in the special provisions, by the methods specified in section 7.

7.3 Surging with Plunger

Upon completion of installation of lining or formation stabilizer/gravel pack, the Contractor shall develop the well by mechanical surging with a valve-type surge plunger approved by the Engineer

Before start of surging and with 1 hour interval during the surging operation, the depth to the well bottom and to top of gravel pack shall be recorded.

Surging shall be continued until accumulation of sediments in the sump pipe, during a 1 hour period surging operation, is negligible.

7.4 Deflocculation (applicable for rotary method only)

Upon completion of installation of lining or formation stabilizer/gravel pack, the drilling mud shall immediately be displaced from the well by pumping clean water into the sump pipe.

Mud displacement shall immediately be followed by injection and/or jetting through the screened sections with a polyphosphate solution to deflocculate the mud cake on the borehole wall. The concentration of the polyphosphate solution shall be 3.0 percent by weight of the quantity of the water in the borehole. The well shall then be left for 12-24 hours before developing is continued, to allow the polyphosphate to react.

7.5 High Velocity Jetting

After the deflocculation material has been allowed to work for 12-24 hours all sections screened with continuous slot screens shall be developed by high velocity jetting.

The jetting tool shall be equipped with two or four nozzles. The nozzles design shall be such that it produces a concentrated jetting action. The tool shall be presented to the Engineer for approval before start of drilling operation.

The jetting tool shall be supplied with water through a high-pressure pump capable of producing a nozzle velocity of 50-70 m per second. The pump shall be equipped with a suitable pressure gauge on the discharge side to facilitate monitoring of nozzle velocity.

The development shall be carried out by slowly rotating the jetting tool and gradually lowering it in order to cover the entire surface of the screen.

At the same time as the high velocity jetting is performed, the well shall be discharged with a discharge rate slightly higher than the discharge rate from the jetting tool.

Each Section of the screen shall be jetted until the return water is free from drilling mud, but no section shall be jetted less than 20 minutes per meter of screen.

7.6 Development by Airlifting

Upon completion of high-velocity jetting, and/or surging with plunger, the well shall be discharge by the airlifting method.

The compressor used for pumping by airlifting shall be capable of developing a minimum pressure of not less than 100 psi. The delivery shall be no less than 7 cum air per minute.

The quantity of water discharge from the well and the drawdown in the well at the commencement of the development shall be limited and shall be gradually increased only as the water clears. From time to time the air flow shall be stopped to facilitate loosening of trapped sand grains. The well may also be backwashed by pumping clean water into the well.

During the airlifting operation, position of air pipe and conductor pipe, drawdown in well, approximate yield and time for each change in position shall be recorded by the Contractor.

The development shall be completed with a conduct or pipe not more than 0.5 m above the bottom of the well to ensure that all sand has been cleaned out of the sump pipe.

7.7 Well Cleaning

Upon completion of the development operations, the Contractor shall demonstrate to the satisfaction of the Engineer that the bottom of the well is clear of all sand, mud and other foreign materials.

7.8 Freedom from Sand

The Contractor shall develop the well by the methods specified until the water pumped from the well is substantially free from sand and until the turbidity is less than 5 on the Silica Scale described in Standard Methods of Water Analysis (latest edition as published by AWWA, APHA and WPCT).

The water pumped from the well shall not contain an amount of fine material in excess of 1.0 mg per liter when the well is pumped at its maximum expected yield. The equipment for measurement of the sand content shall be furnished by the Contractor.

7.9 Acceptance of Development

The development by the specified methods shall be repeated and continued until the well is thoroughly developed in accordance with the criteria specified in section 7.8.

If the well yield after the well has been confirmed sand-free is still below the yield, which is considered acceptable for the penetrated aquifer, then the Engineer may instruct the Contractor to perform further development.

WELL TESTING

8.1 Scope

The Contractor shall, unless otherwise specified in the Special Provisions, provide and operate a Pumping Unit for the following purposes:

- Step-drawdown pumping tests on the completed well
- Constant discharge pumping test on the completed well.

8.2 Equipment Capacity

The Contractor shall provide and operate pumping machinery capable of carrying out the specified pumping and shall provide adequate controls to allow discharge rates to be kept constant at varying pumping water levels and to permit pumping with a variation of not more than 5% of the designated discharge rate during any period of yield or aquifer testing.

The Pumping Unit set shall be able to deliver a discharge rate, which is min. 50% higher than the expected yield of the well and a minimum discharge, which is maximum 15% of the expected yield of the well when suitably throttled by use of a gate valve.

8.3 Suitable pumping machinery will be deemed to be:

Submersible electric pump unit together with generator and such accessories needed to run the pump.

Line-shaft pump and internal combustion prime mover together with all accessories needed to run the pump.

8.4 Equipment Operation

The Contractor shall supply and operate all equipment and accessories necessary for installation and removal of pumps.

The Contractor shall maintain on site sufficient fuels, lubricants, spares and other accessories needed to run the Pumping Unit for whatever period may be specified by the Engineer.

The Contractor shall provide sufficient competent personnel including a qualified fitter and electrician, as may be necessary to install and operate the Pumping Unit.

8.5 Control of Discharge Rate

The Contractor shall, during the pumping tests, provide a suitable gate valve on the discharge pipeline, to facilitate easy control of the discharge rate.

8.6 Water Level Sounding Pipe

The Contractor shall, if instructed by the Engineer, provide and install a temporary tube of at least 1 inch diameter from the top of the well to 2 m above the pump bowl assembly to facilitate easy measurements of water level. The tube shall be open only at the bottom and top.

Payment for providing, installing and removing the tube shall be deemed to be included in the rates given for pumping tests.

8.7 Discharge Rate Monitoring

Discharge rates up to 15 lps (54 cum/hr) may be measured by drum filling. Discharge rates in excess of 15 lps shall be recorded with a water meter or by a V-notch weir. All items are subject to the Engineer's approval before start of drilling.

8.8 Definition of "Pumping Unit"

The equipment specified in Clause 8.2 – 8.6 is referred to as the Pumping Unit.

8.9 Pumping Procedure

The Engineer will determine the pumping procedure necessary to obtain the objectives of this Contract.

8.10 Suspension of Pumping

If the Engineer condition of any equipment, personnel, fuel, lubricants or accessories will prejudice the quality of data obtained from any pumping test he may suspend the work in accordance with the provisions of the Conditions of Contract.

8.11 Equipment Breakdown During Pumping

The pumping must be continuous and at a constant rate during the pumping tests. The Engineer will instruct the Contractor as to the expected maximum duration of each pumping test before start of each test.

If pumping is interrupted or the discharge rate fluctuates by more than 5% of the designated discharge rate, the test may be repeated after a period of recovery determined by the Engineer.

If any pumping test is interrupted because of equipment breakdown or inadequate supervision or discharge control, no payment will be made for any pumping period before recommencing the test.

8.12 Duration of Tests

The step-drawdown pumping tests shall be performed on 5 steps with a duration of 1 hour each.

The constant discharge pumping tests shall be performed for a period of 2-5 days, unless otherwise specified in the Special Provisions or unless otherwise instructed by the Engineer.

8.13 Temporary Pipeline

The Contractor shall provide a temporary pipeline as directed by the Engineer for the discharge from pumping tests and for clearance to a suitable water course or drain.

Under certain circumstances when re-infiltration cannot be avoided or it is costly to provide for this condition, the Engineer shall decide to what distance from the well, water may be discharge on the ground.

9

CEMENT GROUTING

9.1 Scope

The Contractor shall, unless otherwise specified in the Special Provisions, provide the cement and mixing equipment required for the mixing of the grouting indicated in the Tentative Well Design and shall place the cement grout as specified.

9.2 Grouting Material

Cement grout shall consist of a mixture of 95% Portland Cement, 5% bentonite and clean water, mixed in the proportion of 52.5 kg of Portland Cement/bentonite to max. 30 liters of water.

All cement shall, unless otherwise specified in the Contract Documents, conform to the "Specifications for Portland Cement" (ASTM C150- latest revision).

9.3 Method of Placing Grout Material

The method and equipment for placing the grout shall be to the approval of the Engineer. No method will be approved that does not provide for the forcing of grout from the bottom of the casing/hole/annulus to be grouted, to the surface. Flushing of the annular space with fluid to assure the space is open and to remove loose material will be required by the Contractor before grouting is commenced.

Any grouting operation shall be continuous and before starting, sufficient grout shall be mixed to complete the whole operation. During the grouting operation, the mixed grout shall be continuously stirred. The Contractor shall provide such tanks, hoppers and other equipment as may be necessary to meet these requirements.

9.4 Setting Time

No work will be allowed on the well within a period of 72 hours after completion of grouting unless a quick setting cement is used. In such case, the idle period may be reduced to 24 hours subject to the Engineer's prior approval.

WELL DISINFECTION AND CLEANING

10.1 Scope

The Contractor shall upon completion of well construction and well testing thoroughly clean the well of all foreign substances including tools, timbers, rope, debris of any kind, cement, oil, grease and scum.

The casing pipe shall be thoroughly swabbed using alkalis, if necessary, to remove oil and grease of joint dope. The Contractor shall then, unless otherwise specified in the Special Provisions, disinfect the well with a chlorine solution.

10.2 Chlorine Solution

The chlorine solution for disinfecting the well shall be of such volume and strength that a concentration of at least 50 mg/liter of chlorine shall be obtained in all parts of the borehole.

The chlorine solution shall be prepared and applied in accordance with the directions of and to the satisfaction of the Engineer and shall remain in the well for a period of at least two hours.

10.3 Cleaning of Test Pump

In the event that the test pump is to be installed after the well has been disinfected, all exterior parts of the test pump coming in contact with the water shall be dubbed with a chlorine solution as directed by the Engineer.

10.4 Disinfection Procedure

Method A: Where practical, the chlorine solution of standard concentration used to disinfect the well shall be prepared on the surface in containers having a volume of water contained in the well. This prepared solution shall then be discharged rapidly into the well, care being taken to flush the walls of the well above the water level.

Method B: In lieu of using Liquid chlorine solutions, a perforated pipe container capped at both ends containing a granular chlorine compound, HTH or Perchloron, may be moved up and down in the well by means of a weighted cable. The amount of compound applied should be such as to provide the standard concentration.

WELL COMPLETION

11.1 Scope

The contractor shall provide and operate all equipment necessary to restore the site as near as possible to its condition before commencement of drilling and shall furnish and install a well head cap as specified in the Contract Drawings.

11.2 Site Restoration

The site shall be restored to a condition as nearly possible to that which existed before the well drilling and testing activities commenced. This work shall include, but not limited to, restoration of fences and structures, removal of drill cuttings, levelling of the disturbed ground surfaces and replacement or compensation for the destroyed plants and landscaping.

11.3 Well Head Capping

The well head shall be completed with a well head assembly fully welded to the upper casing as well as a water level sounding tube with screw cap in order to prevent any unauthorized tampering of the well.

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SUBMITTAL OF REPORTS AND BOREHOLE DATA

12.1 Scope

The Contractor shall submit to the Engineer daily records in duplicate containing the following information:

- Site
- Date
- Description of each stratum encountered
- Depth below ground of each change of stratum
- Depths and details of all disturbed samples

The Contractor will be required to keep a record of penetration rate, mud losses and mud conditions.

At the end of the well construction and before final payment is made, the Contractor shall submit to the Engineer a report containing the following information:

- The total depth of the well
- Description of the strata encountered
- The sizes and the lengths/specifications of the casing installed
- The date of the start and the completion of the well construction
- The locations and the description of the casing perforations or the well screen placement
- The locations of the gravel, the size of gravel, if applicable, and the amount of cement grout installed
- Records of discharge rates and drawdown during well development together with description of the methods of the development
- The well yield (expressed as discharge rate and drawdown), the dates and the duration of the test(s)
- The methods of measuring the discharge rate and the drawdown
- The cost of records shall be deemed to be included in the contract rates.