

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
GROUNDWATER SECTION

I - WATER SUPPLY SYSTEM SPECIFICATIONS
FOR REPLACEMENT WELLS
FOR PROJECTS FUNDED BY
PART 201, ACT 451, PA 1994

PART ONE - GENERAL

1.1 SCOPE OF WORK

The work to be done shall consist of furnishing all labor, materials, and equipment necessary for the complete and satisfactory construction of a water well and installation of pumping equipment, pitless adapter, and other appurtenances as specified herein. The CONTRACTOR shall procure all permits required by law and shall comply with all federal, state, and local laws and ordinances relating to performance of the work. All work is to be done in accordance with the Michigan Water Well Construction and Pump Installation Code, Act 368, PA of 1978, Part 127, known as the Ground Water Quality Control Act, herein referred to as the "CODE", Michigan Safe Drinking Water Act, Act 399, PA of 1976, Administrative Rules adopted thereunder, and specifications described therein, where applicable.

The proposed water supply site is indicated on Schedule I (Water Supply System Specifications Summary Sheet). The site has been evaluated by the Michigan Department of Environmental Quality (herein referred to as the "DEPARTMENT") and the proposed location for the replacement well on the site has been determined. This information is found on the attached Water Supply Survey Form.

It is recommended that all bidders thoroughly examine the Technical Specifications for this work and make a personal examination of the site(s) of the proposed work. Failure by the CONTRACTOR to examine the site(s) prior to making his proposal shall not be considered as cause for an increase in the contract amount.

Obtaining a potable water supply on this site will require drilling through, and adequately sealing off, a water-bearing formation which may be contaminated. It is anticipated that a safe and suitable water supply can be developed on the site if the well is constructed in accordance with the depth and design specifications as described on Schedule I and herein, although the work may be stopped at a shallower depth or continued to greater depths as directed by the DEPARTMENT. Attached with these specifications are water well records for water supplies in the area that produce water of suitable quality.

All work shall be subject to the order of the DEPARTMENT representative who shall be kept informed at all times as to the status of the work. The DEPARTMENT representative must be on site when work is performed unless the CONTRACTOR is given approval to perform work in his absence. Drilling which results in an unusable well or a dry hole will be reimbursed by the DEPARTMENT only when the practices outlined in these specifications or approved by the DEPARTMENT representative, have been followed. Unusable wells or dry holes which result from equipment failure, contractor error or negligence, or other factors which are not the fault of the DEPARTMENT will not be reimbursed.

Figures for depths of wells listed in Schedule I are estimates based on the information available to the DEPARTMENT. Determination of where a usable aquifer exists shall be the responsibility of the CONTRACTOR, with the assistance of the DEPARTMENT representative. In all cases the final depth of the well shall be approved by the DEPARTMENT. The DEPARTMENT does not guarantee the depth of wells and where the depth of completion is different than estimated in the specifications, the unit price bid by the CONTRACTOR will prevail regardless of depth drilled.

1.2 REGISTRATION

The work shall be completed by a water well drilling contractor registered in the State of Michigan, who shall comply with all applicable rules, regulations, and guidelines published by the State of Michigan regarding the performance of the work.

1.3 UTILITIES FOR CONSTRUCTION

Unless otherwise provided for in these specifications, the CONTRACTOR shall furnish his own source of electricity, fuel, and water required to perform the work, and shall bear the cost of these services.

1.4 PROTECTION OF PROPERTY

The CONTRACTOR shall properly protect all surface and subsurface structures and surrounding areas from damage which may result from the methods employed in performing the work. The CONTRACTOR shall be responsible for any damages to such structures resulting from his operations. Damaged property shall be repaired or replaced to a condition which is equal to that which existed prior to damage. The DEPARTMENT shall have the right to approve these restoration measures.

1.5 NOTIFICATION OF UTILITIES

The CONTRACTOR shall comply with Act 53, PA of 1974, by notifying public utilities of the proposed drilling or excavating at least 48 hours prior to the commencement of such activities by contacting MISS DIG at 1-800-482-7171.

1.6 DISPOSAL OF WATER

The CONTRACTOR shall make all provisions necessary for conveying any water encountered in performing the work away from adjacent structures, and shall take measures necessary to prevent erosion and/or flooding of the site and adjacent properties. The CONTRACTOR shall also prevent discharge water from flowing over any adjacent wells and/or sewage disposal systems.

1.7 CLEAN-UP

The CONTRACTOR shall provide all material and labor to maintain the site in an orderly condition which is conducive to a safe work area. The CONTRACTOR shall keep the site free from accumulation of waste materials, rubbish, drill cuttings, and other debris resulting from the work.

1.8 SAFETY

The CONTRACTOR shall comply with all applicable laws and regulations governing the furnishing and use of safeguards, safety devices, and protection equipment. The CONTRACTOR shall take any necessary precautions to protect the life and health of employees and the public in the performance of the work.

1.9 ELECTRICAL WORK

Electrical work for single-family dwellings, extending from the pump to the first point of connection inside the dwelling (pressure switch), may be performed by the CONTRACTOR. All electrical work on public water supply systems or electrical work beyond the first point of connection within a single-family dwelling shall be performed under permit by a licensed electrical contractor in compliance with the Michigan Electrical Administrative Act, Act 217, PA 1956 as amended.

1.10 SUBCONTRACTORS

The CONTRACTOR shall provide the DEPARTMENT with a list of all subcontractors which may be used. Such listing shall indicate which portions of the work are to be completed by the subcontractors.

1.11 TIME OF COMPLETION

The CONTRACTOR shall begin work on the site within 20 days from the date the contract is awarded and all work shall be completed within 30 days from the date the work is begun unless otherwise specified in Schedule I.

PART TWO - METHOD OF MEASUREMENT AND BASIS OF PAYMENT

2.1 WELL DRILLING

Payment for well drilling in all formations shall be on the basis of the unit price per lineal foot as measured in place and shall include all materials and labor required to drill the well and to perform initial capacity testing.

2.2 WELL CASING

Payment for well casing shall be on the basis of the unit price per lineal foot of casing actually installed and left in place, and shall include all other material, equipment, and labor to install casing pipe. The unit price shall include removing and pulling back the casing where required.

2.3 DRIVE SHOE

Payment for the drive shoe shall be on the basis of unit price per each and shall include all labor, material, and equipment to install the drive shoe, where applicable.

2.4 GROUTING

Payment for grouting shall be on a per foot basis and shall include all material, equipment, and labor necessary to seal the casing. The unit price shall include circulation of drilling fluid or water to surface prior to grouting.

2.5 WELL SCREEN

Payment for well screen shall be on a lump sum basis and shall include blanks, packers, bottom plug, and related fittings necessary for proper well screen installation. The lump sum shall include initial development of the well screen for a period of one hour.

2.6 ADDITIONAL WELL DEVELOPMENT

Payment for additional well development, where deemed necessary by the DEPARTMENT, shall be on the basis of the unit price per hour of actual development and shall include all equipment, equipment set-up, and labor necessary for complete development of the well.

2.7 ADDITIONAL WELL CAPACITY TEST

Payment for additional well capacity test, where deemed necessary by the DEPARTMENT, shall be on the basis of the unit price per hour measured for the time that the test pumping equipment is in operation, and shall include all equipment, equipment set-up, and labor.

2.8 DISINFECTION AND TESTING

Payment for disinfection and testing shall be on a lump sum basis and shall include all equipment, materials, and labor necessary to clean, disinfect, and pressure test the completed water system including the well, pump, drop pipe, service lines, tank, connection to existing water system, and any other equipment installed by the CONTRACTOR. The lump sum price shall include leak correction and subsequent additional disinfection as required to provide a satisfactory system.

2.9 PITLESS ADAPTER

Payment for pitless adapter(s) shall be on the basis of the unit price per each pitless adapter actually installed, and shall include the well cap and all other materials, equipment, and labor required.

2.10 SUBMERSIBLE PUMP

Payment for submersible pump(s) shall be on the basis of the unit price per each submersible pump actually installed and left in place, and shall include all materials and labor to install the pump and all electrical pump controls required.

2.11 EXISTING EQUIPMENT

Payment for the reinstallation of existing pumping equipment or pressure tank where specified by the DEPARTMENT shall be on the basis of the unit price per hour and shall include all material, equipment, and labor necessary to remove existing submersible pump from the well being replaced and disconnect existing pressure tank and reinstall pump and tank in the replacement water supply system.

2.12 SUBMERSIBLE PUMP CABLE

Payment for the submersible pump electrical cable shall be on the basis of the unit price per lineal foot of cable actually installed from the pump to the control box and from the control box to the existing household electrical system. The unit price shall include all materials, equipment, and labor to install the electrical cable.

2.13 PUMP DROP PIPE

Payment for submersible pump drop pipe shall be on the basis of the unit price per lineal foot of pipe installed and shall include all couplings and fittings required from the pump to the pitless adapter.

2.14 WATER SERVICE LINE

Payment for water service line shall be on the basis of the unit price per lineal foot of pipe installed from the pitless adapter to the pressure tank and from the pressure tank to the existing building plumbing, and shall include all material, equipment, and labor to install the piping. The unit price shall include all fittings, trench excavation and backfill, restoration of trench area, and openings through building walls where required.

2.15 PRESSURE STORAGE TANK

Payment for the pressure storage tank shall be on the basis of the unit price per each tank and shall include all material, equipment, and labor to install the tank and fittings. The unit price shall include the tank cross fitting, pressure relief valve, pressure gauge, sampling tap, and mounting provisions.

2.16 SITE CLEAN-UP AND RESTORATION

Payment for site clean-up and restoration shall be on the basis of the unit price per work site and shall include all materials, equipment, and labor to clean up and restore the site.

2.17 PERMITS

Payment for water supply permits issued by the local health departments shall be on the basis of actual fees charged by the agency.

PART THREE - MATERIALS

3.1 WELL CASING

Permanent well casing shall be new, black or galvanized steel pipe conforming to the ASTM specification A 589-89a, A 53-90b, or A 106-91 or the API specification 5L-90, in accordance with the CODE, R325.1626, Rule 126, construction of wells; steel casing and R324.1627, Rule 127, Construction of wells; steel casing and types of joints. Casing size shall be as listed in Schedule I.

If requested, the CONTRACTOR shall furnish the DEPARTMENT with a copy of a receipt or invoice from the casing supplier.

In some cases the DEPARTMENT may allow PVC casing. The use of PVC casing shall be as listed in Schedule I. Where allowed, PVC casing shall be new pipe conforming to the ASTM specification F-480-90, in accordance with the CODE, R325.1631a, Rule 131a, construction of wells, PVC casing dimensions, R325.1631b, Rule 131b, construction of wells, PVC casing material standards, and R325.1631c, Rule 131c, construction of wells, PVC casing joints.

3.2 DRIVE SHOE

The drive shoe (if required) shall be hardened, forged steel and the size compatible with that of the casing.

3.3 WELL SCREEN MATERIAL AND DESIGN

The well screen, if required, shall be new and consist of the continuous slot, wire-wound design and made of Type 304 stainless steel. The wire configuration must produce inlet

slots with sharp outer edges, widening inwardly so as to minimize clogging. All intake openings shall be free from jagged edges, irregularities or other defects that would hinder passage of sand during well development.

3.4 WELL SCREEN FITTINGS

The telescope size screen shall be provided with a minimum two foot long blank extension of the same size as the screen, a bottom plug to close the bottom of the screen, and a packer to provide a tight seal between the top of the screen and the well casing. The blank shall be of new, standard weight schedule 40 black or galvanized steel pipe. A neoprene-type figure K packer shall be installed at the top of the blank.

3.5 ROTARY DRILLING FLUID

The rotary drilling fluid shall consist of clean, chlorinated water in compliance with R325.1639, Rule 139(8), construction of wells, drilling water, and finely ground sodium bentonite meeting section 4 of API specification 13A. Any additives to the drilling fluid system shall be approved in compliance with R325.1640, Rule 1640, certification of water system components.

3.6 GROUT MATERIAL

Grout material for sealing the annular space between the casing and borehole shall be neat cement grout or neat cement plus bentonite. Neat cement grout shall consist of a mixture of 1 bag of cement (94 pounds) of Type I or Type IA (air-entraining) Portland cement to not more than 6 gallons of clean water in accordance with the CODE, R325.1603a(1), Rule 103a(1), definitions:N,O. Table 3.6 shall be used to determine the amount of bentonite, water requirements, and resulting slurry weights and volumes for neat cement/bentonite admixtures. Addition of bentonite shall not exceed 5% by weight of cement. The cement shall be mixed as a neat cement slurry prior to addition of any bentonite.

TABLE 3.6

CEMENT/BENTONITE SLURRY PROPERTIES

Percent Bentonite	Bentonite Req. lbs./bag	Water Req. gal./bag	Slurry Wgt. lbs./Gal	Slurry Vol. ft. ³ /bag
0	0	6.0	15.0	1.18
1	1	6.25	14.8	1.27
2	2	6.5	14.7	1.38
3	3	7.2	14.4	1.45
4	4	7.8	14.1	1.55
5	5	8.5	13.8	1.65

NOTE: Compliance with the slurry weight and volume properties requires mixing the cement prior to addition of any bentonite to the slurry unless the cement and bentonite are pre-mixed in dry form.

3.7 DRILLING FLUIDS, GROUTS AND ADDITIVES

Bentonite grouts, special cements, or other admixtures to the drilling fluid or grout slurry to reduce permeability, increase fluidity, control time of set, or alter the slurry composition in any way shall not be used unless approved by the DEPARTMENT. DEPARTMENT approval shall be based upon compliance with the following specifications as applicable: ANSI/NSF standards 60 or 61 (additives), ASTM specification C 150 (cements), or section 10 of the API specification 10 and section 4 of the API specification 13A (bentonites), in accordance with the CODE, R325.1640, Rule 140, certification of water well components.

3.8 PITLESS ADAPTER

The pitless adapter shall be of the clamp-on, weld-on or thread-on design and shall be a model approved by the Michigan Department of Environmental Quality, in accordance with the CODE, R325.1642, Rule 142, below ground well casing connections.

3.9 WELL CAP

Well caps shall be of insect-proof design with a screened vent, in accordance with the CODE, R325.1657, Rule 157, pump installation; vents, and Rule 157a, pump installation; well caps and seals.

3.10 SUBMERSIBLE PUMP

(THE DEPARTMENT SHALL CHOOSE ONE OF THE FOLLOWING)

- A. Replacement Pump - The pumping equipment shall be a 4-inch nominal size submersible pump, NEMA standard, 1/2 horsepower, single phase, with a 10 gallon per minute capacity. The pump shall have a brass, bronze, stainless steel or engineered thermoplastic discharge head and intake (motor mounting bracket). The pump housing and motor housing shall be Type 304 stainless steel. The voltage of the pump motor shall be identical to the electrical AC current power supply to the existing pump at each replacement well location, either 115 volt single phase or 230 volt single phase, and either two-wire or three-wire. **The submersible pump information is provided for bidding purposes only. Actual pump selection will be determined based on well data and existing pump capacity. Additions or deletions in the amount to be paid will be made equivalent to the difference in the cost of the pump.**

OR

- B. Existing Pump - The submersible pump used with the existing water supply will be reused in the new well. The existing pump shall be removed from the existing contaminated well and reinstalled in the new well.

3.11 SUBMERSIBLE PUMP CONTROLS

- A. Two-wire Systems - The two-wire pump controls shall consist of a pressure actuated switch, Square D, Class 9013, Type FSG, or equivalent factory set at 30/50 psi operating range. A fused disconnect switch or manual reset circuit breaker shall be provided with properly sized fuses or circuit breakers to meet amperage requirements of the pump. If the pump does not include lightning protection, a lightning arrestor shall be included with the controls.

- B. Three-Wire Systems - The three-wire pump controls shall be as specified for the two-wire system with the addition of a control box complete with terminal strip, starting relay, start and run capacitors, and lightning protection is not provided with the pump motor.

3.12 SUBMERSIBLE PUMP ELECTRICAL INSTALLATION

Electrical service shall be provided in accordance with the Electrical Administrative Act, Act No. 217, PA of 1956 as amended.

The location of the wiring entrance through the building wall shall be the same location as the existing wiring or as agreed upon by the DEPARTMENT and the property owner, and shall be made below grade where practical. Building wiring shall include connections to the existing pump power supply with a junction box, and to the pump controls. Where required by the electrical code, any wiring inside the building shall be installed in protective conduit.

3.13 PUMP DROP PIPE

The drop pipe and couplings shall be Schedule 80, polyvinyl chloride, PVC 1120/1220, shall meet specification ASTM D1785 and be approved by NSF for potable water use. Drop pipe shall be 1 inch I.D. Couplings shall be a PVC machined type with recessed, tapered threads or galvanized steel with tapered threads. Drop pipe and couplings shall bear manufacturer's markings that will identify the material as that which is specified. Where pump settings exceed 200 feet in depth, a rubber or neoprene torque arrestor shall be installed directly above the pump and cable guards shall be installed every 20 feet on the drop pipe.

3.14 PRESSURE TANK

- A. Replacement Pressure Tank - The pressure tank shall be a pre-pressurized, diaphragm or bladder-type design with a minimum total capacity of 30 gallons. The tank shall be constructed of steel and coated with a corrosion resistant, zinc-based epoxy primer and enamel finish. Tank linings and diaphragm or bladder materials shall be approved by either FDA or NSF for contact with potable water. The rated maximum working pressure for the tank shall be at least 100 pounds per square inch. The tank shall provide a minimum available drawdown of 10 gallons at a 30-50 psi operating cycle. The pressure tank capacity information is provided for bidding purposes only. Actual tank size(s) will be determined based on well performance, existing tank capacity, and current supply needs.

OR

- B. Existing Pressure Tank - The pressure tank used for the existing water supply has been determined by the DEPARTMENT to be adequate for the new well and pumping equipment. The existing tank shall be disconnected from the existing contaminated water supply and connected to the replacement water supply.

3.15 PRESSURE TANK FITTINGS

A new standard brass tank cross-tapped for a pressure switch, pressure gauge, pressure relief valve and sampling tap shall be provided. The pressure gauge shall have a range of 0-100 psi. The pressure relief valve shall be brass and have a pressure setting of 75 psi. The sampling tap shall consist of 3/4-inch brass boiler drain.

3.16 WATER SERVICE LINE

The water service line between the well and the building shall be flexible copper tubing, Type K conforming to specification ASTM B 88. The pipe shall be 1 inch I.D. The water service line shall have no couplings or splices between the well and pressure tank. Brass compression fittings shall be used for connections to the pressure tank cross and pitless adapter.

In some cases the DEPARTMENT may allow plastic service line. The use of plastic service line shall be as listed in Schedule I. Where allowed, plastic service line shall conform to the CODE, R325.1655(2).

3.17 DISINFECTANT

Chemicals used for disinfecting the drilling water, well, pumping equipment, storage tank, and piping shall be sodium hypochlorite or calcium hypochlorite or others approved by the DEPARTMENT.

PART FOUR - COMPLETION OF WORK

4.1 WELL CONSTRUCTION

- A. Well Location - The well shall be constructed in the location designated by the DEPARTMENT. Any deviation in location shall be approved by the DEPARTMENT.
- B. Drilling Method - The well shall be constructed using either the cable tool or rotary drilling method. Special construction requirements for each drilling method are specified herein. Other drilling methods may be used only with the permission of the DEPARTMENT.
- C. Drilling Equipment - Drilling machines shall be of sufficient size to efficiently complete the work. If requested by the DEPARTMENT, the CONTRACTOR shall present evidence of sufficient equipment and tools to complete the work.
- D. Drilling Water - Water necessary for drilling operations shall be obtained by the CONTRACTOR at his expense from a municipal water supply or a well free of organic or bacterial contamination and comply with the CODE in accordance with R325.1639, Rule 139(8), construction of wells, drilling water.
- E. Well Screen - The CONTRACTOR shall select the screen to be used based upon analysis of samples from the formation. For naturally developed wells, the screen slot size should be such that between 40 and 50 percent of the material present in the water-bearing formation will be retained by the screen and comply with the CODE in accordance with R325.1639, Rule 139(1), construction of wells, well screens. For gravel-packed wells, the slot size should be such that 90 percent of the gravel pack material is retained by the screen. The minimum length and diameter of the well screen should be based on a maximum inlet velocity of 0.1 feet per second for the selected slot size.
- F. Formation Sampling and Well Records - The CONTRACTOR shall maintain a complete and accurately written record of types of formations encountered, depths and thicknesses of formations during construction of a well. Such written log shall be

available for inspection on site at the request of the DEPARTMENT. The CONTRACTOR shall be responsible for collecting and evaluating formation samples at each change of formation and at each five-foot interval above the water level and each two-foot interval below the water level. The completed water well record shall be submitted directly to the DEPARTMENT within 60 days of the completion of the well. Final approval and payment by the DEPARTMENT shall be withheld until the water well record has been submitted.

- G. Temporary Capping - At all times during the progress of the work, the CONTRACTOR shall use reasonable precautions to prevent either tampering with the well or the entrance of foreign material into the well. Upon completion of the well, temporary capping shall be provided, in accordance the CODE, R325.1639, Rule 139(6), construction of wells, temporary capping.
- H. Well Alignment - The completed well shall be sufficiently plumb and straight in accordance the CODE, R325.1639, Rule 139(7), construction of wells, well alignment.
- I. Casing Termination - The CONTRACTOR shall terminate the well casing no less than 12 inches and no greater than 18 inches above final grade.

4.2 GROUTING

A. General Requirements

- 1. The annular space between the well casing and borehole shall be tightly sealed to prevent the entrance of surface water and the vertical migration of contaminants along the well casing and borehole.
- 2. The CONTRACTOR shall be responsible for determining the volume of grout required. The volume of dry cement or cement/bentonite grout available on site shall be at least 25% greater than the calculated volume of dry grout required to fill the annulus. And in no case should the grout volume mixed be less than the calculated volume. Appendix V of the Michigan Water Well Construction and Pump Installation Code, Act 368, PA of 1978, Part 127, known as the Ground Water Quality Control Act and administrative rules may be used as a guide for casing and borehole sizes not listed in the following table.

TABLE 4.2
BAGS OF CEMENT REQUIRED

Casing size (inches)		4			5			6	
Borehole (inches)		8			9			10	
Depth (feet)/% Bentonite	0	2	5	0	2	5	0	2	5
25	5.6	4.8	4.1	6.5	5.6	4.7	7.4	6.4	5.3
30	6.7	5.8	4.8	7.8	6.7	5.6	8.9	7.7	6.4
50	11.1	9.5	8.0	13.0	11.2	9.3	14.8	12.7	10.6
100	22.2	19.0	15.9	25.9	22.2	18.6	29.6	25.4	21.2
150	33.3	28.5	23.9	38.9	33.3	27.9	44.4	38.0	31.8
200	44.4	38.0	31.8	51.8	44.3	37.1	59.2	50.7	42.4
300	66.6	57.0	47.7	77.7	66.5	55.6	88.8	76.0	63.6

3. The CONTRACTOR shall maintain records of the grouting method and the volume of grout material used.
4. Neat cement grout shall be consistent in texture, free of lumps and shall be pumped into the annulus before initial set, in accordance with the CODE, R325.1633a, Rule 133a(1-6), construction of wells, grouting and R325.1634a, Rule 134a(1), construction of wells; grouting rotary-bored or augered wells.
5. When the DEPARTMENT representative authorizes the CONTRACTOR to grout the well in his absence, the CONTRACTOR shall provide the DEPARTMENT with a copy of a billing invoice for the grout material purchased. Such invoices shall be submitted to the DEPARTMENT with the final bill.

B. Grouting Methods

Grout material shall be placed into the annular space between the well casing and borehole, in accordance with the CODE, R325.1634a, Rule 134a(1), construction of wells, grouting rotary-bored or augered wells, using one of the following methods:

1. Tremie Pipe Outside Casing - A tremie pipe, minimum size 3/4-inch I.D. shall be placed to the bottom of the zone to be grouted. Grout material shall be pumped down a grout pipe (tremie) and placed in the annulus, from bottom to top, in one continuous operation. The end of the tremie pipe must be submerged in the emplaced grout at all times until grouting is complete. The tremie pipe shall remain full of grout at all times until grouting is complete. In the event of interruption in the grouting operations, the bottom of the pipe should be raised above the grout level and not be resubmerged until all air and water have been displaced from the tremie pipe.
2. Displacement Plug Method - The well casing shall be raised off the bottom of the drillhole high enough to allow flow of cement up the annulus. The required volume of grout shall be placed into the well casing. A drillable displacement plug is placed on the top of the grout column. Pressure is then applied to the displacement plug to push it to the bottom of the well, forcing the grout up the annular space. Pressure on the displacement plug shall be maintained a minimum of 24 hours or until such time as a sample of the grout indicates a satisfactory set.

If the grout material does not appear at the surface upon completion of grouting by the displacement method, grouting of the remaining annular space shall be accomplished by the tremie pipe placement method (See #1 above).

Other grouting methods proposed by the CONTRACTOR shall be approved by the DEPARTMENT prior to use.

4.3 ROTARY DRILLING

General Requirements - The following specification shall apply to all wells constructed using the mud rotary drilling method:

- A. A sand separator or desander shall be used with the drilling fluid system to improve filter cake properties and formation samples, and reduce the potential for circulating contaminants in the borehole. The desander shall be operated either continuously while drilling or each time an additional drill rod is being added to the drill stem.

- B. The CONTRACTOR shall be responsible for controlling critical drilling fluid properties such as density and viscosity to avoid excessive downhole pressure, recirculation of cuttings, and damage to the water bearing formation. Measurements of drilling fluid properties may be required at the discretion of the DEPARTMENT representative to determine if properties are within recognized industry standards.
- C. After drilling through the contaminated formation, the drilling fluid may contain contaminants and require disposal as deemed necessary by the DEPARTMENT representative. A fresh batch of drilling fluid shall then be prepared and used to drill the remainder of the well.

4.4 CABLE TOOL WELL CONSTRUCTION

General Requirements - The following specifications shall apply to all wells constructed using the cable tool method.

- A. A temporary outer casing shall be used with the cable tool method in order to prevent caving of the overburden material and maintain an open annular space around the casing for grout. The temporary outer casing shall extend from the surface to a minimum of three (3) feet into a confining formation. If no confining formation exists, the temporary casing shall extend the length of the permanent casing. The temporary casing shall be pulled back and removed as grouting proceeds in order to expose the grout to the borehole wall.
- B. Dry granular bentonite shall be maintained around the temporary well casing while being driven. A funnel-shaped excavation approximately two times the casing diameter in depth and four times the casing diameter in width shall be provided around the top of the well casing. The excavation shall be for the purpose of containing the bentonite. The casing with drive shoe shall be placed in the funnel-shaped excavation and the bentonite poured around the casing until the excavation is full. The bentonite shall be replenished as the level drops in the funnel due to the casing being driven.

4.5 WELL DESIGN

THE DEPARTMENT WILL SPECIFY WHICH OF THE FOLLOWING DESIGNS MAY BE USED

- A. Single-Cased Method - The borehole size shall be a minimum of 4 inches larger than the nominal casing size. The oversized borehole shall extend from ground surface to the top of the water-bearing formation for screened wells and at least 5 feet into the bedrock for rock wells. After casing is installed the well shall be grouted without delay unless approval is given by the DEPARTMENT to delay grouting.
- B. Gravel-Packed Method - The borehole size shall be a minimum of 4 inches larger than the nominal casing size. The borehole shall extend from ground surface to the bottom of the portion to be screened. After casing and screen are installed, the annular space between the screen and borehole wall shall be backfilled with clean, chlorinated, filter-pack material of appropriate size to a point 5 feet above the top of the screen. The annular space between the borehole wall and casing from the top of the filter-pack to surface shall be grouted without delay, unless approval is given by the DEPARTMENT to delay grouting.
- C. Telescoped Casing Method - The upper borehole shall be a minimum of 4 inches larger than the normal size of the outer casing. The outer casing shall extend from the surface to at least 3 feet into the confining formation above the artesian aquifer. A

drive shoe or rotary shoe shall be attached to the outer casing and pressure applied to seat the casing. A lower borehole one inch smaller than the nominal outer casing size shall be drilled through the remainder of the confining formation and penetrate the water-bearing formation. The lower casing consisting of a blank extension and well screen shall be installed within the outer casing. The space between the screen blank extension and the well casing shall be sealed with a K-packer. The packer shall be installed no closer than two feet from the end of the outer casing. The annular space between the outer casing and borehole wall shall be grouted without delay.

4.6 WELL SCREEN PLACEMENT

Well screen placement shall be either 1) telescoped out the casing exposing not less than four feet to the formation or 2) attached directly to the casing where the filter-pack method is used. Additional screen length may be necessary as determined by the CONTRACTOR depending upon the nature and thickness of the water-bearing formation penetrated.

4.7 WELL DEVELOPMENT

- A. General requirements - The well shall be developed to produce water free of sand, silt, or other material at the pumping rate of the permanent pump, in accordance with the CODE, R325.1621, Rule 121(2), location and construction of wells generally and R325.1639, Rule 139(1) and Rule 139(5), construction of wells; well screens; well pumping rate.
- B. Chemical Development - Any chemicals used for well screen development shall be approved by the DEPARTMENT prior to use.

4.8 WELL CAPACITY TESTING

- A. Design and Pumping Rate - The well shall be capable of sustaining a permanent pumping rate of 10 gallons per minute. If limiting geological conditions are present, the DEPARTMENT may authorize a lower final pumping rate. In such instances, additional storage capacity will be provided at the expense of the DEPARTMENT.
- B. Initial Capacity Testing - Initial capacity testing shall be performed by pumping the well with compressed air, submersible pumping equipment, or a plunger. A discharge outlet shall be provided for measurement of flow rate with a 5-gallon pail and stop watch. Capacity testing shall be performed by pumping the well at 15 to 20 gpm or 1.5 to 2 times the pumping rate of the final pumping equipment, whichever is greater, for a period of one hour.
- C. Additional Capacity Testing - Additional well capacity testing shall be performed at the pumping rate and length of time as specified by the DEPARTMENT representative.

4.9 PITLESS ADAPTER

The pitless adapter shall be installed on the well casing in accordance with the manufacturer's instructions and in accordance with the CODE, R325.1641, Rule 141, above grade well casing connections and R325.1642, Rule 142, below ground well casing connections. The pitless adapter shall be installed so that the discharge line is generally 84 inches below grade but in no case less than 42 inches, or as modified by the DEPARTMENT due to local climactic conditions. A 90° elbow directed downward at an angle approximately 45° shall be installed on the discharge saddle and the saddle shall be installed so that the discharge is directed perpendicular to the direction of the water service line to provide a swing connection.

No surface water, dirt or other debris shall be allowed to enter the well casing during installation of the pitless adapter.

4.10 PUMPING AND STORAGE EQUIPMENT

- A. The submersible pump and controls shall be installed in accordance with the manufacturer's instructions.
- B. The pressure switch, pressure gauge, pressure relief valve, and sampling tap shall be installed on the tank cross.
- C. The sampling tap shall be installed in accordance with the CODE, R325.1658, Rule 58, pump installation; sampling faucets.
- D. The pressure tank shall be installed in accordance with the CODE, R325.1656, Rule 156, pump installation; pressure tanks.

4.11 WATER SERVICE LINE

The water service line shall be one continuous length without splices between the well and pressure tank. Splicing of service lines exceeding 100 feet or for connection to existing service lines may be allowed when done in accordance with the state plumbing code and the approval of the DEPARTMENT. The water service line shall have a minimum of 42 inches of cover. Under paved areas a minimum of 60 inches of cover or insulation and an outer conduit shall be provided to protect the water service line from freezing. The DEPARTMENT may modify minimum bury depths due to local climactic conditions.

4.12 SYSTEM TESTING

After completion of the well, installation of the pump, and completion of the piping and pressure tank installation, the water system shall be pressure tested by operating the pump through three complete pumping and delivery cycles. The underground piping and electrical wiring shall not be backfilled prior to the testing. The CONTRACTOR shall inspect all piping and connections during the pressure test to insure watertight construction at the operating pressure of the system. The electrical circuits shall be tested and found to be free from grounds or other malfunctions. Leaking piping or connections or other defects in the system shall be corrected by the CONTRACTOR and the system retested and found to be free of defects.

4.13 BACKFILLING

After the water service line has been installed, inspected, and tested, the excavation shall be backfilled using soil material originating from the excavation. Rocks and other debris that may damage the piping or other equipment shall be removed from the backfilling material.

4.14 DISINFECTION

After completion of the pressure testing, the well, piping and pressure tank shall be disinfected in accordance with the CODE, R325.1661, Rule 161, disinfection of well and pumping equipment.

4.15 WATER SAMPLING

Prior to placing the well into service, the DEPARTMENT representative shall collect a water sample from the well and submit it for bacteriological analysis. If the analysis shows that the water contains coliform bacteria or interference organisms, the CONTRACTOR shall again

disinfect the well as specified herein. Additional sampling and disinfection shall be performed as required to obtain a bacteriologically safe sample.

A sample of water shall be collected by the DEPARTMENT or its representative and submitted for partial chemical analysis. Chemical parameters desired on each analysis will be determined by the DEPARTMENT. The DEPARTMENT shall collect and analyze samples for the chemical contaminants present in the ground water source being replaced.

In the event the DEPARTMENT or its representative cannot be present on the site, the DEPARTMENT may authorize the CONTRACTOR to collect the necessary samples.

4.16 ABANDONMENT OF WELL

In the event the well is not accepted by the DEPARTMENT due to insufficient capacity, unsatisfactory quality, or should it be abandoned due to loss of drilling tools or other causes, the CONTRACTOR shall seal the well in accordance with the abandonment specifications described herein.

4.17 OPERATING INSTRUCTIONS, MANUALS, AND WARRANTIES

The CONTRACTOR shall provide the property owner with all operating instructions, equipment manuals, repair parts lists and warranties by the manufacturer for the pumping equipment, pressure tank and other equipment installed.

4.18 GUARANTEE

The CONTRACTOR shall guarantee the water system to be free from defects or faulty workmanship for a period of one year from the date of completion. The CONTRACTOR shall furnish and install any parts that malfunction or prove to be defective without further cost, providing that the need for such replacement is not due to negligence of the property owner.

4.19 SITE RESTORATION

The CONTRACTOR shall restore the site by backfilling all trenches and all ruts caused by well drilling operations on the site. Additional soil may be required to fill these areas to prevent undue settling. The work area shall be graded and then raked.

Special site restoration activities deemed necessary by the DEPARTMENT will be specified in Schedule I. Additional unanticipated site restoration will be completed by the CONTRACTOR with the approval of the DEPARTMENT, with the cost to be reimbursed by the DEPARTMENT. Damage to property caused by the negligence of the CONTRACTOR shall be repaired by the CONTRACTOR at his expense.

4.20 SITE CLEAN-UP

Upon completion of the work, the CONTRACTOR shall remove from the premises all materials, debris, tools and machinery. Drilling mud, cuttings, grout material, or other materials which have accumulated on structures or around the premises shall be removed. The CONTRACTOR may dispose of these materials on site, with permission of the property owner and the DEPARTMENT.

4.21 FINAL BILLING

Upon completion of all work, the CONTRACTOR shall submit the following items to the DEPARTMENT.

1. Itemized bill for each well consistent with the items listed on the Itemized Bid Sheet.
2. Completed water well and pump records.
3. Completed well abandonment records (completed on water well record form).

The above items shall be mailed to the following address: