

### 3.0 GENERAL

In selecting the source of water to be developed, the designing engineer must prove to the satisfaction of the reviewing authority that an adequate quantity of water will be available, and that the water which is to be delivered to the consumers will meet the current requirements of the reviewing authority with respect to microbiological, physical, chemical and radiological qualities. Each water supply should take its raw water from the best available source which is economically reasonable and technically possible.

### 3.1 SURFACE WATER

A surface water source includes all tributary streams and drainage basins, natural lakes and artificial reservoirs or impoundments above the point of water supply intake. A source water protection plan enacted for continued protection of the watershed from potential sources of contamination shall be provided as determined by the reviewing authority.

#### 3.1.1 Quantity

The quantity of water at the source shall:

- a. be adequate to meet the maximum projected water demand of the service area as shown by calculations based on a one in fifty year drought or the extreme drought of record, and should include consideration of multiple year droughts. Requirements for flows downstream of the intake shall comply with requirements of the appropriate reviewing authority;
- b. provide a reasonable surplus for anticipated growth;
- c. be adequate to compensate for all losses such as silting, evaporation, seepage, etc.;
- d. be adequate to provide ample water for other legal users of the source.

#### 3.1.2 Quality

A study shall be made of the factors, both natural and man made, which may affect water quality in the water supply stream, river, lake or reservoir. Such a study shall include, but not be limited to:

- a. determining possible future uses of impoundments or reservoirs;
- b. determining degree of control of watershed by owner;
- c. assessing degree of hazard to the supply posed by agricultural, domestic, industrial, or recreational activities in the watershed, which may generate toxic or harmful substances detrimental to treatment processes,;
- d. assessing all waste discharges (point source and non point sources) and activities that could impact the water supply. The location of each waste discharge shall be shown on a scale map;
- e. obtaining samples over a sufficient period of time to assess the microbiological, physical, chemical and radiological characteristics of the water;
- f. assessing the capability of the proposed treatment process to reduce contaminants to

applicable standards;

- g. consideration of currents, wind and ice conditions, and the effect of confluencing streams.

### 3.1.3 Minimum treatment

- a. The design of the water treatment plant must consider the worst conditions that may exist during the life of the facility.
- b. The minimum treatment required shall be determined by the reviewing authority.
- c. Filtration preceded by appropriate pretreatment shall be provided for all surface waters. Exemptions may be approved by the reviewing authority on a case-by-case basis.

### 3.1.4 Structures

#### 3.1.4.1 Design of intake structures

shall provide for:

- a. withdrawal of water from more than one level if quality varies with depth;
- b. separate facilities for release of less desirable water held in storage;
- c. where frazil ice may be a problem, holding the velocity of flow into the intake structure to a minimum, generally not to exceed 0.5 feet per second;
- d. inspection of manholes every 1000 feet for pipe sizes large enough to permit visual inspection;
- e. occasional cleaning of the inlet line;
- f. adequate protection against rupture by dragging anchors, ice, etc.;
- g. ports located above the bottom of the stream, lake or impoundment, but at sufficient depth to be kept submerged at low water levels;
- h. where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris from entering an intake structure;
- i. when buried surface water collectors are used, sufficient intake opening area must be provided to minimize inlet headloss. Particular attention should be given to the selection of backfill material in relation to the collector pipe slot size and gradation of the native material over the collector system.

#### 3.1.4.2 Raw water pumping wells

shall:

- a. have motors and electrical controls located above grade, and protected from flooding as required by the reviewing authority;
- b. be accessible;

- c. be designed against flotation;
- d. be equipped with removable or traveling screens before the pump suction well;
- e. provide for introduction of chlorine or other chemicals in the raw water transmission main if necessary for quality control;
- f. have intake valves and provisions for backflushing or cleaning by a mechanical device and testing for leaks, where practical;
- g. have provisions for withstanding surges where necessary;
- h. be constructed in a manner to prevent intrusion of contaminants.

#### 3.1.4.3 Off-stream raw water storage reservoir

An off-stream raw water storage reservoir is a facility into which water is pumped during periods of good quality and high stream flow for future release to treatment facilities. These off-stream raw water storage reservoirs shall be constructed to assure that:

- a. water quality is protected by controlling runoff into the reservoir;
- b. dikes are structurally sound and protected against wave action and erosion;
- c. intake structures and devices meet requirements of Section 3.1.4.1;
- d. point of influent flow is separated from the point of withdrawal;
- e. separate pipes are provided for influent to and effluent from the reservoir;
- f. a bypass line is provided around the reservoir to allow direct pumping to the treatment facilities.

#### 3.1.5 Zebra Mussel Control

If it is determined that chemical treatment is warranted for the control of zebra mussels:

- a. chemical treatment shall be in accordance with Chapter 5 of the Recommended Standards for Water Works and shall be acceptable to the reviewing authority;
- b. plant safety items, including but not limited to ventilation, operator protective equipment, eyewashes/showers, cross connection control, etc. shall be provided;
- c. solution piping and diffusers shall be installed within the intake pipe or in a suitable carrier pipe. Provisions shall be made to prevent dispersal of chemical into the water environment outside the intake. Diffusers shall be located and designed to protect all intake structure components;
- d. a spare solution line should be installed to provide redundancy and to facilitate the use of alternate chemicals;

- e. the chemical feeder shall be interlocked with plant system controls to shut down automatically when the raw water flow stops;
- f. when alternative control methods are proposed for the control of zebra mussels, appropriate piloting or demonstration studies, satisfactory to the reviewing authority, may be required.

### 3.1.6 Impoundments and reservoirs

#### 3.1.6.1 Site preparation

shall provide where applicable:

- a. removal of brush and trees to high water elevation;
- b. protection from floods during construction;
- c. abandonment of all wells which will be inundated, in accordance with requirements of the reviewing authority.

#### 3.1.6.2 Construction

may require:

- a. approval from the appropriate regulatory agencies of the safety features for stability and spillway design;
- b. a permit from an appropriate regulatory agency for controlling stream flow or installing a structure on the bed of a stream or interstate waterway.

#### 3.1.6.3 Water Supply Dams

Water supply dams shall be designed and constructed in accordance with the requirements of the appropriate regulatory agency.

### 3.1.7 Security

Adequate security should be provided to prevent unauthorized access to vulnerable components. Specific consideration should be given to installation of fencing, locks, surveillance cameras, etc.

## 3.2 GROUNDWATER

A groundwater source includes all water obtained from dug, drilled, bored or driven wells, and infiltration lines.

### 3.2.1 Quantity

#### 3.2.1.1 Source capacity

The total developed groundwater source capacity, unless otherwise specified by the reviewing authority, shall equal or exceed the design maximum day demand with the largest producing well out of service.

### 3.2.1.2 Number of sources

A minimum of two sources of groundwater shall be provided, unless otherwise specified by the reviewing authority. Consideration should be given to locating redundant sources in different aquifers or different locations of an aquifer.

### 3.2.1.3 Standby power

- a. To ensure continuous service when the primary power has been interrupted, a standby power supply shall be provided through a dedicated portable or in-place auxiliary power of adequate supply and connectivity.
- b. When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, design shall assure that the pre-lubrication is provided when auxiliary power is in use.

## 3.2.2 Quality

An assessment should be made of the factors, both natural and man-made, which may affect water quality in the well and aquifer.

Such an assessment may include, obtaining samples over a sufficient period of time to assess the microbiological and physical characteristics of the water including dissolved gases, chemical, and radiological characteristics. A ground water under the direct influence of surface water determination acceptable to the reviewing authority shall be provided for all new wells.

### 3.2.2.1 Microbiological quality

After disinfection of each new, modified or reconditioned groundwater source, one or more water samples shall be submitted to a laboratory satisfactory to the reviewing authority for microbiological analysis with satisfactory results reported to such agency prior to placing the well into service.

### 3.2.2.2 Physical, chemical and radiological characteristics

- a. Every new, modified or reconditioned groundwater source shall be examined for applicable physical, chemical and radiological characteristics as required by the reviewing authority by tests of a representative sample in a certified laboratory, with results reported to such authority.
- b. Samples shall be collected and analyzed at the conclusion of the test pumping procedure.
- c. Field determinations of physical and chemical constituents or special sampling procedures may be required by the reviewing authority.

## 3.2.3 Location

### 3.2.3.1 Well location

The reviewing authority shall be consulted prior to design and construction regarding a

proposed well location as it relates to required separation between existing and potential sources of contamination and groundwater development. The well location should be selected to minimize the impact on other wells and other water resources.

#### 3.2.3.2 Continued sanitary protection

Continued sanitary protection of the well site from potential sources of contamination shall be provided either through ownership, zoning, easements, leasing or other means acceptable to the reviewing authority. Fencing of the site may be required by the reviewing authority.

#### 3.2.3.3 Wellhead protection

A wellhead protection plan for continued protection of the wellhead from potential sources of contamination shall be provided as determined by the reviewing authority.

#### 3.2.4 General well construction

##### 3.2.4.1 Drilling fluids and additives shall:

- a. not impart any toxic substances to the water or promote bacterial contamination;
- b. be acceptable to the reviewing authority.

##### 3.2.4.2 Minimum protected depths

Minimum protected depths of drilled wells shall provide watertight construction to such depth as may be required by the reviewing authority, to:

- a. exclude contamination, and;
- b. seal off formations that are, or may be, contaminated or yield undesirable water.

##### 3.2.4.3 Surface or Temporary steel casing

Surface or temporary steel casing used for construction shall be capable of withstanding the structural load imposed during its installation and removal. Surface or temporary casing shall be removed during or prior to grouting or it shall be grouted in place when set according to section 3.2.4.9. If the temporary casing cannot be withdrawn, approval of a method to finish the well must be obtained from the reviewing authority.

##### 3.2.4.4 Permanent steel casing pipe

Shall:

- a. be new single steel casing pipe meeting AWWA Standard A-100, ASTM or API specifications for water well construction;
- b. have minimum weights and thickness indicated in Table I;
- c. have additional thickness and weight if minimum thickness is not considered sufficient to assure reasonable life expectancy of a well;
- d. be capable of withstanding forces to which it is subjected;

- e. be equipped with a drive shoe when driven, and;
- f. have full circumferential welds or threaded coupling joints.

#### 3.2.4.5 Polyvinyl chloride plastic (PVC) well casing

The reviewing authority may approve the use of PVC casing for all or for limited applications. Where approved, PVC casing, as a minimum:

- a. shall be new pipe meeting ASTM F480 and ANSI/NSF Standard 61 and be appropriately marked;
- b. shall have a minimum wall thickness equivalent to SDR (standard dimension ratio) 21; however, diameters of 8 inches or greater or deep wells may require greater thickness to meet collapse strength requirements;
- c. shall not be used at sites where permeation by hydrocarbons or degradation may occur;
- d. shall be properly stored in a clean area free from exposure to direct sunlight;
- e. shall be assembled using couplings or solvent welded joints; all couplings and solvents shall meet ANSI/NSF Standard 14, ASTM F480, or similar requirements; and;
- f. shall not be driven.

#### 3.2.4.6 Other nonferrous casing materials

- a. Approval of the use of any nonferrous material as well casing shall be subject to special determination by the reviewing authority prior to submission of plans and specifications.
- b. Nonferrous material proposed as a well casing must be resistant to the corrosiveness of the water and to the stresses to which it will be subjected during installation, grouting and operation.

#### 3.2.4.7 Packers

Packers shall be of material that will not impart taste, odor, toxic substances or bacterial contamination to the well water. Lead packers shall not be used.

#### 3.2.4.8 Screens

shall:

- a. be constructed of materials resistant to damage by chemical action of groundwater or cleaning operations;
- b. have size of openings based on sieve analysis of formation and/or gravel pack materials;
- c. have sufficient length and diameter to provide adequate specific capacity and low aperture entrance velocity. Usually the entrance velocity should not exceed 0.1 feet per second;

- d. be installed so that the pumping water level remains above the screen under all operating conditions;
- e. where applicable, be designed and installed to permit removal or replacement without adversely affecting water-tight construction of the well, and;
- f. be provided with a bottom plate or washdown bottom fitting of the same material as the screen.

#### 3.2.4.9 Grouting requirements

All permanent well casing shall be surrounded by a minimum of 1 ½ inches of grout to the depth required by the review authority. Other forms of grouting may be approved for driven casing. All temporary construction casings shall be removed. Where removal is not possible or practical, the casing shall be withdrawn at least five feet to ensure grout contact with the native formation.

##### a. Neat cement grout

- 1. Cement conforming to AWWA A100, and water, with not more than six gallons of water per 94 pounds of cement, must be used for 1 ½ inch openings.
- 2. Additives may be used to increase fluidity subject to approval by the reviewing authority.

##### b. Concrete grout

- 1. Equal parts of cement conforming to AWWA A100, and sand, with not more than six gallons of water per 94 pounds of cement may be used for openings larger than 1½ inches.
- 2. Where an annular opening larger than four inches is available, gravel not larger than one-half inch in size may be added.

##### c. Bentonite, where allowed by the reviewing authority.

This is a mixture of water and commercial sodium-bentonite clay manufactured for the purpose of water well grouting. Bentonite mixtures shall contain no less than 20 percent bentonite solids. Organic polymers used in the grout mixtures must meet ANSI/NSF Standard 60.

##### d. Clay seal

Where an annular opening greater than six inches is available a clay seal of clean local clay mixed with at least 10 percent swelling bentonite may be used when approved by the reviewing authority.

##### e. Application

- 1. Sufficient annular opening shall be provided to permit a minimum of 1½ inches of grout around permanent casings, including couplings.
- 2. Prior to grouting through creviced or fractured formations, bentonite or similar materials may be added to the annular opening, in the manner indicated for grouting.



3. When the annular opening is less than four inches, grout shall be installed under pressure by means of a grout pump from the bottom of the annular opening upward in one continuous operation until the annular opening is filled.
4. When the annular opening is four or more inches and less than 100 feet in depth, and concrete grout is used, it may be placed by gravity through a grout pipe installed to the bottom of the annular opening in one continuous operation until the annular opening is filled.
5. When the annular opening exceeds six inches, is less than 100 feet in depth, and a clay seal is used, it may be placed by gravity.
6. After cement grouting is applied, work on the well shall be discontinued until the cement or concrete grout has properly set.
7. Grout placement must be sufficient to achieve proper density or percent solids throughout the annular space.

f. Guides

The casing shall be provided with sufficient guides welded to the casing to center the casing in the drill hole, prevent displacement of the casing and still permit unobstructed flow and uniform thickness of grout.

3.2.4.10 Upper terminal well construction

- a. Permanent casing for all groundwater sources shall project at least 12 inches above the pumphouse, well platform floor or concrete apron surface and at least 18 inches above final ground surface.
- b. Where a well house is constructed, the floor surface shall be at least six inches above the final ground elevation.
- c. Sites subject to flooding shall be provided with an earth mound to raise the pumphouse floor to an elevation at least two feet above the highest known flood elevation, or other suitable protection as determined by the reviewing authority.
- d. The top of the well casing at sites subject to flooding shall terminate at least three feet above the 100 year flood level or the highest known flood elevation, whichever is higher, or as the reviewing authority directs.
- e. Protection from physical damage shall be provided as required by the reviewing authority.
- f. The upper terminal shall be constructed to prevent contamination from entering the well.
- g. Where well appurtenances protrude through the upper terminal, the connections to the upper terminus shall be mechanical or welded connections that are water tight.

## 3.2.4.11 Development

- a. Every well shall be developed to remove the native silts and clays, drilling mud or finer fraction of the gravel pack.
- b. Development should continue until the maximum specific capacity is obtained from the completed well.
- c. Where chemical conditioning is required, the specifications shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors.
- d. Where blasting procedures may be used, the specifications shall include the provisions for blasting and cleaning. Special attention shall be given to assure that the grouting and casing are not damaged by the blasting.

## 3.2.4.12 Disinfection of every new, modified or reconditioned groundwater source:

- a. shall be provided after completion of work, if a substantial period elapses prior to test pumping or placement of permanent pumping equipment, and;
- b. shall be provided after placement of permanent pumping equipment;
- c. shall be done in accordance with AWWA C654 or method approved by the reviewing authority.

## 3.2.4.13 Capping requirements

- a. All wells, temporary or permanent, shall be effectively located/sealed against the entrance of water and contaminants.
- b. A welded metal plate or a threaded cap is the preferred method for capping a well.
- c. At all times during the progress of work, the contractor shall provide protection to prevent tampering with the well or entrance of foreign materials.

## 3.2.4.14 Well abandonment

- a. Test wells and groundwater sources which are not in use shall be sealed by such methods as necessary to restore the controlling geological conditions which existed prior to construction or as directed by the appropriate regulatory agency.
- b. Wells to be abandoned shall:
  1. be sealed to prevent undesirable exchange of water from one aquifer to another;
  2. preferably be filled with neat cement grout;
  3. have fill materials other than cement grout or concrete, disinfected and free of foreign materials, and;
  4. when filled with cement grout or concrete, these materials shall be applied to the well hole through a pipe, tremie, or bailer.

### 3.2.5 Testing and records

#### 3.2.5.1 Yield and drawdown tests

- a. A yield and drawdown test shall be conducted in accordance with a protocol pre-approved by the reviewing authority.
- b. The test shall be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump.
- c. The test methods shall be clearly indicated in the project specifications.
- d. The test pump should have a capacity at least 1.5 times the flow anticipated at maximum anticipated drawdown.
- e. The test shall provide, as a minimum, for continuous pumping for at least 24 hours at the design pumping rate or until stabilized drawdown has continued for at least six hours when test pumped at 1.5 times the design pumping rate, or as required by the reviewing authority.
- f. The following data shall be submitted to the reviewing authority:
  1. test pump capacity-head characteristics;
  2. static water level;
  3. depth of test pump setting;
  4. time of starting and ending each test cycle, and;
  5. the zone of influence for the well or wells.
- g. A report shall be submitted which provides recordings and graphic evaluation of the following at one hour intervals or less as may be required by the reviewing authority:
  1. pumping rate;
  2. pumping water level;
  3. drawdown, and;
  4. water recovery rate and levels.
- h. At the discretion of the reviewing authority, more comprehensive testing may be required.

#### 3.2.5.2 Plumbness and alignment requirements

- a. Every well shall be tested for plumbness and alignment in accordance with AWWA Standards.
- b. The test method and allowable tolerance shall be clearly stated in the specifications.
- c. If the well fails to meet these requirements, it may be accepted by the engineer if it does not interfere with the installation or operation of the pump or uniform placement of grout.

## 3.2.5.3 Geological data shall:

- a. be determined from samples collected at 5-foot intervals and at each pronounced change in formation;
- b. be recorded and samples submitted to the appropriate authority;
- c. be supplemented with a driller's log, accurate geographical location such as latitude and longitude or GIS coordinates, and other information on accurate records of drill hole diameters and depths, assembled order of size and length of casing, screens and liners, grouting depths, formations penetrated, water levels, and location of any blast charges.

## 3.2.5.4 Retention of records

The owner of each well shall retain all records pertaining to each well, until the well has been properly abandoned.

## 3.2.6 Aquifer types and construction methods -- Special conditions

## 3.2.6.1 Sand or gravel wells

- a. If clay or hard pan is encountered above the water bearing formation, the permanent casing and grout shall extend through such materials or at least 25 feet below the original ground elevation, whichever is lower
- b. If a sand or gravel aquifer is overlaid only by permeable soils the permanent casing and grout shall extend to at least 25 feet below original or final ground elevation, whichever is lower. Excavation of topsoil around the well casing should be avoided.
- c. If a temporary or a surface casing is used, it shall be completely withdrawn

## 3.2.6.2 Gravel Pack Material

- a. Gravel pack materials shall:
  1. be sized based on sieve analysis of the formation;
  2. be well-rounded particles, 95 percent siliceous material, that are smooth and uniform, free of foreign material, properly sized, washed and then disinfected immediately prior to or during placement.
- b. Gravel pack
  1. Gravel pack shall be placed in one continuous operation.
  2. Gravel pack shall be placed in a manner that prevents segregation and gradation during placement.
  3. The annular space between the well screen and the hole shall be to allow proper placement of gravel pack.
  4. Gravel refill pipes, when used, shall be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 12 inches above the pump house floor.

5. Gravel refill pipes located in the grouted annular opening shall be surrounded by a minimum of 1 ½ inches of grout.
  6. Gravel pack shall extend above the highest well screen with an allowance for settling.
  7. Protection from leakage of grout into the gravel pack or screen shall be provided.
  8. Permanent inner casing and outer casings shall meet requirements of subparagraph 3.2.5.4.
- c. Minimum casing and grouted depth shall be acceptable to the reviewing authority.

#### 3.2.6.3 Radial water collector

- a. Locations of all caisson construction joints and porthole assemblies shall be indicated.
- b. The caisson wall shall be reinforced to withstand the forces to which it will be subjected.
- c. Radial collectors shall be in areas and at depths approved by the reviewing authority.
- d. Provisions shall be made to assure that radial collectors are essentially horizontal.
- e. The top of the caisson shall be covered with a watertight floor.
- f. All openings in the floor shall be curbed and protected from entrance of foreign material.
- g. The pump discharge piping shall not be placed through the caisson walls. In unique situations where this is not feasible, a water tight seal must be obtained at the wall.

#### 3.2.6.4 Infiltration lines

- a. Infiltration lines should be considered only where geological conditions preclude the possibility of developing an acceptable drilled well.
- b. The area around infiltration lines shall be under the control of the water purveyor for a distance acceptable to or required by the reviewing authority.
- c. Flow in the lines shall be by gravity to the collecting well.
- d. Water from infiltration lines shall be considered as groundwater under the direct influence of surface water unless demonstrated otherwise.

#### 3.2.6.5 Limestone or sandstone wells

- a. Where the depth of unconsolidated formations is more than 50 feet, the permanent casing shall be firmly seated in uncreviced or unbroken rock. Grouting requirements shall be determined by the reviewing authority.
- b. Where the depth of unconsolidated formations is less than 50 feet, the depth of casing and grout shall be at least 50 feet or as determined by the reviewing authority.

## 3.2.6.6 Naturally flowing wells

- a. Naturally flowing wells shall require special consideration by the reviewing authority where there is an absence of an impervious confining layer.
- b. Flow shall be controlled. Overflows shall discharge at least 18 inches above grade and flood level, and be visible. Discharge shall be to an effective drainage structure.
- c. Permanent casing and grout shall be provided.
- d. If erosion of the confining bed appears likely, special protective construction may be required by the reviewing authority.

## 3.2.7 Well pumps, discharge piping and appurtenances

## 3.2.7.1 Line shaft pumps

Wells equipped with line shaft pumps shall:

- a. have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least one-half inch into the pump base;
- b. have the pump foundation and base designed to prevent water from coming into contact with the joint, and;
- c. avoid the use of oil lubrication at pump settings less than 400 feet. Lubricants must meet ANSI/NSF Standard 61 or be approved by the reviewing authority.

## 3.2.7.2 Submersible pumps

Where a submersible pump is used:

- a. the top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables, and;
- b. the electrical cable shall be firmly attached to the riser pipe at 20 foot intervals or less.

## 3.2.7.3 Discharge piping

- a. The discharge piping shall:
  1. be designed to minimize friction loss;
  2. have control valves and appurtenances located above the pumphouse floor when an above-ground discharge is provided;
  3. be protected against the entrance of contamination;
  4. be equipped with a check valve in or at the well, a shutoff valve, a pressure gauge, and a means of measuring flow;
  5. be equipped with a smooth nosed sampling tap located at a point where positive pressure is maintained, but before any treatment chemicals are applied. The sample

tap shall be at least 18-inches above the floor to facilitate sample collection.

6. where applicable, be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust/relief piping terminating in a down-turned position at least 18 inches above the floor and covered with a 24 mesh corrosion resistant screen;
  7. be valved to permit test pumping and control of each well;
  8. have all exposed piping, valves and appurtenances protected against physical damage and freezing;
  9. be properly anchored to prevent movement, and be properly supported to prevent excessive bending forces;
  10. be protected against surge or water hammer;
  11. conform to the latest standards issued by the ASTM, AWWA and ANSI/NSF, where such standards exist, or in the absence of such standards, conform to applicable product standards and be acceptable to the reviewing authority;
  12. be constructed so that it can be disconnected from the well or well pump to allow the well pump to be pulled.
- b. The discharge piping should be provided with a means of pumping to waste, but shall not be directly connected to a sewer.
- c. For submersible, jet and line shaft pumps, the discharge, drop or column piping inside the well shall:
1. conform to the latest standards issued by the ASTM, AWWA and ANSI/NSF, where such standards exist, or in the absence of such standards, conform to applicable product standards and be acceptable to the reviewing authority. Any lubricants, fittings, brackets, tape or other appurtenances shall meet ANSI/NSF Standards 60/61, where applicable;
  2. be capable of supporting the weight of the pump, piping, water and appurtenances and of withstanding the thrust, torque and other reaction loads created during pumping. The actions of fatigue from repeated starting and stopping of the pump shall be considered when choosing a pipe and fittings;
  3. be fitted with guides or spacers to center piping and well pump in the casing.

#### 3.2.7.4 Pitless well units

- a. The reviewing authority must be contacted for approval of specific applications of pitless units.
- b. Pitless units shall:
  1. be shop-fabricated from the point of connection with the well casing to the unit cap or cover;
  2. be threaded or welded to the well casing;

3. be of watertight construction throughout;
  4. be of materials and weight at least equivalent and compatible to the casing;
  5. have field connection to the lateral discharge from the pitless unit of threaded, flanged or mechanical joint connection, and;
  6. terminate at least 18 inches above final ground elevation or three feet above the 100 year flood level or the highest known flood elevation, whichever is higher, or as the reviewing authority directs.
- c. The design of the pitless unit shall make provision for:
1. access to disinfect the well;
  2. a properly constructed casing vent meeting the requirements of Section 3.2.7.6;
  3. facilities to measure water levels in the well (see Section 3.2.7.7);
  4. a cover at the upper terminal of the well that will prevent the entrance of contamination;
  5. a contamination-proof entrance connection for electrical cable;
  6. an inside diameter as great as that of the well casing, up to and including casing diameters of 12 inches, to facilitate work and repair on the well, pump, or well screen, and;
  7. at least one check valve within the well casing or in compliance with requirements of the reviewing authority.
- d. If the connection to the casing is by field weld, the shop-assembled unit must be designed specifically for field welding to the casing. The only field welding permitted will be that needed to connect a pitless unit to the casing.

#### 3.2.7.5 Pitless Adapters

Pitless adapters may be acceptable at the discretion of the reviewing authority. The use of any pitless adapter must be pre-approved by the reviewing authority.

#### 3.2.7.6 Casing vent

Provisions shall be made for venting the well casing to atmosphere. The vent shall terminate in a downturned position, at or above the top of the casing or pitless unit, no less than 12 inches above grade or floor, in a minimum 1½ inch diameter opening covered with a 24 mesh, corrosion resistant screen. The pipe connecting the casing to the vent shall be of adequate size to provide rapid venting of the casing. Where vertical turbine pumps are used, vents into the side of the casing may be necessary to provide adequate well venting; installation of these vents shall be in accordance with the requirements of the reviewing authority.



## 3.2.7.7 Water level measurement

- a. Provisions shall be made for periodic measurement of water levels in the completed well.
- b. Where pneumatic water level measuring equipment is used it shall be made using corrosion-resistant materials attached firmly to the drop pipe or pump column and in such a manner as to prevent entrance of foreign materials.

## 3.2.7.8 Observation wells

shall be:

- a. constructed in accordance with the requirements for permanent wells if they are to remain in service after completion of a water supply well, and;
- b. protected at the upper terminal to preclude entrance of foreign materials.

## 3.2.7.9 Liners

Liners may be acceptable at the discretion of the reviewing authority. The use of any liner must be pre-approved by the reviewing authority.

Table I  
STEEL PIPE

SIZE	DIAMETER (inches)		THICKNESS (inches)	WEIGHT PER FOOT (pounds)	
	EXTERNAL	INTERNAL		PLAIN ENDS (calculated)	WITH THREADS AND COUPLINGS (nominal)
6 id.	6.625	6.065	0.280	18.97	19.18
8	8.625	7.981	0.322	28.55	29.35
10	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 od.	14.000	13.250	0.375	54.57	57.00
16	16.000	15.250	0.375	62.58	
18	18.000	17.250	0.375	70.59	
20	20.000	19.250	0.375	78.60	
22	22.000	21.000	0.500	114.81	
24	24.000	23.000	0.500	125.49	
26	26.000	25.000	0.500	136.17	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	31.000	0.500	168.21	
34	34.000	33.000	0.500	178.89	
36	36.000	35.000	0.500	189.57	