



## Natural Resources Conservation Service

### CONSERVATION PRACTICE STANDARD

## WATER WELL

### CODE 642

(no)

#### DEFINITION

A hole drilled, dug, driven, bored, jetted, or otherwise constructed into an aquifer for water supply.

#### PURPOSE

This practice is used to accomplish the following purpose:

- To provide access to a groundwater supply suitable for livestock watering, fire control, wildlife, and other agricultural uses

#### CONDITIONS WHERE PRACTICE APPLIES

#### CRITERIA

##### General Criteria Applicable to All Purposes

##### Law and regulations

The investigation, design, and installation of an agricultural water supply well must comply with all applicable governmental regulations, laws, permits, licenses, and registrations. In particular, federal law requires:

- A proposed well that has a domestic usage component must comply with criteria in *ANSI/AWWA American National Standard, A100-06, 2007*;
- A proposed irrigation well must comply with criteria in *ANSI/ASAE American National Standard, EP400.3, 2007*;
- The well design and installation must follow applicable industry consensus standards;
- Potential effects of installation and operation of the well on cultural, historical, archeological, paleontological, or scientific resources at or near the site need to be investigated.

Colorado statutes govern the use of underground water. Well planning, design, and installation shall be in accordance with the most recent version of the State of Colorado 2 CCR 102-2 "Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction" (WWCR) as set forth by the State of Colorado – State Board of Examiners.

It is the responsibility of the landowner to comply with all Federal, State, Tribal, and local laws. The landowner is responsible for obtaining all permits and water rights.

##### Suitability of Site

Use reliable local experience and all available relevant geologic maps, reports, and well records maintained by State and Federal agencies. Review design, construction, and maintenance records of nearby wells to help determine whether groundwater is available in sufficient quantity and of the desired quality for the intended use. If local hydrogeologic data are limited or if conditions are complex and

uncertain, use additional expertise to conduct on-site evaluation and to provide professional recommendations regarding the suitability of the site.

Do not locate the well near overhead and underground utility lines and other safety hazards.

If site conditions allow, locate the well up- gradient from potential sources of surface contamination and away from areas subject to flooding. In determining gradient, consider both pumped and static conditions.

Clear the site of all trees, brush, and obstructions and provide a relatively flat, reasonably dry, working surface for the drill rig and related equipment to ensure a safe and effective working environment.

Refer to WWCR Rules 10.1 and 10.2 for additional siting criteria. Wells shall not be located closer than one hundred (100) feet horizontally to the nearest source of contaminants or fifty (50) feet from a septic tank, sewer line or other vessel containing contaminants. A variance is required if the above requirements cannot be met from the Board of Examiners of Water Well Construction and Pump Installation Contractors. In no case shall the horizontal distance be less than twenty- five (25) feet.

Determine if the site is in a Colorado designated groundwater basin and follow the WWCR rules.

### **Wellhead Protection**

Divert all surface runoff, precipitation, and drainage away from the wellhead. At the wellhead, compact, mound, and slope earth material away from the wellhead.

Protect the wellhead and associated appurtenances from contamination or damage by wildlife, livestock, farm machinery, vehicle parking, or other harmful human activity.

Locate the well at least 100 feet from potential sources of surface and subsurface pollution.

### **Well Borehole and Installation**

The borehole shall be sufficiently round, straight, and adequate diameter to permit satisfactory installation of inlet, well casing, filter pack, annular seal, and passage of tremie pipe (including couplings), if used.

See WWCR Rule 10.4 for construction installation requirements.

### **Casing Diameter**

Casing diameter shall be sized to permit satisfactory installation and efficient operation of the pump, and large enough to assure that up-hole velocity in the water supply pipe is 5 feet per second or less for

the designed discharge to protect against excessive head loss. In no instance shall the outside diameter of the casing be less than four and one-half (4.5) inches. See WWCR Rule 10.3

### **Grouting and Sealing the Casing**

Hard rock formations or physically stable geologic materials may not require casing except for the uppermost 10 feet.

If drilling encounters erodible, friable, or otherwise unstable material, install watertight, grouted casing throughout, with the exception of the intake portions.

Provide a watertight seal in the annulus of all well casing. Acceptable sealants include mortar containing expansive hydraulic cement, bentonite-based grout, bentonite chips and pellets, sand-cement grout, neat cement, or concrete. See WWCR Rule 10.5 for approved grouts. The length of grout seal shall be no less than 10 feet and not less than minimum specified in state or locally applicable construction codes. See WWCR Rule 10.4 for grouting requirements for the specific type of aquifer.

If one or more zones are encountered that produce water of unacceptable quality, use grout or packers to prevent comingling of waters or cross-contamination of aquifers.

Provide a packer, or similar retaining device, or a small quantity of sealant between the casing and the less pervious material overlying the aquifer of artesian wells. Provide a similar positive seal to separate water bearing zones where co-mingling of waters is undesirable.

For artesian conditions, seal the confining geologic units directly above and below the aquifer in such a manner as to retain its confining pressure.

If casing extends to the bottom of the drill hole, install a watertight end cap or grout seal to prevent entry of geologic material into the well from the bottom.

When the design requires telescoped screen assemblies, install one or more sand-tight seals between the top of the telescoped screen assembly and the casing.

Do not design maximum drawdown to reach the top of the highest screen or pump intake.

Upon completion, provide a suitably threaded, flanged, or welded cap or compression seal to prevent entry of contaminants into the well.

The casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions from the casing to prevent contamination. The slab shall slope away from well.

### **Casing Materials**

Acceptable materials for casing include steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete or other material of equivalent strength and which has sufficient chemical resistance to the groundwater for the design life of the well. To prevent galvanic corrosion, do not join dissimilar metals.

Use only steel pipe casing in driven wells.

Select a casing diameter to permit satisfactory installation and efficient operation of a submersible pump, if used.

Select casing material that can withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development, and use throughout the design life of the well. Refer to NEH 631.3200, Water Well Design, for guidance in determining proper differential head limitations for approved casing materials.

Ensure well casing joints have adequate strength to carry the weight of casing throughout its length while maintaining a watertight seal. If needed, mechanically support the casing during installation to maintain joint integrity. Terminate mechanically supported casings on material that can adequately support the casing weight.

Well casing shall consist of materials which will ensure adequate protection against failure for the intended use of the well. All casing shall be new or unused pipe, except that casing recovered when a well is modified or replaced may be reused in the new well if it will ensure satisfactory well performance. All surface casing shall be steel pipe and may be used pipe if it is undamaged, free of pits and corrosion, and has been decontaminated. Used oilfield pipe shall not be installed in any well (See WWCR Rule 10.3).

All casing wall thickness shall be adequate to prevent collapse due to hydrostatic pressures. The following minimum wall thickness shall be applicable to well casings:

1. Steel well casing – 0.188 inches
2. PVC well casing – 0.200 inches
3. Precast concrete rings – 3.00 inches (WWCR Rule 10.3).

Steel well casings shall meet or exceed requirements specified in ASTM A 589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A 589. Only steel pipe casings shall be used in driven wells.

To prevent galvanic corrosion, dissimilar metals shall not be joined in direct contact.

Plastic casings and joints made of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.

Plastic pipe manufactured for water or irrigation pipelines may be used if the quality equals or exceeds requirements specified in ASTM F 480.

Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting-resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing.

Fiberglass pressure pipe (also called reinforced plastic mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517.

### **Screen and Filter Pack**

Use a screen and filter pack (also called gravel pack) if any of the following conditions exist:

- Presence of a poorly graded, fine sand aquifer or heaving or caving sands;
- Presence of a highly variable aquifer, such as alternating sand and clay layers;
- Presence of a poorly cemented sandstone or other loosely compacted material;
- Requirement for maximum yield from a low-yielding aquifer;
- Aquifer material likely to produce silt or sand;
- Holes drilled by reverse circulation.

If acceptable filter materials are unavailable, use a commercially manufactured, pre-packed well screen. A pre-packed well screen consists of inner and outer screens that contain the engineered filter material. The material must meet the following quality criteria:

- Less than five percent fines (the proportion that passes the number 200 sieve);
- Predominantly rounded, dense, siliceous materials;
- No angular particles, such as crushed rock, or flat particles, such as mica;
- No earthy or soft materials, such as clay, shale, silt, gypsum, or anhydrite;
- No organic matter, no other impurities or metallic substances;
- No material soluble in hydrochloric acid, such as limestone.

Use a pre-packed well screen for horizontal or angled wells.

Position the well screen according to the depth of the water-bearing zone(s) below the ground surface and the thickness of the water-bearing zone penetrated by the drill hole. Install a conventional filter pack from the bottom up and place in a manner that avoids segregation and bridging of particles.

Screen perforation by any method is allowable with the following provisions:

- For uniform size aquifer material, screen openings are smaller than the average diameter of aquifer material;
- For non-uniform aquifer material, screen openings are smaller than 60 percent of the aquifer material;
- Screen openings, for filter/gravel pack must exclude at least 85 percent of the filter pack material;
- Size the length and open area of the screen to keep entrance velocity or shear stress below the threshold for erosion of filter pack particles and transport into the well;

- Casing must not be functionally weakened or deformed.

For a screened well cased to the bottom of the well, install several extra feet of blank screen or casing at the bottom of the well to accommodate sediment that passes through the well screens and settles to the bottom of the well.

The filter pack material shall be limited to the producing aquifer and shall not extend to the ground surface (WWCR Rule 10.4.11).

#### **Access Port**

Install an access port with a minimum diameter of 0.5 inch to allow for unobstructed measurement of depth of the water surface, or for the installation of a pressure gage for measuring shut-in pressure of a flowing well.

Seal or cap access ports, pressure gages, and all other openings in the well cover to prevent entry of unwanted materials and to discourage tampering. A removable cap is acceptable for an access port.

#### **Water Development**

After completion of well construction, ensure that the well is developed. Well development is required regardless of whether the well is finished in unconsolidated materials or hard rock aquifers. Use one or more development techniques to effectively loosen and remove silt, fine sand, drill cuttings, drilling muds, or additives deposited by the drilling operation on the uncased borehole face and in adjacent portions of the aquifer. For screened zones, the development technique must collapse sand bridges and remove fines outside the screen. Following the development process, remove accumulated sediment at the bottom of the well bore by bailing or pumping.

Pump the well at approximately 120 percent of the anticipated normal production rate until suspended sediment and associated turbidity clears. Do not use the permanent pump to conduct any well development work.

Refer to NEH 631.32 for guidance on various well development techniques. Refer to WWCR Rule 10 for well development.

Fluids resulting from well construction, development or disinfection shall not be discharged into the waters of the state without first obtaining a permit pursuant to the Colorado Discharge Permit System (CDPS) administered by the Colorado Department of Public Health and Environment (per WWCR Rule 6.8).

#### **Water Well Testing**

If local water quality conditions are unknown or questionable, test the well water using parameters that pertain to well performance or the suitability of the water for its intended usage. Test well water according to NRCS CPS *Groundwater Testing (Code 355)*.

#### **Well performance Testing**

After completion of well construction and the water level is stable, conduct a pump test to determine specific

capacity and dynamic water level. Record the length of test and pumping rate. Determine if the flow rate is adequate for the intended use. A performance curve for the well may need to be developed for a large flow well (WWCR Rule 12).

#### **Disinfection**

Prior to final chemical disinfection, remove foreign substances, such as grease, soil, sediment, joint dope, and scum from the well and near the wellhead. Clean all pump parts before placing them into the well.

Disinfect the well using a chlorine compound at a concentration of no less than 100 mg/L (100 ppm) available chlorine in solution to treat the entire well. The disinfection process shall comply with all Local and State requirements. See WWCR Rule 15 for minimum disinfectant standards.

## CONSIDERATIONS

Consider evaluating the potential for adverse interference with existing nearby production wells when planning and designing the water well.

In planning, consider the potential for groundwater overdraft and the long-term safe yield of the aquifer.

Consider the watering facility a potential source of contamination and if the site conditions allow, place the well up-gradient of the water facility.

## PLANS AND SPECIFICATIONS

Develop plans and specifications that clearly describe requirements for applying the practice to achieve its intended purpose(s). If not already specified in the documentation required by the State regulatory authority, record the following information in the installation record:

- Location of water well by Global Positioning System (GPS) coordinates or in a sufficiently detailed narrative description to readily locate the well
- Record the Colorado permit number or other authorization of construction
- Name of well owner
- Name, title, and address of person responsible for drilling the water well
- Type of casing material or schedule, and whether new or used
- Height of casing extending above ground surface
- Static water level measured from top edge of casing or from ground surface
- Notification of whether aquifer is artesian or non-artesian. If well is flowing artesian, provide flow rate and pressure
- Well development method(s) used
- Results of pump test including length of test, stability of water level, pumping rate, and specific capacity after water level had stabilized, if needed.
- Driller's log (include Colorado permit number, date of completion of water well, total depth of water well, specific of well, length of casing and screening, inside diameter of well bore or casing; type, amount, and concentration amount of disinfection agent; and lithologic log of the geology and a geophysical log if required by the permit (WWCR Rule 17)
- If water quality was tested, record the parameters and test results, date of sampling, name of person who took sample, and name of laboratory that conducted tests.
- A Well Report shall be submitted to the Colorado State Engineer per WWCR.
- If water quality is tested a water quality report shall be submitted to the Colorado State Engineer per WWCR.

## OPERATION AND MAINTENANCE

Prepare a plan for operation and maintenance of the water well. The owner is responsible for keeping and maintaining well construction records with the maintenance plan. The owner must ensure periodic inspection of the well for proper functioning and water quality.

Ensure no agricultural chemicals, such as fertilizers and pesticides, are stored or mixed or containers rinsed within a 100-foot radius of the wellhead.

The inspection must include conditions that affect well performance as designed for the water use. As a minimum, these conditions include:

- Declines in discharge, static level, maximum pumping level, and pressure (for artesian wells) that are outside acceptable limits for the well design
- Appearance of sediment that may damage the well, pump, or appurtenances

- Changes in water quality including odor, color, taste, and chemistry
- Presence of algae or iron bacteria

For screen wells that have blank casing installed at the bottom, periodically bail or flush the well to remove excessive, accumulated sediment.

In the maintenance record, include statements describing identified problems, corrective action taken and date, and specific capacity of well before and after corrective action. The owner must remedy unacceptable conditions in a timely manner.

In the event the well becomes unserviceable, it may be decommissioned according to NRCS CPS *Well Decommissioning* (Code 351).

## REFERENCES

American Society for Testing and Materials:

ASTM A589/A589M, "Seamless and Welded Carbon Steel Water-Well Pipe"

ASTM D2996, "Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe"

ASTM D3517, "Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe"

ASTM F480, "Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80"

ANSI/ASAE American National Standard *EP400.3, 2007, Designing and Constructing Irrigation Wells.*

ANSI/AWWA American National Standard,

*A100-06, 2007, Standard for Water Wells.*

State of Colorado- Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction (Water Well Construction Rules) 2 CCR 402-2 (available on the web: <http://water.state.co.us/DWRIPub/Documents/constructionrules05.pdf> (accessed December 2014)).

Publications from the Colorado Division of Water Resources, Office of the State Engineer, (<http://water.state.co.us/>), include the following:

- The Beginner's Guide to Augmentations Plans for Wells
- Determining Your Well Location
- Determine if you are in a designated ground water basin
- New Well Permits
- Guide to Well Permits, Water Rights, and Water Administration.
- Well Permitting Forms

USDA, NRCS, Conservation Engineering Division, National Engineering Handbook, Geology, 631.32, Water Well Design.

USDA, NRCS, Conservation Engineering Division, Agricultural Waste Management Field Handbook 651.01, Laws, Regulations, Policy, and Water Quality Criteria.