



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

This practice applies to all types of agricultural land where the quality and quantity of underground water is appropriate for the intended purpose.

This practice does not apply to wells constructed solely for domestic or public water supply. It does not apply to wells installed solely for monitoring or observation purposes (use NRCS Conservation Practice Standard (CPS) *Monitoring Well (Code 353)*), injection wells, temporary test wells, or piezometers.

This practice does not apply to pumps, surface supply lines, storage facilities, and related appurtenances.

CRITERIA

General Criteria Applicable to All Purposes

Laws 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.

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.

An NRCS Geologist or qualified person as defined in National Engineering Handbook Part 531 Subpart A shall prepare the report.

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.

Particular attention must be given to avoid petroleum and natural gas pipelines, buried electrical and fiber optic cables, overhead power and telephone lines, and other utilities.

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. *The level of protection of at least the 25-year, 24-hour storm event is required.*

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.

*Wells shall be located at safe distances from potential sources of pollution, including unsealed abandoned wells. The allowable distance shall be based on consideration of site-specific hydro- geologic factors and shall comply with requirements of all applicable local, State, Tribal, or Federal regulations or construction codes. **Table 1** shows the minimum setback requirements for New Mexico for the installation of wells.*

Table 1 Minimum Horizontal Distance from Well Head and Potential Contamination Source(s)

Potential Contamination Source	Minimum Distance
Agricultural Waste Facility	300
Cesspool	150
Silo Pit, Seepage Pit	150
Livestock and Poultry Yards	100
Manure Pile, Privy	100
Septic Tank and Disposal Field	100

Wells shall be located a safe distance from both overhead and underground utility lines and other safety hazards.

Borehole

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

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 *in accordance with State requirements. The length of the grout seal shall be no less than 20 feet and not less than the minimum specified in state or locally applicable construction codes.*

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.

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. *Materials shall be of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing, using depth and material tables.*

Asbestos cement pipe shall not be used. 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.

Plastic casings 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.

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. Joints shall meet requirements specified in section 3.8, ASTM F 480.

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.

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.

Casing diameter shall be sized to permit satisfactory installation and efficient operation of the pump, and large enough to assure that uphole velocity is 5 feet per second or less for the designed discharge to protect against excessive head loss. 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.

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;
- 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.

The screen shall be constructed with the slot width determined from aquifer samples. Perforation by any method is allowable provided proper slot size and entrance velocity limits can be met. Screen open areas can range from 1 percent for field-perforated screens to 25 percent or more for continuous wire-wrapped screens. To assure good well efficiency, open

areas should be designed to approximate aquifer porosity. High percentages of open area also make well development more effective.

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.

Maximum drawdown shall not be permitted below the top of the highest screen or pump intake.

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.

A conservative water well design will have a well screen entrance velocity of about 0.1 foot per second, which has been the common industry standard for many years. The American Water Works Association (AWWA) Standard A-100-06, however, no longer stipulates a maximum screen entrance velocity and cites recent research and testing that indicate that allowable well screen velocities are a function of the aquifer characteristics, the overall well design and intended performance, and the quality of the groundwater being pumped. For the purposes of this standard, the maximum recommended entrance velocity shall be less than or equal to 0.7 foot per second.

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.

Installation

Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen. All wells shall be cased to a sufficient height (minimum of 18 inches) above the ground surface to prevent entry of surface and near- surface water.

Casing for artesian aquifers shall be sealed into overlying, impermeable formations in such a manner as to retain confining pressure. If a zone is penetrated that is determined or suspected to contain water of quality unsuitable for the intended use, the zone shall be sealed to prevent infiltration of the poor-quality water into the well and the developed portion of the aquifer.

Water well drillers shall adhere to all State licensing requirements and regulations.

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.

Well 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. *The method of well development used shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.* 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.

Well Water 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)*.

Aquifer Development

For massive, unfractured rock that is unresponsive to well development procedures, the use of aquifer stimulation techniques may be considered to improve well efficiency and specific capacity. Techniques may include dry ice, acidizing, explosives, or hydrofracturing, depending on the composition and structure of the formation.

Grouting and Sealing

The minimum 2-inch annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, or bentonite chips and pellets, in accordance with State requirements. The length of the grout seal shall be no less than 20 feet and not less than the minimum specified in state or locally applicable construction codes.

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. *Adequate contact time shall be allowed for the disinfectant to sanitize the equipment before rinsing (laboratory testing will not be required).*

Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all Local or State requirements.

Water Quality Testing

Sampling and testing shall comply with all applicable Federal, State and Local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water. (See 355 - Water Well Testing)

CONSIDERATIONS**General 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.

If practicable, wells shall be located in higher ground and up-gradient from sources of surface contamination or flooding. In determining gradient, both pumped and unpumped conditions should be considered.

Potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site should be considered in planning.

Fencing of the well and associated equipment should be considered to prevent contamination and damage by wildlife, livestock, or human activity

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.

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
- Name of well owner (*land owner*)
- 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
- 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.
- *Date of completion of the water well*
- *Name, title, and address of person responsible for the water well*
- *Total depth of the water well*
- *Length of casing and screening*
- *Inside diameter of well bore or casing*
- *Water chemistry before and after disinfection*
- *Copy of the Geologist's well feasibility report*

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 ft. 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

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.

National Engineering Handbook, Part 531, Geology

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.*