

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
ARIZONA**

WATER WELL

(No.)

CODE 642

DEFINITION

A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer.

including test well drilling, is conducted on-site, as needed, prior to well construction to determine site-specific hydrogeologic conditions.

PURPOSE

- Provide water for livestock, wildlife, irrigation, human, and other uses.
- Provide for general water needs of farming/ranching operations.
- Facilitate proper use of vegetation on rangeland, pastures and wildlife areas.

The site shall be suitable for safe operation of the drilling equipment.

Well Head Protection. 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 hydrogeologic factors and shall comply with requirements of all applicable state or local regulations or construction codes.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on all land uses where the underground supply of water is sufficient in quantity and quality for the intended purpose.

Surface runoff and drainage that might reach the wellhead from potential areas of contamination, such as those used by livestock, shall be diverted.

This practice applies only to production wells. Specifically excluded are any types of wells installed solely for monitoring or observation purposes; injection wells; and piezometers. The standard does not apply to pumps installed in wells; above ground installations, such as pumping plants, pipelines, and tanks; temporary test wells; and decommissioning of wells (ASTM D5299).

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

CRITERIA

Suitability of Site. The availability of ground water for its intended use at the site shall be determined by using reliable local experience and reviewing all available relevant geologic maps and reports; well records maintained by state and federal agencies; and design, construction, and maintenance records of nearby wells. An appropriate level of investigation,

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.

Use of Casing. Casing shall be installed to seal out undesirable surface or shallow ground water and to support the side of the hole through unstable earth materials. The intake portion of a well through stable geologic materials may not require casing.

Casing Diameter: 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, to protect against excessive head loss.

Materials. Casings may be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete or other material 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.

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.

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.

If the water is to be used for human consumption, plastic pipe shall be approved by the National Sanitation Foundation.

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. 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.

Casing Strength. Well casing wall thickness shall be sufficient to withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development and use. Required casing strength shall be determined as shown in NEH Part 631, Chapter 33, Investigations for Ground Water Resources Development.

Joint Strength. Joints for well casings shall have adequate strength to carry the load due to the casing length and still be watertight, or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Screen. Well screens shall be installed in any aquifer material likely to produce silt or sand. Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections.

The screen shall be constructed with the slot width determined from aquifer samples (Part 631, NEH, Chapter 33). 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 open area percentages also make well development more effective. The length and open area of the screen shall be sized to limit entrance velocity of water into the well to less than or equal to 0.1 foot per second (Part 631, NEH, Chapter 33, Example 33-2).

Depth of the aquifer below ground surface and the thickness of aquifer to be penetrated by the well shall govern the position of the screen in the well.

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

Seals (Packers). Telescoped screen assemblies shall be provided with one or more sand-tight seals between the top of the telescoped screen assembly and casing.

Filter Pack. Installation of a filter pack around the well screen shall be considered under the following conditions: presence of a poorly graded, fine sand aquifer; presence of a highly variable aquifer, such as alternating sand and clay layers; presence of a poorly cemented sandstone or similar aquifer; a requirement for maximum yield from a low-yielding aquifer; and holes drilled by reverse circulation.

Pre-packed Well Screens. For heaving or caving sands, silty or fine-grained aquifers, and for horizontal or angled wells, a commercial pre-packed well screen may be substituted for a conventionally installed (by tremie) filter pack.

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 12 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.

Well Development. Well development shall be performed to repair damage done to the formation by the drilling process, and to alter the physical characteristics of the aquifer

surrounding the borehole so that water will flow more freely to the well.

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

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 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), or bentonite-based grout. The length of the grout seal shall be no less than 10 feet and not less than the minimum specified in state or locally applicable construction codes.

If the water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions.

A positive seal (grouted in place) or packer shall be provided between the casing and the less pervious material overlying the aquifer of artesian wells, and in all aquifers where commingling of waters is undesirable.

Access Port. An access port with a minimum diameter of 0.5 inch shall be installed to allow for unobstructed measurement of depth of the water surface, or for a pressure gage for measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of surface water or foreign material into the well. Removable caps are acceptable as access ports.

Disinfection. 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.

Arizona Criteria Applicable to all Purposes

Well Head Protection. Arizona Department of Water Resources (ADWR) criteria prohibits a well from being drilled within 100-feet of any septic system, sewage disposal area, landfill, hazardous waste facility, storage area of hazardous materials or petroleum storage areas and tanks.

Materials. Only steel or thermoplastic (PVC, SR, ABS) casing materials shall be used in the construction of a well, unless a variance has been granted by the ADWR Director and the State Conservation Engineer.

Casing made of, or which has been exposed to hazardous or potentially harmful materials, such as asbestos, shall not be used.

All installed materials must be approved for human consumption by the National Sanitation Foundation (NSF).

Casing Strength. Casings shall meet the material requirements (wall diameter, gage, schedule, etc.) as found in Construction Specification (CS) 642. Thermoplastic casing materials shall adhere to ASTM F480-89. Steel casing, new or in like-new condition, shall conform to ASTM A53-89, A139-89 or A312/A312M-89, whichever is applicable.

Screens. Screens can be (i) punched or louvered pipe screens, (ii) wire-wound continuous slot screens or (iii) perforated pipe base screens.

Joints between screen sections and casing shall be welded or threaded and coupled. The minimum length of the screen shall be given by:

$$L = Q / (7.48A_eV_e)$$

Where,

L = Length of screen in feet

Q = Quantity specified by purchaser in gallons per minute

A_e = Effective aperture area (sq. ft.) per foot of screen, which is equal to one half of the total aperture area.

V_e = Design entrance velocity (feet/sec) not to exceed 0.1 foot per second.

Pre-packed well screens shall consist of an inner and outer screen, which are completely filled with uniform, well-rounded, pre-washed grains of silica sand of a specified gradation. The screen slot size shall be based on a sieve analysis of the water-bearing aquifer materials; the slot size shall retain 100 percent of the filter pack's minimum size designation. No minimum annular space is required for a pre-packed well screen if the outside diameter is equal to or less than the casing to which it is attached.

Perforation by any method is allowable with the following provisions:

- Screen openings, for uniform size aquifer material, are smaller than the average diameter of the aquifer material,
- Pipe is not damaged, and the required strength can be maintained,
- Screen openings, for non-uniform aquifer material, are smaller than 60 percent of the aquifer material, and
- Screen openings, for filter/gravel pack will exclude at least 85 percent of the filter pack material.

Well screens should be plugged at the bottom either by a plate made of the same material as the screen or by a self closing valve. The plate can be welded or threaded.

Installation. Construction Operations and Materials shall be in accordance with all local, State, Tribal and Federal laws, including the requirements as outlined in Construction Specification 642, Water Well.

Installation shall be in accordance with the attached drawings and documentation. **NO CHANGES ARE TO BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.**

For Construction that does not meet State of Arizona or local Tribal Agency requirements and where deficient construction materials were used, NRCS will consider a waiver request for approval of construction after it has received a construction and material exemption from either the director of ADWR or local Tribal Government. Required exemption shall be for installation of casing materials that do not meet minimum quality criteria as found in applicable ASTM's and AWWA standards.

Well Development. The well shall be developed until it stops producing detrimental quantities of solid particles when the continuous discharge rate is approximately 20-percent greater than the anticipated normal production rate.

Aquifer Development. Requirements for installation of wells under artesian pressure are as follows:

- The well casing shall extend into the confining formation immediately overlying the artesian aquifer and shall be grouted a minimum of 10-feet into the confining formation to the land surface to prevent surface leakage into and subsurface leakage from the artesian aquifer.
- If leaks occur adjacent to the well or around the well casing, within 30-days the well shall be completed with seals, packers or casing and grouting necessary to eliminate such leakage or the well shall be abandoned per ADWR criteria.
- If the well flows at land surface, the well shall be equipped with a control valve, or suitable alternative means of completely controlling the flow.

Grouting and Sealing. The SURFACE SEAL shall consist of a 20-foot steel casing (minimum), one foot of which shall extend above ground level, and cement grout placed in one continuous application to a minimum depth

of 19-feet below natural ground level. The minimum annular space (thickness) between the casing and the borehole for placement of grout shall be 1 ½-inches. If a pitless adaptor is utilized, the cement grout may terminate at the bottom of the pitless adaptor.

Grout, expansive hydraulic cement (ASTM C 845) or bentonite based grout or an approved equivalent shall be used. The aggregate size to be used in the grout mixture shall not exceed ¼-inch. Curing additives, such as calcium chloride, shall not exceed 10-percent of the total volume. Bentonite as an additive shall not exceed 5-percent of the total volume. Any annular space between the surface casing and an inner casing shall be completely sealed to prevent contamination of the well. All wells shall have the casing surrounded on the ground surface by a 4-inch thick concrete slab extending at least 2-feet in all directions.

The top of the well casing shall be installed with a sanitary well seal, well cap or a pump mounting plate that seals the opening to prevent the entrance of contaminated water or other objectionable material.

Vents. Vents installed in the well casing shall open downward and be screened to prevent the entrance of foreign material.

Removal of drilling materials. In constructing a well, the well driller shall take all reasonable precautions to protect the producing aquifer from contamination by drilling materials.

Materials known to present a health hazard, such as chrome-based mud thinners, asbestos products, and petroleum-based fluids, shall not be used as construction, seal, or fill materials or drilling fluids.

Gravel Pack. As dictated by drilling conditions for the actual project, the gradation of the gravel packing and screen slot size shall be as recommended and documented on the well drillers log, and concurred by the NRCS.

If a gravel pack is required, the annular space between the outer casing and the inner casing shall be sealed, either by welding a cap at the top or by filling with cement grout from the bottom of the outer casing to the surface.

Procedure for Testing a Well. The pumping capacity of the well, in gallons per minute, as determined for a non-flowing well shall be measured by the discharge of the pump after continuous operation for at least twenty-four hours. For a flowing well (artesian), the pumping capacity shall be measured as the natural flow at the land surface, averaged over four (4) hours.

Well Driller. The well driller shall maintain a complete and accurate log of the soils, stratum, water table elevations, and all other pertinent facts for the drilled well. The well driller shall adhere to the guidelines, requirements and criteria established by ADWR or the local Tribal Agency, if applicable, for the completion of the well driller's log and report.

Basis of Acceptance. The Supplier, Contractor or Cooperator shall provide NRCS with material certifications for the constructed system components. Documentation will verify that construction materials adhere to criteria established in the drawings and specifications.

The acceptability of this work shall be determined by periodic inspections to check compliance with all the provisions of the applicable specification(s) with respect to the drawings, the appurtenances, and the minimum installation requirements. The documentation for completion and certification of installation shall be signed and filed in the cooperators project file for reference.

The contractor or cooperator shall certify that his work and installation conforms to the requirements of this standard by signing the statement on the drawings certifying that the construction meets all the requirements shown on the drawings and in the specifications.

The Contractor shall furnish a written guarantee to the cooperator that protects the owner against defective workmanship and materials for not less than one (1) year.

State Law. All wells installed under this Standard shall also meet the requirements and applicable laws of the State of Arizona, Department of Water Resources, Statutes and Rules Governing Minimum Well Construction Standards and the Licensing of Well Drillers.

All well drillers performing this work must be licensed by both ADWR and the State Registrar of Contractors (ROC).

CONSIDERATIONS

The potential for adverse interference with existing nearby production wells shall be evaluated in planning.

The potential for ground water overdraft and the long-term safe yield of the aquifer shall be considered in planning.

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 shall be considered.

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

Arizona Considerations Applicable to all Practices

Water Quality Testing. Water sampling and testing is recommended for all well developments.

Contaminant	Quantity	Unit
Dissolved Aluminum	5.0	mg/l
Dissolved Arsenic	0.2	mg/l
Dissolved Boron	1.0	mg/l
Dissolved Cadmium	0.05	mg/l
Dissolved Chromium	1.0	mg/l
Dissolved Cobalt	1.0	mg/l
Dissolved Copper	0.5	mg/l
Dissolved Lead	0.05	mg/l
Total Mercury	0.01	mg/l
Dissolved Selenium	0.05	mg/l
Dissolved Vanadium	0.1	mg/l
Dissolved Zinc	25	mg/l
Radium-226+ Radium-228	30	pCi/l
Tritium	20,000	pCi/l
Total gross alpha ¹	15	pCi/l
Nitrate	45	mg/l

Contaminant	Quantity	Unit
Dissolved Aluminum	5.0	mg/l
Dissolved Arsenic	2.0	mg/l
Dissolved Boron	1.0	mg/l
Dissolved Cadmium	0.05	mg/l
Dissolved Chromium	1.0	mg/l
Dissolved Cobalt	1.0	mg/l
Dissolved Copper	5.0	mg/l
Dissolved Lead	0.5	mg/l
Total Mercury	0.1	mg/l
Dissolved Selenium	0.02	mg/l
Dissolved Vanadium	0.1	mg/l
Dissolved Zinc	10	mg/l
Radium-226+ Radium-228	30	pCi/l
Tritium	20,000	pCi/l
Total gross alpha ¹	15	pCi/l
Nitrate	45	mg/l

¹ Total gross alpha (including radium-226, but excluding radon and uranium)

The following maximum recommended level for total dissolved solids (TDS) applies:

- Small animals - 3,000 mg/L,
- Poultry - 5,000 mg/L,
- Other livestock - 7,000 mg/L.

Information on water sampling and testing is available from the Arizona Department of Health Services, Lac Licensure and Certification

Program at 602-364-0720 or from the ADHS website at:
<http://www.hs.state.az.us/lab/license/env.htm>.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for each specific field site in accordance with this standard and whose construction documents shall describe the requirements for applying the practice to achieve its intended use.

Arizona Plans and Specifications Applicable to all Practices

Development of plans will be guided by the National Engineering Handbook, Part 650, the Engineering Field Handbook, Chapter 5, and shall be in accordance with the National Engineering Manual, Parts 541 and 542. Plans and specifications for Water Well shall provide the information necessary to install the well and appurtenances. As a minimum this shall include the following:

- A map or aerial photograph showing the location of the facility, showing the topographical features or contours;
- Detail drawings showing the well, necessary appurtenances (such as surface seal, casing requirements, etc.) and stabilization of any areas disturbed during construction;
- A map including the section, township and range, including a North arrow;
- Plans and profile views of the proposed system and components, if required;
- A map showing vertical and horizontal controls in the form of one or more reference bench marks with location and elevation clearly shown. Location can be in the form of Northing and Easting coordinates, or Longitude and Latitude. Vertical control can be in the form of previously established benchmarks or in the form of assumed elevations. Preferably, the elevations and coordinates should be based on a local or State grid coordinate system and clearly stated on the plan; and
- Section or detail views of all system appurtenances, if required.

Any designs completed by non-NRCS personal shall be sealed by an Arizona licensed engineer.

American Water Works Association (AWWA), A100-97, Standard for Water Wells

Required Attachments. Construction Drawings shall include the following minimum requirements:

Arizona Administrative Code, Title 18, chapter 11, Article 1, Appendix A: Numeric Water Quality Criteria

- Standard Drawing AZCover_09_09; AZ642_09_09 Water Well; and AZ533x_09_09 Pumping Plant;
- Construction Specification 431;
- Conservation Practice Approval Authority, Acknowledgement and Certification;
- Operation & Maintenance Plan
- Manufacturer Drawings and/or Specifications (if applicable);

Other Attachments

- Associated Practice Specifications
- Water Quality/Quantity Criteria
- Other
- _____
- _____
- _____
- _____

OPERATION AND MAINTENANCE

A plan for maintenance of a well shall be prepared. The well construction records shall be kept on file with the maintenance plan by the owner/operator. As a minimum, the plan shall include a statement of identified problems, corrective action taken, date, and specific capacity (yield per unit drawdown) of well before and after corrective action was taken.

REFERENCES

National Engineering Handbook, Part 631, Chapter 33, Investigations for Ground Water Resources Development

Arizona References Applicable to All Purposes

State of Arizona Department of Water Resources, Statutes and Rules Governing Minimum Well Construction Standards and the Licensing of Well Drillers