NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WATER WELL

(No.)

CODE 642

DEFINITION

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

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 *353- Monitoring Well*), injection wells, temporary test wells, or piezometers.

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

CRITERIA

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.

In California, counties (and some cities) administer and enforce laws or ordinances pertaining to the construction, alteration, maintenance, and destruction of water wells, using standards that equal or exceed those developed by the Department of Water Resources (DWR). More stringent requirements set forth by the local enforcing agency supercede those set forth in this standard.

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 Federal, State, and Local 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 onsite 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.

Locate the well at least 100 feet from known and potential sources of surface and subsurface contamination, and beyond the minimum horizontal separation distances established by the local regulatory authority. 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.

Grouting and Sealing the Casing. 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. A minimum of 2 inches of sealing material shall be maintained between all casings and the borehole wall, within the interval to be sealed.

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.

If one or more zones are encountered in uncased portions of the well column that produce water of unacceptable quality, use grout or packers to prevent comingling of waters or cross-contamination of aquifers. Provide a similar positive seal to separate water bearing zones where co-mingling of waters is otherwise undesirable. Extend the seal at least 10 feet into the impervious material above and below the water-bearing zone(s) to be sealed.

For artesian conditions, seal the confining geologic units directly above and below the aquifer in such a manner as to retain its confining pressure. Provide a packer, or similar retaining device, or sealed casing.

The length of the annular surface seal shall not be less than the minimum set forth by the local regulating agency. California water well standards require a minimum 20-foot long annular surface seal, except where the water to be produced is at a depth less than 20 feet. In no cases shall the length of the annular surface seal be less than 10 feet. Local requirements may be more restrictive.

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.

Screen and Filter Pack. Use perforated casing or a screen with a natural or artificial filter ("gravel") pack as needed, to allow the water from the aquifer to enter the well and to stabilize the aquifer material.

Design the screen so that it will provide sand-free water at its maximum rate of production.

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.

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.

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.

Use an artificial filter pack if any of the following conditions exist:

- Presence of a poorly graded, fine sand aquifer (Coefficient of Uniformity, D_{60}/D_{10}) $\leq$ 2.0) 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.

Design the artificial filter pack using guidelines set forth in NEH Part 631.32.

Install a conventional filter pack from the bottom up and place in a manner that avoids segregation and bridging of particles.

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.

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. For screened zones, the development technique must collapse sand bridges and remove fines outside the screen.

Hydraulic fracturing is not an accepted as a development method.

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 use. Test well water following criteria set forth in according to NRCS Conservation Practice Standard *355-Groundwater Testing*.

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.

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

Surround the casing at the ground surface with a concrete slab that is at least 4 inches thick and extends at least 2 feet in all directions from the outside of the casing. The slab shall be free of cracks, voids, or other significant defects likely to prevent water tightness.

Where freezing conditions require the use of a pitless adapter, and the well casing and annular seal do not extend above ground surface or into a pit or vault, a concrete base or pad shall be constructed as a permanent location monument for the covered well. The base shall be 3 feet in length on each side and 4 inches in thickness, unless otherwise approved by the enforcing agency. The base shall have a lift-out section, or equivalent, to allow access to the well. The lift-out shall facilitate inspection and repair of the well.

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.

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. The pump test duration shall be at least one hour. Unless information from nearby wells is sufficient to reasonably determine drawdown potential, the pump test shall be at least four hours where nearby wells may be affected.

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.

Following the pump test, monitor the recovery rate of the water level in the well. If the water level fails to return to nearly its original level after 24-hours, the reliability of the producing zone may be limited.

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
- 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.

This information can be provided using California Department of Water Resources (DWR) Well Completion Report Forms. The drilling contractor is required by the state to submit the completed form to DWR. Copies of the Well Completion Report shall be provided to NRCS and the landowner.

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 Conservation Practice Standard *351-Well Decommissioning*.

REFERENCES

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

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

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*.

California Department of Water Resources, Well Completion Reports, including forms and instructional pamphlets: http://www.water.ca.gov/groundwater/wells/well_completion_reports.cfm ; accessed 5/6/2015.

California Department of Water Resources, Water Well Standards: Combined Bulletins 74-81 and 74-90, http://www.water.ca.gov/groundwater/wells/california_well_standards/well_standards_content.cfm ; accessed 5/6/2015.