

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

WELL DECOMMISSIONING

(No.)

CODE 351

DEFINITION

The sealing and permanent closure of a water well no longer in use.

PURPOSE

- Prevent entry of animals, debris, or other foreign substances into well or well bore hole;
- Eliminate the physical hazard of an open hole to people, animals, and farm machinery;
- Prevent entry of contaminated surface water into well and migration of contaminants into unsaturated (vadose) zone or saturated zone;
- Prevent commingling of chemically or physically different ground waters between separate water bearing zones;
- Eliminate possibility of well being used for any other purpose;
- Conserve yield and hydrostatic head of aquifers;
- Restore, as far as feasible, hydrogeologic conditions that existed before well was constructed.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to any drilled, dug, driven, bored, or otherwise constructed vertical water well determined to have no further beneficial use.

This practice does not apply to water wells that were used for waste disposal.

CRITERIA

Criteria for all purposes shall conform to decommissioning procedures presented in ASTM D5299, Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.

Disinfection shall conform to procedures explained in Ground Water and Wells (Driscoll, 1986, pp. 620-623).

Closure options shall be compatible with all applicable federal, state, and local requirements.

Data collection. As-built construction documents, maintenance records and other available data for the abandoned water well shall be collected, reviewed and applied toward the development of a well decommissioning plan. This includes length and diameter of the casing, total well depth, depth to water table, type of liners and screens, and related information. Available drillers records are located in files at the Hydrogeology Division of the Geological Survey of Alabama in Tuscaloosa at 205-349-2852. The existing conditions of the well shall be documented as shown in the "**Plans and Specifications**" section. Data shall be recorded on NRCS Form AL-ENG-45 or AL-ENG-45a.

Well preparation. The well shall be cleared of all pumping equipment, valves, pipelines, casings, liners, screens, grease, oil, scum, debris, and other foreign material as explained in ASTM D5299, part 7.3.8.

Disinfection. Before sealing, the entire column of well water shall be brought to an available

chlorine concentration of 50 ppm or greater, or other solution specified by local or state requirements. After being agitated in the well water, the chemical solution shall be left for no less than 24 hours to assure complete disinfection.

Sealing materials. Properties of sealing materials shall conform to characteristics listed in ASTM D5299, part 6.3. Acceptable sealing materials are provided in ASTM D5299, part 6.4. Sealing materials do not require disinfection.

Water to be mixed with grout shall be compatible with the grouting material, and shall be of a quality that conforms to criteria provided in ASTM D5299, part 7.3.3.

Where the geologic hydraulic conductivity is unknown, sealing material should have a maximum allowable hydraulic conductivity of 10^{-6} gpd/ft².

Fill material. Fill materials can be used in lieu of sealing materials under certain conditions to reduce cost. The use of fill materials to plug a drilled well should be used only after careful examination of the drilling logs. Assistance from a trained geologist may be necessary.

Fill materials can include sand, pea gravel, sand-gravel mix, crushed stone, and agricultural lime, all of which shall be clean and free of organic or other foreign matter. Clay subsoil can be used in certain situations.

The gradation of fill materials shall be such that bridging does not occur during placement. To protect against bridging during placement, the maximum particle size of the fill materials should not exceed 1/10 of the well diameter. Materials greater than 3 inches should not be used regardless of the well diameter. For wells greater than 30 inches in diameter, backfill shall be placed in a manner that minimizes segregation and bulking in order to prevent surface subsidence.

Placement of material. Fill material shall be placed into the well only after the well water has been disinfected. Fill material is placed at a minimum thickness of one foot starting at the top of the lowest water bearing zone and

successively placed at intervals every 10 feet or less throughout the entire well column. All material shall be placed from the bottom of the well upward by methods that avoid segregation, dilution, or bridging of the material.

For wells greater than 30 inches in diameter, backfill shall be placed and compacted in a manner that minimizes segregation and bulking to prevent surface subsidence.

Removal of well casing. If possible, the casing shall be completely removed from the well by either pulling or overdrilling (overreaming) as explained in ASTM D5299, part 7.3.1. Casing that cannot be removed completely shall be ripped, perforated, or cut off at a depth greater than the maximum potential for frost penetration or any other near surface soil fracturing hazard (such as desiccation), or three feet, whichever is greater.

Casings grouted in place. Casings to be grouted in place shall employ a pressurized grouting procedure that will completely fill and seal the open space around the casing.

Perforated or ripped casing shall provide sufficient apportioned open area to assure passage of the grout into the space. The casing shall be perforated or ripped throughout the entire length of a confining layer.

Casings to be removed from a collapsing formation shall be grouted concurrently with removal such that the bottom of the casing remains submerged in the grout.

Surface seal. The interval between the ground surface and the top of cut off casing shall be sealed with sealing materials that conform to ASTM D5299, part 6.3. These materials may be an extension of the sealing materials used below this depth.

The interval between the ground surface and the top of the cut off casing shall be filled with soil material that achieves an in-place hydraulic conductivity equivalent to or less than the surface soil surrounding the well. The ground surface at the sealed well site shall be mounded and graded in a manner that prevents ponding of surface runoff.

Annular space around the outside of the well casing below the cutoff depth shall be grouted as needed. Wells with gravel exposed in the annular space at cutoff depth shall have at least a 3-foot depth of the gravel removed and the annular space backfilled with grout, bentonite chips or other expansive sealer.

Control of elevated formation pressure. If a well penetrates a formation that is under artesian head (confined conditions), or from which a gas is being released under pressure, the grout pressure must be maintained greater than the formation pressure until initial grout set occurs. Procedures for balancing formation pressures during grouting operations shall conform to ASTM D5299, part 7.3.7.

Vegetation. All areas which are disturbed during the decommissioning operation shall be smoothed and dressed at the completion of sealing the well. These areas shall be established with vegetation in accordance with the FOTG Standard for Critical Area Planting (342), unless the area is to be utilized for crop production.

CONSIDERATIONS

This practice may be part of a ground water protection system that includes water and chemical management practices.

To the extent practicable, an abandoned well should be decommissioned in a manner that restores the original hydrogeologic conditions of the well site and does not preclude the use of the site from future land management practices.

All decommissioning procedures and fill and sealing materials need to be selected with due consideration of the site-specific geological, biological, physical and climatic conditions, the chemical composition of the surrounding soil, rock and ground water at the well site, and the well's construction practices. For additional information on local conditions, discuss site conditions with drilling and well servicing contractors. Special equipment may be required; therefore, it is advisable that a qualified contractor perform the work.

In some Karst terrains, where large voids may exist, it may be difficult to plug a well. Another consideration is that large quantities of sealing materials may cut off an underground stream or otherwise alter the hydrogeology.

Checking for contaminants is recommended. Waste oil, pesticides, and garbage are among some of the more common contaminants found in wells. Groundwater remediation (not covered in this standard) may be required. Pumping and removal of contaminants may prevent future widespread groundwater contamination problems. The Alabama Health Department or Alabama Department of Environmental Management should be contacted for guidance on remediation and sealing of contaminated wells.

If allowed by state regulations, fill materials, such as sand, pea gravel, sand-gravel mix, crushed stone, or agricultural lime can be used to plug the well provided that zones of sealing material conform to ASTM D5299, part 6.3).

PLANS AND SPECIFICATIONS

Plans and specifications for decommissioning abandoned water wells shall be consistent with this standard and shall describe the requirements for applying the practice to achieve its intended purposes. A record of the installation of this practice shall be made and shall include the following information:

- Location of the decommissioned well by latitude/longitude, township/range, or other georeference convention, of such precision that it can be readily located in the field, if required, in the future
- Date of completion of well decommissioning
- Name of landowner
- Name, title, and address of person responsible for well decommissioning
- Total depth of well
- Length of casing

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- Length of casing removed or length of casing cut off below ground level
- Inside diameter of well bore or casing
- Type of casing material or schedule (e.g., standard weight steel, or PVC sch-80)
- Static water level measured from ground surface prior to decommissioning
- Types of materials used for filling and sealing, quantities used, depth intervals for emplacement of each type, and emplacement method used.

OPERATION AND MAINTENANCE

The practice site shall be inspected periodically to ensure that the decommissioned well and the adjacent area have not settled or eroded, or are otherwise adversely disturbed. The well site and adjacent ground surfaces shall be maintained in a manner that prevents ponding of surface runoff on the site.

REFERENCES

ASTM D 5299-92

AWWA Standard for Deep Wells -
AWWA A100-97

ADEM Administrative Code

335-7-5-13

EPA-57019-75-001 Manual of Water Well
Construction Practices

ADEM - Water Well Standards Program

Code R. 335-9-1-.06(g)

CONSTRUCTION SPECIFICATIONS FOR DECOMMISSIONING ABANDONED WATER WELLS

Debris Removal

Before sealing begins, pumping equipment and any obstacles or debris shall be removed from the well. Dug wells shall be cleaned of debris and refuse using mechanical equipment from the ground surface. Casing that is not sealed should be removed, if possible. Driven and drilled wells should be flushed with water or compressed air if needed to remove materials which would hinder sealing operation.

Proper disposal of displaced fluids and other materials (such as pulled or drilled out casing and cement seals) should be considered. Some of these materials may be classified as hazardous waste under federal, state, or local regulations.

Measurement of Well Depth and Water Depth

The depth of the well and the depth of the water shall be measured after debris removal and before well sealing begins.

Safety Consideration

When sealing operations are temporarily suspended, such as overnight shut down or awaiting materials, the well or hole shall be covered. The cover shall be anchored to prevent easy or unintentional entry and sealed to prevent the seepage of surface water and foreign material into the well or hole. If a well pit must be entered, workers shall comply with all OSHA safety regulations. Hard hats should be worn around heavy equipment.

Chlorination

The water in the well shall be brought to a 100 ppm chlorine concentration before sealing.

A 100 ppm chlorine solution will require:

- 1 gal. 5% chlorine bleach per 500 gal. of water
- 1 pt. 5% chlorine bleach per 62 gal. of water
- 1.3 lbs. high-test calcium hypochlorite tablets per 1,000 gal.

To determine the volume of water in the well, use the chart shown in the Materials section.

Materials

An estimate of the amount of materials needed to seal the well should be calculated prior to construction.

An estimate of the borehole volume can be calculated as follows:

$$V = 3.1416 \cdot D^2 \cdot L/4$$

where:

$$V = \text{Volume (cu. ft.)}$$

$$D = \text{diameter of hole (ft.)}$$

$$L = \text{length of hole to be sealed (ft.)}$$

To determine the volume of water in the well or the volume of materials needed per foot of depth, use the following chart.

Hole diameter (inches)	Volume per foot of depth gal/ft	cu ft/ft
4	0.7	0.1
6	1.5	0.2
8	2.6	0.3
10	4.1	0.5
12	5.9	0.8
14	8.0	1.1
16	10.4	1.4
20	16.3	2.2
24	23.5	3.1
36	52.9	7.1
48	94.0	12.6

Materials used in decommissioning abandoned wells are as follows:

Bentonite. Predominantly composed of the clay mineral sodium montmorillonite which swells when wet. Pelletized bentonite consists of granular bentonite which has been compressed into tablets. Pelletized bentonite with a soluble coating is recommended for sealing wells. Chipped bentonite is raw mined in the form of chunks 1/4 to 3/4 inch in size. As bentonite chips are difficult to place, they should be used with caution. Granular and powdered forms of bentonite are not recommended for dry placement in well sealing operations.

Cement-bentonite slurry. A mixture of cement, bentonite, and water, consisting of not more than eight (8) percent bentonite by dry weight of the cement and a maximum of ten (10) gallons of water per sack (94 pounds) of cement.

Cement grout. Mixture of cement, sand (1:1 ratio) and water [not more than 6 gal. of water per sack (94 lbs.) of cement.]

Grout. Material consisting of bentonite, cement, or a cement-bentonite mixture.

High solids clay grout. Blend of powdered polymer-free bentonite clay mixed with water that forms a creamy slurry with a minimum of 20% solids by weight and a density of 9.4 lb./gal.

Local Clay Subsoil. Any clayey material of local origin found below the topsoil. It should have a medium or loamy texture or be classified a silty clay (CL-ML) or lean clay (CL) in the Unified Soil Classification System.

Neat cement. Neat cement is a mixture of one bag (94 pounds or 1 cubic foot) of portland cement and 6 gal. of water. It is about the consistency of thick cream and can be pumped with special piston pumps. The mixture of one 94 lb. bag of cement and 6 gal. of water yields a volume of 1.1 cubic foot.

Sand. Sand shall be clean sand.

Sand/gravel mix. Material shall be clean. Gravel shall have a maximum size of 1/10 of the well diameter. Materials greater than 3 inches should not be used regardless of the well diameter.

The above mixtures may be varied to improve pumping, gravity flow, expansion, etc., as approved by the engineer.

Handling and Placement of Materials

Cement. If cement is used to seal the well, it shall continue to be placed to within 4 ft. of the ground surface. Cement shall be placed through a pipe from the bottom of the well. The pipe should be raised slowly as the cement is added. Complete this operation in one continuous operation. The cement mix will displace the water if installed with a pipe as specified. When the overflowing cement is similar to that being pumped down the hole, the sealing is considered complete. As a precaution, free-standing water present in the well prior to the placement of cement should be bailed or pumped out, if possible.

Neat cement is generally preferred to grout as it avoids the danger of separation.

Bentonite. If bentonite is used, it should be screened through a 1/2 in. mesh to remove dust and fine particles which would tend to clog when being added to the well. The bentonite should be added slowly at a rate of about one bag (50 lbs.) per five minutes to prevent bridging unless otherwise recommended. The bentonite should become saturated with water as it is placed in the well. If there isn't sufficient water in the well to saturate the bentonite, water should be added at a rate of 8 gal. per bag.

Use bentonite chips or pellets only where it is practical to place. Bentonite chips and pellets have a tendency to stick to the damp side walls of

the well, causing bridging. Dry bentonite should be tamped in place to ensure bridging does not occur. In deep holes, one of the slurry materials should be used.

Use caution when using bentonite in saline ground water, due to shrinkage that may occur when in contact with high concentrations of salt.

Local Clay Subsoil. Compacted local clay subsoil shall be moist so as to obtain good compaction. The clay shall be compacted in 6 in. layers with a 2x4 or 4x4 board, a long pipe with a flat end, or other suitable tamping device.

Sand/Gravel Mix. If over 20 ft. of sand/gravel is used in filling the well above the water level seal, an intervening 3 ft. seal of bentonite or cement shall be placed about halfway in the sand column, or at 20 ft. intervals in deep wells.

Inspection

NRCS representative should be on-site during field activities to verify that the activities are completed as planned. Written certification of conformance to specifications will be required if physical inspection is not conclusive.

Sealing Procedure

The well casing and bore hole shall be completely filled with materials as stated in this specification and shown on the drawing, including the annular space outside of the casing or liner.

Surface seal. All wells will have a surface seal as follows:

- A 3 ft. plug of cement shall be placed in the well to within 3 ft. of ground level, forming a seal from 6 ft. to 3 ft. below the surface.

A pit shall be excavated around the upper 3 ft. of the well. The pit diameter shall exceed the diameter of the casing by at least 4 feet. The casing, if it has not been pulled, should be cut off at the base of the pit. With dug wells, the upper 3 ft. of the well lining should be removed. The pit shall be backfilled with a 1.5 ft. thick layer of bentonite or cement-bentonite slurry. The 1.5 ft. of bentonite shall be overlain with compacted, low permeability soil, mounded to direct surface water away from the abandoned well location. The mounded soil shall be sodded or seeded with appropriate vegetation and mulched, unless the area is to be utilized for crop production.

Well Pits. To properly abandon a well pit, knock in at least one wall, breakup or perforate the floor, and then fill the pit using the procedure for dug wells.

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