NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WATER WELL

(No.)

CODE 642

I. DEFINITION

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

II. PURPOSE

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

Water developments 20 ft deep or less at natural springs or dugouts, including offset wells, are not covered under this standard. Consult Practice Standard 574- Spring Development.

III. 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.

IV. CRITERIA

A. <u>Laws and Regulations</u>. 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. **In North Dakota, a water appropriation is required on state regulated lands prior to drilling a well with the following exception: the well must be for the purpose of domestic, livestock, fish/wilidlife, or recreational use and be intended to supply no more than 12.5 ac-ft annually. Consult with the appropriate tribal government when planning wells on tribal trustlands.**

B. <u>Suitability of Site</u>. 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.

The following minimum setback distances are required for safety and/or water quality protection:

- **50 feet from barnyards, septic tanks, feedlots, absorption fields, and the high water mark of lakes, streams, sloughs, or wetlands when well is constructed in unconsolidated soils with filtering properties.**
- **30 feet from sewer lines.**
- **30 feet from basements and pits if entrained gases in groundwater can be reasonably expected, 10 feet from basements and pits if not**
- **20 feet from overhead power lines and other hazardous devices.**

Well casings may not terminate in, or extend through, well pits, basements, or any other below grade structure.

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.

C. 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.

The casing or pitless unit shall project not less than 12 inches above the local ground surface (and pumphouse floor if applicable). In floodprone areas, the casing or pitless unit will project at least 2 feet above the highest known flood elevation and be surrounded by earthfill.

D. 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.

The annular space between a well hole excavation and the outside of the well casing shall be filled with neat cement grout, high-solids bentonite clay grout, bentonite chips, or bentonite tablets at least 1-1/2" inches in thickness from a depth of not less than 30 feet to the ground surface or the upper end of the well casing if a pitless unit or adapter is installed. Wells with a depth of 30 feet or less shall be grouted from within 2 feet of the top of the well screen to the ground surface or from the upper end of the well casing if a pitless unit or adapter is installed. Greater depths are preferable.

The annular space of wells constructed in unconsolidated formations without overlying confining beds and static water levels less than 30 feet below the ground surface shall be filled with neat cement grout, high-solids bentonite clay grout, bentonite chips, or bentonite tablets at least 1-1/2 inches thickness from the static water level or a depth of not less than 10 feet, whichever is greater, to the ground surface or from the upper end of the well casing if a pitless unit or adapter is installed.

Driven well casing (ex. sand point wells) may, when conditions warrant, be installed without grouting.

The construction of flowing wells shall be such that the flow from them can be controlled. Well casing shall be installed, and the annular space grouted with neat cement to form a tight seal. The neat cement grout shall extend upward from within 20 feet of the top of the aquifer to the ground surface or from the upper end of the well casing if a pitless unit or adapter is installed.

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.

E. 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.

F. 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.

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.

G. 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.

H. 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. 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.

I. 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)*.

Wells used as a source for livestock water shall not exceed 7,000 ppm of Total Dissolved Solids or 200 ppm Nitrate Nitrogen (NO_3-N). Consult NDSU Extension "Livestock and Water" and MT NRCS Environmental Tech Note 1 "Assessing Water Quality of Human Consumption, Agriculture, and Aquatic Life Uses" for additional recommendations.

J. 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.

V. 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.

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.

A yield and drawdown test will be performed on all wells at approximately 150% of the design pumping rate until the decline of the pumping water level has stabilized. The following information is required: static water level, pumping rate, drawdown during test, recovery water level, depth of pump, duration of test.

Safety. Water wells in North Dakota are known to have dangerous gases associated with them. These gases may be toxic (hydrogen sulfide), explosive (methane), or asphyxiating (carbon dioxide, nitrogen). Casing of wells producing gas shall be vented to the atmosphere in a manner that disperses

gas away from well pits, well houses, or any other enclosed spaces.

If entrained gases in groundwater can be reasonably expected, locate well pits or pumphouses a minimum of 30 feet from the well, and compact clay soils in the trench to the pitless adaptor. Ensure well houses are ventilated, particularly if heaters are planned for installation.

In addition to local knowledge and physical indicators at the completed well, the potential for entrained gas can be evaluated using information from the ND Geologic Survey: https://www.dmr.nd.gov/ndgs/documents/Publication_List/pdf/geoinv/GI_135.pdf Flowing wells are particularly likely to have entrained gases.

VI. PLANS AND SPECIFICATIONS

Develop plans and specifications that clearly describe requirements for applying the practice to achieve its intended purpose(s). **Design and construction of new water wells and rehabilitation of existing artesian wells must be completed by a Water Well Contractor certified by the ND State Board of Water Well Contractors. Installation of pitless adaptors on wells must be completed by a Pump and Pitless Unit Installer certified by the ND State Board of Water Well Contractors.**

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.

VII. 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.

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*.

North Dakota Century Code Chapter 33-18-01 Water Well Construction and Water Well Pump Installation, July 2008.

NDSU Extension, Livestock and Water, 2008.

MT NRCS, Assessing Water Quality for Human Consumption, Agriculture, and Aquatic Life Uses, 2011.

North Dakota Geological Survey, Geochemical Indicators of Shallow Gas in Groundwater in North Dakota, 2011.