

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

WELL

(Number)

CODE 642

DEFINITION

A well constructed or improved to provide water for irrigation, livestock, wildlife, or recreation.

SCOPE

This standard applies to drilled, driven, and dug vertical or horizontal wells constructed to supply water from an underground source. It does not apply to pumps installed in the well or to aboveground installations, such as pumping plants, pipelines, or tanks.

A test well constructed for geological investigations before the installation of a permanent well is temporary and is not covered by this standard.

PURPOSES

- To facilitate proper use of vegetation on rangeland, pastures, and wildlife areas
- To supply the water requirements of livestock and wildlife
- To provide an adequate supply of water for conservation irrigation
- To provide for human use at recreation sites.

CONDITIONS WHERE PRACTICE APPLIES

All irrigation wells shall be planned and located to serve as a source of water for an irrigation water distribution or conveyance system designed to facilitate the conservation use of the soil and water resources on a farm or group of farms.

Irrigation wells are limited to geological sites where sufficiently large volumes of underground water are available at a rate that will permit practical irrigation of the land on which the water is to be used. Wells may be the only source of

water or they may supplement other sources. The land on which the water is to be used must be suitable for the production of locally adapted crops grown under irrigation farming. The water must be of adequate quality to insure that it will not materially reduce the productive capacity of the soil on which it is to be used.

Wells are applicable on rangeland, pastures, cropland, and wildlife and recreation areas where present water facilities are inadequate and the underground water supply is adequate in quantity and quality for the purpose to be served and can be developed at an economical cost.

DESIGN CRITERIA

General. The suitability of the well site and the type of well installed shall be based on detailed geologic investigations, including test drilling, on ground-water assessment studies made by local, State or Federal agencies, or on reliable local experience. The design should include ground-water conservation measures, provisions for controlling contamination from one aquifer to another in the well, and methods for obtaining a maximum supply of sediment-free water.

Well construction and materials shall conform to this standard and/or the North Dakota State Department of Health Regulation 43-35, whichever is more restrictive.

No public water well can be constructed or modified without prior approval from the North Dakota State Department of Health.

Flow controls are required on all wells with artesian flow.

Well diameter. The diameter of the well shall be adequate to meet the yield capacity of the formation in relation to the nature and extent of the water-bearing area and to permit the installation of a pump to deliver the needed amount of water to the projected lift elevation. Diameters smaller than 4" are to be used only if

approved by the NRCS State Conservation Engineer.

Casing and materials. Wells shall be cased from the surface through upper consolidated or fractured strata. If the lower portion of the well is completed in consolidated strata which will maintain an open hole, casing must extend a minimum of two feet into the consolidated formation. Casing shall be grouted in accordance with the method outlined in the NRCS Well Specifications "Protection" section. Materials shall meet the requirements detailed under "Well Specifications".

The maximum depth for well casings shall be based on critical collapse pressure as calculated by the Cleideinst Equation in ASTM-F-480,

appendix X2. Depth, as used in this standard, applies to the difference in static head between the inside and outside of the casing. This can be determined by measuring the static head or by using the total depth of the well. Satisfactory evidence is required to support static water levels, otherwise the total well depth will be used.

Table 1 gives the depth limitations for polyvinyl chloride (PVC) well casing pipe having different standard dimension ratios and moduli of elasticity. The standard dimension ratio (SDR) for all plastic pipe shall be 21 or less, and the minimum pipe stiffness (PS) shall be 224 (lb.ft./in. x in.)

Table 1 - Maximum depth of installation for plastic (SDR-PR) pipe

Standard	ASTM 1784		
Material	PVC 1120 PVC 1220	PVC 4120	PVC 2120
Modulus of Elasticity	400,000	360,000	320,000
SDR	Maximum depth (feet) for pressure rated pipe		
13.5	985	885	785
17.0	475	430	380
21	245	220	200

Acrylonitrile-butadiene-styrene (ABS) and styrene-rubber (SR) well casing pipe does not always carry the National Sanitary Foundation (NSF) approval and their use would be in violation of North Dakota State Codes. Styrene-rubber is also very brittle and often cracks or breaks during installation. Because of these reasons, ABS and SR well casings will not be approved.

Table 2 gives the dimensions and maximum depth of installation for PVC Schedules 40, 80, and 120 pipe constructed of material having a modulus of elasticity equal to 400,000 lb/in². The factors given at the bottom of this table may be used in calculating depth limitations for other PVC classifications.

**Table 2 - Dimensions and maximum depth of installation
 for Schedules 40, 80, and 120 PVC plastic pipe**

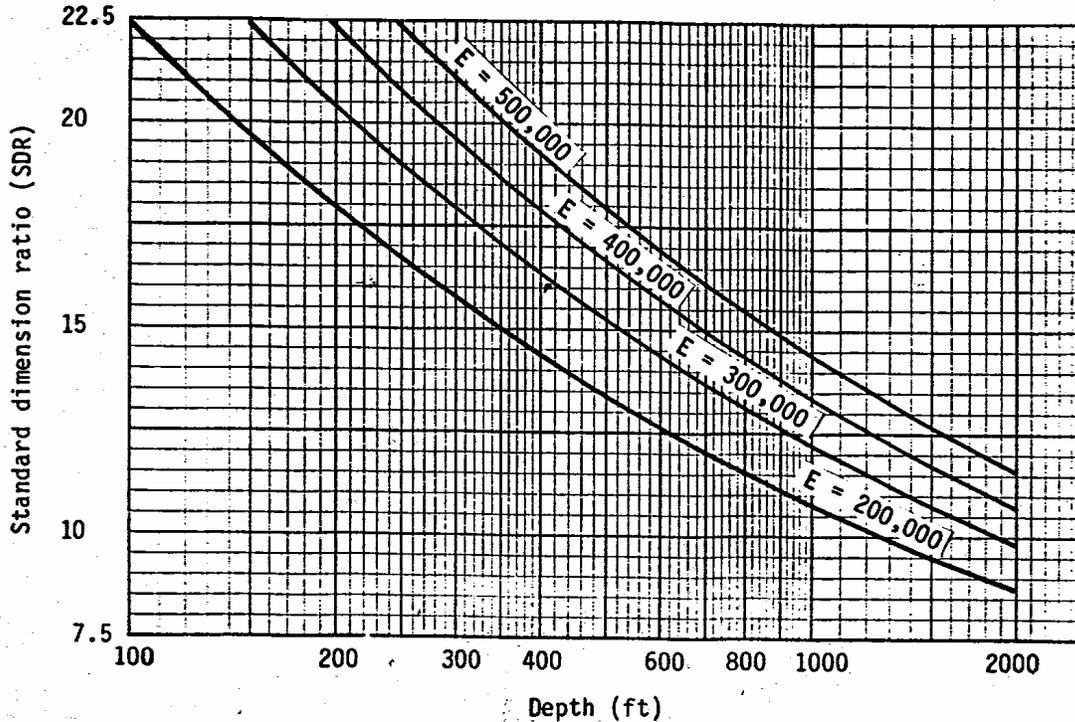
Nominal Diameter (inches)	Schedule 40			Schedule 80			Schedule 120			
	Outside Diameter (inches)	Minimum Wall Thickness (inches)	SDR	Maximum Depth (feet)	Minimum Wall Thickness (inches)	SDR	Maximum Depth (feet)	Minimum Wall Thickness (inches)	SDR	Maximum Depth (feet)
* 2	2.375	0.154	15.4	650	0.218	10.9	1960	0.250	9.5	3020
* 2-1/2	2.875	0.203	14.2	840	0.276	10.4	2260	0.300	9.6	2920
* 3	3.50	0.216	16.2	550	0.30	11.7	1550	0.350	10.0	2560
* 3-1/2	4.00	0.226	17.7	420	0.318	12.6	1220	0.350	11.4	1680
4	4.50	0.237	19.0	340	0.337	13.4	1010	0.437	10.3	2330
5	5.563	--	--	--	0.375	14.8	740	0.500	11.1	1830
6	6.625	--	--	--	0.432	15.3	660	0.562	11.8	1510
8	8.625	--	--	--	0.50	17.3	450	0.718	12.0	1430
10	10.75	--	--	--	0.593	18.1	390	0.843	12.8	1160
12	12.75	--	--	--	0.687	18.6	360	1.00	12.8	1160

This table is for PVC Schedule Pipe made of Type 1, Grades 1 and 2 material having a modulus of elasticity of 400,000 psi. For PVC pipe having a modulus of elasticity of 360,000, multiply the depths by a factor of 0.9. For PVC pipe having a modulus of elasticity of 320,000, use a factor of 0.8. Minimum (SDR) and (PS) criteria will be calculated and observed for all plastic pipe materials.

*Casing diameters of less than 4" will be use only if approved by the NRCS State Conservation Engineer.

Figure 1 can be used in determining the maximum depth of plastic casings not covered by Tables 1 and 2.

Figure 1 - Maximum depth of installation for plastic (SDR-PR) pipe. Note that minimum PS = 224 lb.ft/in² must be maintained for all pipe



Plastic pipe strength is reduced by increased temperatures. Water or earth temperature at depth should be considered when designing casings. Table 3 has appropriate strength reduction values for PVC pipe. Reinforced plastic mortar, fiberglass, concrete, asbestos cement, aluminum, copper, plastics or other material not described in this standard will be allowed only after receiving prior approval from the State Conservation Engineer and the North Dakota Department of Health.

TABLE 3 - PVC temperature coefficients.

Maximum Service Temperature		Percentage of Allowable Design Stress or Pressure-Class Rating at 73.4° F (23° C)
°F	°C	
80	27	88
90	32	75
100	38	62
110	43	50
120	49	40
130	54	30
140	60	22

Table 4 gives the minimum allowable thickness for Schedule 40 steel casings. Depth restrictions for Schedule 40 steel casings are well below the maximum depths of water wells constructed in North Dakota, so no depth restrictions are listed.

**Table 4 - Schedule 40 steel casing
 minimum wall thickness - No depth restrictions for
 Schedule 40 steel casings**

Diameter (Nom.)	Thickness (In.)
* 2	.154
* 2 1/2	.203
* 3	.216
* 3 1/2	.226
4	.237
5	.258
6	.280
8	.322
10	.365
12	.406

*Casing <4" only with prior approval.

Screens. All wells constructed to recover water from unconsolidated aquifers shall be equipped with manufactured screen sections or well points meeting the criteria stated below. The screen openings for aquifer material of near uniform size shall be smaller than the average diameter of the aquifer material. The screen or slotted casing section must be protected with a device immediately above the intake section if necessary to prevent well stabilizer materials from entering the intake section area.

For graded aquifer materials (of nonuniform gradation), the screen shall be sized so that 40 percent of the aquifer material is larger than the screen opening. For wells in which a gravel pack envelope is used, the screen shall have openings that will exclude at least 90 percent of the gravel pack material. The length and open area of the screen shall be adequate to maintain the entrance velocity of water into the well at an acceptable level, preferably less than .10 ft/sec.

The position of the screen in the well shall be governed by the depth of the aquifer below the ground surface and the thickness of the aquifer to be penetrated by the well. The top elevation

of the screen shall be below the lowest water level expected during pumping and be located opposite the most permeable area in the water-bearing strata.

Filter pack. Sand or gravel filter packs shall be used in wells constructed in fine material or relatively uniform grain size to prevent the aquifer materials from passing through the well screen or the perforated casing. The pack shall be 3 to 12 in. thick and shall consist of sand or gravel material having D30 grain size 4 to 12 times the D30 grain size of the aquifer material. Provisions shall be made for centering the casing in the filter pack.

Sanitary protection. Wells shall be located a safe distance from sources of contamination. Details pertaining to local water wells, such as depth, type of construction, and vertical zone of influence, together with data on the geological formations and porosity of subsoil strata, shall be considered in determining the safe allowable distances.

The recommended minimum horizontal distance between the water supply and the source of contamination is:

Source of Contamination	Minimum Distance ft.
Water disposal lagoon	300
Cesspool	150
Livestock and poultry yards	100
Privy, manure pile	150
Silo pit, seepage pit	150
Septic tank and disposal field	100
Gravity sewer or drain (not pressure tight)	50
Gravity sewer or drain (pressure tight)	25

If possible, wells shall be located in ground that is higher than any potential source of contamination or flooding. Drainage that might reach the source from areas used by livestock shall be diverted. Wells must be readily accessible for maintenance and repair and be located a safe distance from overhead utility lines or other safety hazards.

Each well shall be provided with a watertight cover or seal to prevent the entry of contaminated water or other objectionable materials. The annular space around the casing shall be at least 3 in. and shall be filled with neat cement grout or high solids bentonite clay grout to a depth of not less than 20 feet or 20 feet below the cutoff point for a pitless unit. A positive seal of neat cement grout shall be provided between the casing and the impervious material overlying the aquifer of artesian wells.

The source of construction water used in well installations will be such that it will not contaminate the well. Chlorination of construction water will be according to North Dakota Water Well Standards.

PLANS AND SPECIFICATIONS

Plans and specifications for wells shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purposes.

PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY

Quantity

1. Effects that the cone of depression, formed by pumping the well, has on adjacent water uses and users.
2. Balance of water removed from the aquifer versus its available recharge to estimate the life and utility of the well.

Quality

1. Effects of well discharge on surrounding surface and ground water quality.
2. Methods and procedures used in the construction, development, operation, and maintenance of the well that could prevent damage to surface or ground water quality.

PLANNING CONSIDERATIONS FOR RANGE AND PASTURE

This practice must (1) improve grazing distribution throughout the pasture, (2) provide reliable quality water to meet livestock water requirements, and (3) be a practical method of providing the needed water.

Normal distribution of watering facilities provides water between 1/4 to 1/2 mile distance in rough terrain and 1/2 to 1 mile in gentle terrain. For more specific guidelines, refer to Section 803.3 Livestock Water Facilities, National Range Handbook, NRH-1, July 13, 1976.

WELL SPECIFICATIONS

Alinement

Drilled vertical wells shall be round, plumb, and alined to permit satisfactory installation and operation of a pump of the proposed size and type to the greatest anticipated depth of setting.

Casings

Materials. Casings can be made of steel or plastic. Other materials of equivalent strength and durability such as copper, fiberglass, asbestos-cement, or concrete can be used only if approved by the NRCS State Conservation Engineer and the North Dakota State Department of Health.

Steel or plastic pipe casings shall be used in drilled wells, unless approved otherwise by the NRCS State Conservation Engineer and the North Dakota State Department of Health. Only steel pipe casings shall be used in driven wells. Steel well casings shall equal or exceed the requirements specified in ASTM-A-589. Steel pipe manufactured for other purposes can be used if the quality of the pipe equals or exceeds that specified in ASTM-A-589, and is approved by the NRCS State Conservation Engineer. Used steel pipe can be used for well casings if it is of prime quality and has a wall thickness equal to or greater than that of Schedule 40 pipe (Table 4). Prior steel pipe use may prohibit its use for potable water.

Plastic casings shall be made of polyvinyl chloride (PVC) and shall conform to the requirements specified in ASTM-F-480. Plastic pipe manufactured for water or irrigation pipelines can be used if the quality of the pipe equals or exceeds that specified in ASTM-F-480. If the water is to be used for human consumption, plastic casings for transporting potable water supplies must be approved by the National Sanitation Foundation.

Fiberglass casings, when approved, can be used only if tests indicate that:

1. The material meets the 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-2996 are not needed because the pipe is to be used for well casing.

2. The joints meet the requirements specified in Section 3.8, ASTM-F-480.
3. The modulus of elasticity is certified for use in determining maximum depth.

Asbestos-cement casings, when approved, shall equal or exceed the requirements specified in ASTM-C-296 (pressure pipe), ASTM-C-668 (transmission pipe), or SCS 430-BB (irrigation pipe). The minimum crushing strength shall be 1,500 lb/ft.

Concrete casings, when approved shall be reinforced and shall meet or exceed the requirements specified in ASTM-C-76. The minimum 28-day compressive strength shall be 4,000 lb/in.².

Reinforced plastic mortar casings, when approved, shall equal or exceed the requirements specified in ASTM-D-3517.

Joints. 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.

Gravel pack. If gravel packing is used, it shall have the gradation and thickness specified in the design and shall be carefully placed to prevent segregation and bridging. Gravel pack material shall extend a minimum of 10 ft. above the top of the perforated or screened section and shall extend through the length of the water-bearing formation.

Installation. In consolidated formations, the casing shall extend from the ground surface through the overburden material to an elevation of at least 2 ft. into the consolidated material.

In unconsolidated formations, the casing shall extend from the ground to the screen.

For artesian aquifers, the casing shall be sealed into the overlying impermeable formations to retain the artesian pressure. Flowing wells shall be grouted from within 5 feet of the aquifer to the ground surface and the casing must be set and grouted before the screen is set.

If a water-bearing formation known to contain or suspected of containing poor quality water is penetrated, the formation shall be sealed to prevent infiltration of poor quality water into the well and the developed aquifer.

Drillers are required to supply the North Dakota State Board of Water Well Contractors with an accurate record of the drill hole diameters and depths, assembled order of size and length of casings and liners, grouting depths, formations penetrated, water levels, and pumping tests.

Developing

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.

Every well should be tested for yield and drawdown. The test pump should have a maximum capacity at least equal to one and one-half times the quantity of water anticipated. The test pump should be able to operate continuously until the water level has nearly stabilized. Test data recorded should include: static water level, pumping rate, drawdown during test, recovery water levels, and depth of pump setting.

Duration of the test shall be determined with due consideration given to pumping of sand, clarity of water pumped, and the obtaining of a representative sample of water for chemical analysis.

Protection

All wells shall be cased to not less than twelve inches above the ground surface or well cover slab to prevent the entry of surface and near-surface water.

If the well water is for animal or human consumption, the annular space outside the casing must be filled with a watertight cement grout or high solids bentonite grout from the surface to a minimum of 20 ft. below the ground surface or pitless unit if installed. All grouting shall be performed by adding the mixture from the bottom of the annular opening upward, in one continuous operation, until the annular opening is filled. Sufficient annular opening shall be provided to permit a minimum of 3 inches of grout around the casing. Care must be taken when grouting plastic well casing with neat cement grout. Heat caused by hydration during curing of the cement may cause

weakening of the well casing. This can be minimized by adding sand or bentonite to the grout to increase curing time.

The casing shall be surrounded at the ground surface by a 4-inch concrete slab extending at least 2 feet in all directions. A sanitary well seal shall be installed at the top of the well casing to prevent the entry of contaminated water or other objectionable materials.

Disinfection

The well shall be thoroughly cleaned and disinfected after completion and before installation of the pumping equipment. A sufficient amount of chlorine compound should be added to the well to give a dosage of 50 mg/liter. Install pump, circulate the solution throughout the system and then allow it to remain for 24 hours. Pump and flush thoroughly and then collect a water sample for chemical and bacteriological analysis.

Workmanship

The well casing pipe, couplings, and screens shall be homogeneous throughout and shall be free of visible cracks, holes, foreign materials, or other injurious defects. The well casing pipe, couplings, and screens shall be uniform in color, density, and other physical properties as is commercially possible.

Markings

The well casing pipe shall be marked according to the ASTM specification for the material used and carry the National Sanitation Foundation (NSF) seal.

Certification

Markings on material identifying the manufacturer and indicating compliance with appropriate specifications can be accepted as evidence that the material meets the requirements of this standard. If the material does not bear these markings, the manufacturer can certify that it complies with the requirements of this standard. The State Conservation Engineer, however, can request tests supporting this certification.

Wells shall meet all requirements as set forth in Chapter 33-18.01 of the North Dakota Administrative Code (Water Well Construction and Water Well Pump Installation).