

**NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI CONSTRUCTION SPECIFICATION**

WATER WELL

CODE 642

GENERAL

Construction operations shall be carried out in such a manner and sequence such that erosion and air and water pollution will be minimized and held within legal limits. A land disturbance permit from the Missouri Department of Natural Resources may be needed if the disturbed area is greater than one five acre in size.

The completed job shall present a workmanlike appearance and shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used. The contractor shall be assured that all state laws concerning buried utilities are met prior to beginning work.

All well construction shall comply with Missouri Well Construction Rules, Missouri Department of Natural Resources, Division of Geology and Land Survey, (DGLS), Wellhead Protection Section. If there is a difference between MoDNR DGLS Rules and this specification, the most restrictive criteria applies.

INSTALLATION REQUIREMENTS

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

Casing installation. In consolidated formations, the casing shall extend from the ground surface through the overburden material to an elevation at least 2 feet into the consolidated foundation.

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 so as to retain the artesian pressure.

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

For wells constructed in bedrock that are designed and equipped to be pumped at a rate of less than thirty (30) gallons per minute:

- (1) Set a minimum of eighty (80) feet of casing, or where unconsolidated materials are fifty (50) feet in depth or deeper, extend casing not less than thirty (30) feet into solid bedrock;
- (2) Construct the drillhole a minimum of eight (8) inches in diameter to the casing point;
- (3) Provide a minimum of three (3) spacer guides within twenty (20) feet of the bottom of the casing;
- (4) Sealing and casing shall be as follows:

- a) Seal the lowermost twenty (20) feet and the upper thirty (30) feet annular space between the casing and the wall of the well with neat cement grout, or fill the entire annular space with bentonite;
- b) Set and seal casing of wells drilled to a depth greater than five hundred (500) feet as determined by the Missouri Division of Geology and Land Survey, Missouri Department of Natural Resources.
- c) St. Francois Mountain Area: Case all wells with not less than thirty (30) feet of casing and seal annular space between the casing and wall of the well with neat cement grout from the bottom of the casing to the ground surface.
- d) Springfield Area: Provide a casing point for wells drilled below the Northview shale fifty (50) feet below the Swan Creek sandstone formation.

For wells constructed in bedrock that are designed and equipped to be pumped at a rate of more than thirty (30) gallons per minute:

- (1) Obtain the casing point determination prior to commencing drilling from the Missouri Division of Geology and Land Survey, Missouri Department of Natural Resources;
- (2) Construct drillhole at least four (4) inches larger than normal diameter of casing to the casing point;
- (3) Install one (1) set of three (3) spacer guides for each one hundred (100) feet of casing;
- (4) Set the casing to the depth determined by the Missouri Division of Geology and Land Survey;
- (5) Seal the annular space between the casing and wall of the well by neat cement grout introduced at the bottom of the casing and forced upward to the ground surface;
- (6) Suspend drilling operations following grouting for a minimum of seventy-two (72) hours.

For well constructed in "glacial drift" or "alluvium":

- (1) Seal the upper thirty (30) feet of annular space between casing and earth materials with neat cement grout;
- (2) In the event that the well screen (or its equivalent) is less than thirty (30) feet below the ground surface, seal the annular space between the casing and earth materials in its entirety by neat cement grout.

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

Well to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidance provided in ASTM D5521, Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers.

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

Protection. All wells shall be constructed at a sufficient height above the ground surface to exclude the entrance of surface and near surface water. Leave a minimum of one (1) foot of casing extending above the finished grade or four (4) feet above maximum flood level, whichever is highest.

For wells used 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 on all wells. A sanitary well seal shall

be installed at the top of the well casing to protect the entrance of contaminated water or other objectionable material. Ground and backfill shall be graded and shaped to drain away from the well.

Disinfection. Wells shall be disinfected immediately following their construction or repair to neutralize any contamination for equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all local or state requirements. Disinfect the well with a chlorine compound with a strength of at least fifty (50) parts per million.

Gravel pack. If gravel packing is used, it shall be of the specified gradation and thickness and shall be carefully placed to prevent segregation and bridging. Gravel pack materials shall extend a minimum of ten (10) feet above the top of the perforated or screened section and shall extend through the length of the water-bearing formation. Details of gravel pack shall be as shown on the drawings.

MATERIALS

For wells constructed in bedrock that are designed and/or equipped to be pumped at a rate of less than thirty (30) gallons per minute, install new six (6) inch inside diameter steel or wrought iron casing weighing not less than 12.9 pounds per foot, or polyvinyl chloride (PVC) plastic casing conforming to requirements in this specification.

For wells constructed in bedrock that are designed and/or equipped to be pumped at a rate of more than thirty (30) gallons per minute, install new steel casing with a minimum of six (6) inch inside diameter weighing not less than 18.9 pounds per foot with corresponding higher weights for larger casing.

Casing materials for all other wells may be made of steel, copper, plastic, concrete, or other similar materials of equivalent strength and durability.

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

Steel pipe, copper, reinforced plastic mortar, or plastic pipe may be used for well casings in drilled wells. Used steel pipe may be used for well casing, provided that it is of good quality and has a wall thickness equal to or greater than standard weight as defined in ASTM A53. Plastic material used for casing shall be polyvinyl chloride (PVC). Plastic casing shall be National Sanitation Foundation (NSF) -- approved for transport of potable water supplies -- if the water will be used for human consumption.

PVC casing pipe material shall meet or exceed the requirement of ASTM Specification D1784, cell classification 12454-A, B, C, or 14333-A, B, C, D. PVC casing pipe, couplings and screen plastics shall be made of virgin plastic produced by the original compounder without extenders. It shall contain polyvinyl chloride homopolymer, and such additives (stabilizers, lubricants, processing aids, impact improvers, and colorants) as needed to provide the required processing and toughness characteristics. PVC plastic pipe meeting equivalent specifications, as approved by the engineer, may be used.

Concrete well casings shall be reinforced and shall meet or exceed the requirements of ASTM C76. The minimum 28-day compressive strength shall be 4,000 pounds per square inch. Concrete well casing shall be limited to wells not greater than 500 feet in depth.

Reinforced Plastic Mortar Pressure Pipe well casing shall equal or exceed the requirements of ASTM Specification D3517.

Steel well casings shall equal or exceed the requirements of ASTM A589 or A53.

Tables 1 through 5, as appropriate, give limits for casing materials.

Joints. Joints for well casing shall have adequate strength to carry the load due to the casing length and still be watertight. Connections shall be mechanically supported during the installation process to

maintain joint integrity. Mechanically supported casings shall terminate on firm material that can adequately support the casing.

Joints for plastic well casing pipe may be solvent cement or threaded couplings and shall have sufficient strength to carry the load due to the casing length and still remain watertight. Solvent cement must meet the requirements of the ASTM D2564 for PVC material.

Threaded couplings for plastic well casing pipe shall be either American National Standard Institute B1.5 1973 for ACME 2G screw threads, American National Standard Institute B1.8 for Stub ACME 2G screw threads, or American National Standard Institute for B1.9 1973 for Buttress screw threads, respectively.

Markings. The well casing pipe shall be marked according to the ASTM specification for the material used.

CERTIFICATION AND REPORT.

Complete all necessary certification and registration reports with MoDNR-DGLS according to existing Missouri Well Construction Rules.

Additional Details: _____

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

SDR ^{1/}	Modulus of elasticity (E)		
	400,000	360,000	320,000
	feet	feet	feet
13.5	985	885	785
17	475	430	380
21	245	220	200
26	130	115	100
32.5	65	60	50

^{1/} SDR - Standard Dimension Ratio

Table 2. - Dimensions and maximum depth of installation of Schedule 40, 80, and 120 PVC plastic pipe^{1/}

Nominal diameter	Outside diameter	Schedule 40			Schedule 80			Schedule 120		
		Minimum wall thickness	SDR ^{2/}	Maximum depth	Minimum wall thickness	SDR ^{2/}	Maximum depth	Minimum wall thickness	SDR ^{2/}	Maximum depth
inches	inches	inches	---	feet	inches	---	feet	Inches	---	Feet
4	4.50	0.237	19.0	340	0.337	13.4	1,010	0.437	10.3	2,330
5	5.563	.258	21.6	230	.375	14.8	740	.500	11.1	1,830
6	6.625	.280	23.7	170	.432	15.3	660	.562	11.8	1,510
8	8.625	.322	26.8	120	.500	17.3	450	.718	12.0	1,430
10	10.75	.365	29.5	90	.593	18.1	390	.843	12.8	1,160
12	12.75	.406	31.4	--	.687	18.6	360	1.000	12.8	1,160

^{1/} Table is for PVC Schedule pipe made of Type I, Grades 1 and 2 material having a modulus of elasticity of 400,000 pounds per square inch. For PVC pipe made of Type 4, Grade 1 having a modulus of elasticity of 360,000, multiply the depths by a factor of 0.9. For Type 2, Grade 1 having a modulus of elasticity of 320,000, use of factor of 0.8.

^{2/} SDR - Standard Dimension Ratio

Table 3. - Dimensions and depth limitations for reinforced plastic mortar well casings.

Casing Diameter (inches)	Casing Depth (feet)								
	20	60	100	200	300	400	500	750	1,000
	Minimum Wall thickness (inches)								
8	0.17	0.17	0.23	0.23	0.23	0.29	0.29	0.33	0.33
10	.17	.17	.28	.28	.28	.36	.36	.41	.41
12	.18	.19	.34	.34	.34	.43	.43	.46	.46
14	.19	.22	.34	.40	.40	.43	.46	.46	.46
15	.19	.24	.34	.34	.46	.46	.46	.46	.46
16	.20	.25	.36	.36	.46	.46	.46	.46	.46
18	.21	.28	.40	.40	.46	.46	.46	.52	.52
20	.21	.31	.42	.42	.46	.46	.46	.54	.54
21	.21	.33	.48	.48	.48	.48	.48	.57	.57
24	.24	.38	.48	.48	.57	.57	.57	.57	.57
27	.26	.40	.49	.49	.49	.62	.62	.62	.62
30	.29	.44	.49	.49	.49	.68	.68	.68	.68
33	.32	.44	.60	.60	.60	.75	.75	.75	.75
36	.35	.48	.65	.65	.65	.82	.82	.82	.82

Table 4. - Minimum thickness of steel casings^{1/}

Diameter ^{2/} Steel casing (inch)	Minimum Thickness (inch)
1	0.133
1-1/2	.145
2	.154
2-1/2	.203
4	.237
5	.258
6	.280 ^{3/}
8	.322 ^{3/}
10	.365 ^{3/}
12	.375 ^{3/}
14	.375 ^{3/}
16	.375 ^{3/}
18	.375
24	<u>.375</u>

1/ Conforming to ASTM A53 or A589, standard weight

2/ Diameters 1 through 2-1/2 inches. use only for driven or artesian wells

3/ For low yield wells the minimum thickness of steel casing may be reduced to 0.188 inches as specified in Missouri Well Construction Rules for nominal pipe diameters - 6 though 16 inches

Table 5. - Maximum depth of installation for steel casing

Wall Thickness Gauge (inches)	Casing Size (inch)									
	4	5	6	8	10	12	14	16	18	24
	Outside Diameter (inch)									
	4.50	5.563	6.625	8.625	10.75	12.75	14.00	16.00	18.00	24.00
	Maximum Depth (feet)									
12 Ga (0.105)	2,030	1,060								
10 Ga (0.135)			1,340							
3/16 (0.188)				1,650	840	500	370	250		
7/32 (0.219)					1,340	800	600	400		
1/4 (0.250)						1,190	890	600	420	170
9/32 (0.281)							1,280	850	590	250
5/16 (0.312)								1,170	820	340
11/32 (0.344)									1,100	460
3/8 (0.375)										600
7/16 (0.438)										960

Note: Based on the Cleideinst Equation for Critical Collapse Pressure, using Poisson's ratio (ν) of 0.30 and a modulus of elasticity of (E) of 30,000,000 pounds per square inch.

**NATURAL RESOURCES CONSERVATION SERVICE
MISSOURI OPERATION AND MAINTENANCE**

WATER WELL

CODE 642

OPERATION AND MAINTENANCE

The well shall be inspected at least annually to ensure:

- (1) Surface drainage is not running into the well.
- (2) Well has not been damaged by weather, livestock, or vandalism.
- (3) Pump is delivering the proper amount of water.
- (4) The following tests should be conducted annually for water quality purposes:
 - a) Bacteria and nitrate
 - b) Corrosion
 - c) Hardness, alkalinity, and chloride

Additional Details: _____

