



Rules of
Department of Natural Resources
Division 23—Division of Geology and Land Survey
Chapter 3—Well Construction Code

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**Title 10—DEPARTMENT OF
NATURAL RESOURCES
Division 23—Division of Geology and
Land Survey
Chapter 3—Well Construction
Code**

10 CSR 23-3.010 Location of Wells

Editor's Note: Area maps mentioned in the rule may be found following 10 CSR 23-3.110.

PURPOSE: This rule sets criteria as to the areas a well should be placed.

(1) A well shall be located consistent with the general layout and surrounding area giving due consideration of the size of the lot, contour of the land, the water table, soil deposits, rock formation, local groundwater conditions and other factors necessary to implement the basic policies that follow:

(A) A well shall be—

1. Located on a site which has good surface drainage and, if possible, at a higher elevation than possible sources of contamination. The top of the casing shall extend at least one foot (1') above the finished surface grade;

2. Located so that the well and its surrounding area can be kept in a sanitary condition and provide ready access for repairs, maintenance and inspection;

3. Adequately sized, designed and developed for the intended use;

4. Constructed so as to maintain existing natural protection against pollution of water-bearing formations and to exclude all known sources of contamination from the well including sources of contamination from adjacent property;

5. Located so that proper drainage in the vicinity of the well shall be provided so as to prevent the accumulation and ponding of surface water within ten feet (10') of the well; and

6. If at all possible, located in areas that do not flood. If no reasonable alternative site exists, wells may be constructed in floodplains provided special construction is included. The casing of the well shall terminate not less than two feet (2') above the maximum known floodwater elevation or when flooding is eminent, well vent must be sealed and well discontinued from operation until floodwater subsides.

(2) Lateral distances from Pollution or Contamination Sources.

(A) A well shall be at least—

1. Three hundred feet (300') from a

storage area for commercial fertilizers or chemicals, landfill, lagoon, above ground or underground storage, tank distribution lines for liquid petroleum, petroleum products or chemicals. Petroleum or petroleum products that are not liquid at standard temperatures and pressure are exempt from these set-back requirements;

2. Three hundred feet (300') from earthen, concrete or other manure storage structures or lagoons, from land application areas for domestic or animal waste and from animal composting facilities except as stated in paragraph (2)(A)4. of this rule;

3. One hundred feet (100') from cesspools and unplugged abandoned wells, except as noted in paragraph (2)(A)6. of this rule;

4. One hundred feet (100') from a subsurface disposal field, grave, single family lagoon, building or yard used for livestock or poultry, bird composting facility constructed with a concrete floor cell design covered with a roof, dry litter storage within a poultry building as accumulation of litter occurs during normal facility operations, privy or other contaminants that may drain into the soil;

5. Fifty feet (50') from a buried sewer, septic tank or sewer holding tank, a pit or unfilled space below ground surface, a sump, an existing operating well, except that a well may be drilled closer than fifty feet (50') to a basement and an above ground petroleum storage tank if it is necessary for the operation of the well pump;

6. Wells with casings less than eighty feet (80') in depth and not encountering at least ten feet (10') of impervious material shall be located at least one hundred fifty feet (150') from cesspools and unplugged abandoned wells and at least one hundred fifty feet (150') from a subsurface disposal field, and septic tank, manure storage pile or similar source of contamination. For example, a manure storage pile would be considered as a potential source of contamination to the well; however, the presence of animals in open pasture in an area would not necessarily concentrate contaminants to the degree that would cause contaminants to enter the groundwater; and

7. Ten feet (10') from the right-of-way of any federal, state or county road.

(B) Waste landfill or lagoons. The safe distance that a well should be located from a waste landfill or waste stabilization ponds (lagoon) cannot be assigned a fixed number because of the varieties of hydrologic and geologic parameters associated with the undetermined types and amounts of materials that may be carried by groundwater from

leachates discharged from the waste landfill or waste stabilization ponds (lagoon). It is recommended that wells not be located in an area between the landfill or waste stabilization ponds (lagoons) sites and the point of groundwater discharge to a surface water source. Any well that may intercept leachates from a waste landfill or waste stabilization pond (lagoon) by water withdrawal from the well shall not be used for human consumption and must be plugged unless it is used for a monitoring well.

(C) Irrigation wells require increased setbacks and shall be at least two hundred feet (200') from—

1. Sewer lines, septic tanks, lateral fields, pit privy, seepage pits, feed lots, barnyards, fuel, fertilizer and pesticide storage. Fuel, fertilizer and pesticide tanks up to one thousand gallons (1000 gals.) in capacity will be allowed at well while irrigating and chemigating but must be removed from well site when not in use; and

2. Any well producing potable water.

AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.020 General Protection of Groundwater Quality and Resources

PURPOSE: This rule is for the overall protection of water quality and resources in Missouri.

(1) Reuse of Water, Disposal, Recharge or Gas Storage Wells.

(A) A well for the storage of gas or liquid under pressure may not be drilled without first having secured a permit from the Department of Natural Resources in accordance with the Missouri Statutes.

(B) Water used for cooling parts of engines, air compressors or other equipment shall not be returned to any part of the groundwater system. A well shall not be used for disposal or injection of any substance, including surface water, groundwater or any liquid, gas or chemical associated with the drilling of an oil or gas well, including coal bed methane wells, without first receiving a



permit from the Underground Injection Control Program's rules and 10 CSR 50-2, Oil and Gas Council, Oil and Gas Drilling and Production. A permit through the Division of Environmental Quality, Water Pollution Control Program may be required.

(C) A well previously used for storage of gas or liquid under pressure may not be converted to a well used for water supply.

(2) Maintenance and Repair of Wells.

(A) Every well shall be maintained by the owner in a condition where it will conserve and protect the groundwater resources and where it will not be a source or channel of contamination or pollution to the water supply of that well or any aquifer.

(B) All materials used in maintenance, replacement or repair of any well subject to these rules shall meet the requirement of these rules for new installation.

(C) Broken, punctured or otherwise defective or unserviceable casing, screens, fixtures, seals or any part of the wellhead shall be repaired or replaced. The well shall be plugged in accordance with the requirements of these rules if that repair or replacement is not performed.

(D) Repairs to wells originally completed with the wellhead terminating below ground (buried seal) should include extending the well casing one foot (1') above the finished surface grade. The casing extension material must be of similar material to the original casing (for example, steel to steel and plastic to plastic). On steel casing the joint must be welded, coupled or threaded. On plastic casing, the joint must be glued or fused. All joints and extensions must be sealed to prevent contamination from entering the groundwater. Sealing material must not be a contaminant such as tar. When this type of repair to a well is completed, it must not move at the joint under normal operating conditions. The use of devices specially designed to join dissimilar casing materials together will be considered on a case-by-case basis by the division. Approval must be received in advance.

(3) Cross connections between wells and other systems or equipment containing water or other substances of unknown or questionable safety, including pesticides and fertilizers, are prohibited, except where equipped with a suitable protective device such as a break tank or backflow preventer which is approved by the division and which the owner agrees to install, test and maintain to assure proper operation.

(4) All other wells except those specifically

exempted by the law shall be constructed and maintained in accordance with standards from the division.

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.025 Public Water Supply—Notification to Division
(Rescinded August 30, 2018)

AUTHORITY: sections 256.606 and 256.628, RSMo Supp. 1991. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Rescinded: Filed Dec. 29, 2017, effective Aug. 30, 2018.

10 CSR 23-3.030 Standards for Construction of Wells

PURPOSE: This rule describes the minimum standards for a properly constructed well but does not apply to community or noncommunity public water supply wells. It is the obligation and responsibility of the driller to construct community and noncommunity wells following procedures set forth by the Missouri Public Drinking Water rules.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Casing for Permanent Wells. Steel well casing used for the outside casing must be new and shall be of at least six-inch (6") nominal size (6.625 outside diameter in inch-

es, actual dimensions), thirteen pounds (13 lbs.) per foot, 0.188 wall thickness. Coated casings are permitted as long as they are not a source of contamination to the groundwater. Larger diameter casing shall have minimum weights and thicknesses as specified in subsection (1)(G) of this rule. Concrete casing is permitted for use. Casing for permanent wells shall be of ferrous material, or where permitted by rule, plastic or concrete material. For ferrous pipe, the specifications and installation procedures are prescribed as follows. For plastic pipe, the specifications and installations procedures are prescribed in 10 CSR 23-3.070.

(A) Casing Joints. A protective well casing shall have watertight joints throughout its length. The joints shall be made by being continuously welded, threaded or other types of joints given written approval by the division. Tongue and groove type of joints are acceptable for concrete casings. Recessed or reamed and drifted couplings shall be used on threaded casing, or as an alternate, other couplings can be used but the design, taper and type of thread of the coupling shall match that of the pipe. Other casing design or materials shall be approved only by official written order of the division.

(B) Standard for Pipe. Pipe used as the casing in the permanent construction of a well shall be new pipe produced to recognized standards of the American Society for Testing and Materials, A53 grade A or B, A500 grade A or B, or A589 or other grade weldable new pipe having a quality equal to or greater than those specified. New pipe, when salvaged within thirty (30) days of the drilling of a well for water supply may be used as new pipe if still in new condition and must be decontaminated.

(C) Inside Casing Diameter. Under no condition shall the casing inside diameter be less than six inches (6") unless specifically exempted in 10 CSR 23-3 except for a driven well point or jetted well which shall be equipped with a casing pipe of at least one and one-fourth inches (1 1/4") inside diameter. The well shall also be of sufficient diameter to receive a pump or pumping apparatus of sufficient size to discharge the design capacity including anticipated decline in water levels.

(D) Vertical Extension. A well casing or its extension shall extend vertically at least one foot (1') above the finished surface grade. If the well is located in a floodplain see 10 CSR 23-3.010(1)(A)6. for requirements.



(E) A table of minimum specifications for steel casing for domestic, multifamily, high yield and unconsolidated material irrigation wells and bedrock irrigation wells follows: (A variance must be obtained in advance from the division to install casing not on this table.)



STEEL CASING TABLE

Domestic and Multi-Family Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.188	13 lbs.

High Yield and Bedrock Irrigation Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.280	19 lb.
8	8.625	.322	29 lb.
10	10.75	.365	40 lb.
12	12.75	.375	50 lb.
14	14.00	.375	55 lb.
16	16.00	.375	63 lb.
18	18.00	.375	71 lb.
20	20.00	.375	79 lb.
22	22.00	.500	115 lb.
24	24.00	.500	125 lb.
26	26.00	.500	136 lb.
28	28.00	.500	147 lb.
30	30.00	.500	158 lb.
32	32.00	.500	168 lb.
34	34.00	.500	179 lb.
36	36.00	.500	190 lb.

Unconsolidated Material Irrigation Well

Nominal Pipe Size In Inches	Outside Diameter In Inches	Wall Thickness In Inches	Weight/Foot
6	6.625	.188	13 lb.
8	8.625	.188	17 lb.
10	10.75	.188	21 lb.
12	12.75	.188	25 lb.
14	14.00	.188	28 lb.
16	16.00	.188	32 lb.



(2) Minimum Protective Depths of Well Casing. All wells shall be watertight to such depth as may be necessary to exclude contaminants. A well shall be constructed so as to seal off formations that are likely to pose a threat to the aquifer or human health. Requirements will be fulfilled to the minimum extent when the protective casing has been installed in conformity with the applicable construction set forth in 10 CSR 23-3.030–10 CSR 23-3.110. Sections (17)–(20) state the amount of grout needed to fill the minimum required amount of annular space in the different areas across Missouri. Where it is not feasible to follow the standards contained in this part, the permittee shall obtain approval of the division as to the design of the well before proceeding. The acceptability of the formation for well development shall be based on the satisfactory results of analysis of the water. Any water-bearing formation yielding water which is contaminated, as evidenced by the presence of chemicals or bacteria which may be harmful, shall be regarded as unsatisfactory for use as a potable supply unless adequate treatment is provided. The division will decide acceptable water treatment measures only after all well construction remedies have been exhausted.

(3) Grouting.

(A) Grouting Required for Wells. It is the obligation and responsibility of the well installation contractor to ensure that the annular space is sealed and that the casing does not leak. This obligation and responsibility ends three (3) years after the date of certification unless it can be shown that the well seal has been damaged by other persons. The following is a list of approved grouting methods:

1. Gravity installation method. The grout is poured into the annular space without the use of a tremie or grout pipe. Cement or bentonite slurry may never be poured through standing water without the use of a tremie pipe. The Gravity Grouting Table is a table which states the minimum requirements concerning the depth that grout can be gravity fed in wells that have an annulus from one inch to two inches (1"–2"). This table reflects the use of actual drill bit sizes and a six and five-eighths-inch (6 5/8") outside diameter casing. Nominal sizes may not be used when determining the annular space. Contact the division for instructions concerning grouting wells with larger than a two-inch (2") annulus. Note: When using plastic casing, a larger hole is recommended due to the belled casing ends reducing the annular space.

Gravity Grouting Table

Size Hole (inches)	Outside Diameter of Casing (inches)	Annular Space (inches)	Gravity Feed Depth (feet)
8 5/8	6 5/8	1	100
8 3/4	6 5/8	1 1/16	106
8 7/8	6 5/8	1 1/8	112
9	6 5/8	1 3/16	119
9 1/8	6 5/8	1 1/4	125
9 1/4	6 5/8	1 5/16	131
9 3/8	6 5/8	1 3/8	137
9 1/2	6 5/8	1 7/16	144
9 5/8	6 5/8	1 1/2	150
9 3/4	6 5/8	1 9/16	156
9 7/8	6 5/8	1 5/8	162
10	6 5/8	1 11/16	169
10 1/8	6 5/8	1 3/4	175
10 1/4	6 5/8	1 13/16	181
10 3/8	6 5/8	1 7/8	187
10 1/2	6 5/8	1 15/16	193
10 5/8	6 5/8	2	200

2. Tremie method. In this method the grout is placed in the annular space by gravity through a tremie or grout pipe suspended in the annular space. The tremie pipe is placed into the annulus and extends to within five feet (5') from the bottom of the interval to be grouted. The grout is added into the tremie pipe which should remain submerged in the grouting material during the entire time the grout is being placed. The tremie pipe is gradually withdrawn as the grouting material is placed or may be removed after the annular space is full and before the grout sets;

3. Pressure grouting through tremie method. For this method the same procedure is followed as described in the tremie method, except the grout is pumped into the tremie pipe instead of placed by gravity flow;

4. Pressure grouting through the casing method. Instead of using a tremie pipe placed in the annular space a grout pump is attached to the top of the casing and grout pumped through the casing and allowed to fill the annular space from the bottom. Pumping continues until grout reaches the surface of the annular space. Grout must be allowed to set up before drilling continues;

5. Open-hole method. Grout is poured into the drill hole from the surface and allowed to fill the drill hole to the required level. Note: Much more grout is required to fill the bottom thirty feet (30') of drill hole when using the open-hole method. See 10 CSR 23-3.030(17)–(20) for specific amounts. Then the casing is placed into the drill hole through the grouting material. This method may not be used if water is standing in the drill hole unless grout is placed by one (1) of the tremie grouting methods or if bentonite chips are used, they must be allowed to completely hydrate before the casing is pushed into the grout;

6. Positive displacement method. Casing is set into the borehole to a point about five feet (5') above the casing point. Grout is poured into the well casing followed by a drillable plug. This is designed to push all grout to the bottom of the well. If there is water in the borehole and bentonite or cement slurry is used it must be emplaced via a tremie to the bottom of the borehole. The plug is pushed to the bottom of the casing forcing the grout down the inside of the casing and up the annular space. The casing is then set into the bottom of the drill hole; and

7. Other grouting methods must be approved by the division in advance.

(4) Approved Grouting Methods.

(A) Neat Cement Grout. Neat cement grout is a mixture of one (1) bag, ninety-four pounds (94 lbs.) of Portland cement (ASTM C150) to not more than six (6) gallons of clean water. Bentonite, up to six percent (6%) by weight of cement to reduce shrinkage or other additives (ASTM C688) to reduce permeability or control time of set or both, may be used. If bentonite is used, additional water should be added to the mix.

(B) Bentonite Grout. Sodium bentonite (swelling clay) is available in many forms from granules to pellets to chips. When grouting annular spaces with non-slurry bentonite, great care must be exercised to ensure the bentonite is placed properly. Flash swelling may occur and bridge off the annular space preventing an adequate seal when using powdered, granular, tablets or pelletized bentonite. Therefore, only bentonite specifically designed to prevent flash hydration and to fall through standing water may be used. Chipped or pelletized bentonite may not be used in annular spaces less than one inch (1"). Bentonite must be applied slower than manufacturer's specifications. If there is no water in the annular space, the bentonite must be hydrated after each bag or water poured into the hole before application of the bentonite.

(C) Bentonite Slurry Grout. Sodium bentonite slurry grout is a bentonite/water mixture. There are many additives available that effect viscosity and set-up time. These additives are acceptable unless they are a potential contaminant. Bentonite slurry must have a solids content of at least twenty percent (20%).

(D) Other Grout Types. Other types of grout may be used when necessary if prior approval by the division is granted.

(5) Drill cuttings used by themselves or in conjunction with a drive shoe, packer or boot



are not approved materials for grouting the annulus of any well.

(6) Grouting required for Community and Noncommunity Public Water Supply Wells. It is the obligation and responsibility of the driller to follow procedures set forth by the Missouri public drinking water rules.

(7) Driven Casing Wells. The bottom of the steel well casing shall be equipped with a drive shoe or otherwise protected from damage during construction of the well as dictated by drilling procedures and conditions of each particular well (see 10 CSR 23-3.100(4)(D)3. for grouting techniques).

(8) Capping. Temporary capping of a well until the pumping equipment is installed shall allow no pollution or foreign objects to enter the well.

(9) Alignment. A well shall not vary from the vertical or alignment so as to interfere with installation and operation of the pump.

(10) Well Development. The well shall be developed to remove any material deposited on the aquifer face during the drilling, drilling fluid and the predetermined finer fraction of a gravel pack, all of which shall be done to ensure that the maximum practical specific capacity will be obtained from the completed well.

(11) For further construction requirements for domestic wells see 10 CSR 23-3.090 Regionalization and 10 CSR 23-3.100 Sensitive Areas.

(12) Multifamily wells are water supply wells constructed for the purpose of serving more than three (3) dwellings but having less than fifteen (15) service connections and regularly serves less than twenty-five (25) individuals daily at least sixty (60) days out of the year. A multifamily well must be constructed as follows:

(A) Minimum casing lengths for multifamily wells are the same as domestic wells. Liner may not substitute for casing;

(B) The drill hole shall be constructed a minimum of ten inches (10") in diameter. An increase in hole size to ten and five-eighths inches (10 5/8") in diameter will be effective May 1, 1999. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed;

(C) The casing used must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for multifamily wells. Plastic casing may be used if approved in advance on a case-by-case basis;

(D) The casing must be grouted full-length with grout utilizing the tremie method or one (1) of the pressure grouting methods set out in section (3) of this rule;

(E) The neat cement grout must be allowed to set up based on the parameter of the following:

1. Hi-early cement—minimum of twelve (12) hours;

2. Portland Type I cement—minimum of seventy-two (72) hours; and

3. High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(F) When drilling starts, after cement has set, care should be taken when drilling out the bottom of the casing so that curing cement is not damaged.

(13) Unconsolidated Material Irrigation Well. A well drilled into alluvial, glacial drift or glacial outwash aquifers that is not deeper than two hundred feet (200') and produces water not for human consumption shall conform to the following construction requirements:

(A) The selection of casing shall take into consideration the stress to which the pipe will be subjected during construction and the corrosiveness of the groundwater. Used pipe is prohibited. If steel casing is selected, see subsection (1)(E) Steel Casing Table, for size, wall thickness and weight per foot specifications. If plastic casing is selected (see 10 CSR 23-3.070 for specifications);

(B) Unconsolidated material irrigation wells greater than two hundred feet (200') in depth must be constructed using bedrock irrigation specifications contained in section (14);

(C) The drill hole shall be constructed a minimum of four inches (4") in diameter larger than the outside diameter of the casing to be installed;

(D) Set Screen and Casing. Screen openings shall provide the maximum amount of open area consistent with strength of screen and the grading of the water-bearing formation and gravel pack. The openings shall permit maximum transmitting ability without clogging or jamming;

(E) Gravel Pack. All gravel placed into well shall be clean, washed and disinfected prior to placement or provisions made for disinfection in place. When an oversized drill hole is constructed to permit the placement of a gravel wall around the well screen and casing, grouting and sealing may be suspended

for sixty (60) days to allow for gravel to settle and for well development; and

(F) Grouting. After the well has been developed and pumped, but in no case later than sixty (60) days, dig around the well to a depth of four feet to five feet (4'-5') and fill with sodium bentonite granules, pellets, tablets or chips. Bentonite slurry or organic polymers shall not be used.

(14) Bedrock Irrigation Well. These wells are drilled into bedrock aquifers that are constructed to meet required standards and are equipped with a pump that has the capacity to produce more than seventy (70) gallons of water per minute. The produced water is for irrigating crops but may be used for human consumption. This type of well shall conform to the following construction requirements:

(A) The minimum amount of casing set must be determined by the division in advance on a casing point request form. A casing point request form is available from the division;

(B) The drill hole shall be constructed a minimum of ten inches (10") in diameter. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed;

(C) The casing used must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for high yield and bedrock irrigation wells; and

(D) The casing must be grouted full-length with neat cement grout utilizing the tremie method or one (1) of the pressure grouting methods set out in section (3).

(15) High Yield Well. Those wells that are constructed to meet required standards and are equipped with a pump that has the capacity to produce more than seventy (70) gallons of water per minute.

(A) The minimum amount of casing set must be determined by the division in advance on a casing point request form. A casing point request form is available from the division.

(B) The drill hole a minimum of ten inches (10") in diameter shall be constructed. The drill hole must be at least four inches (4") in diameter larger than the outside diameter of the steel casing to be installed.

(C) The casing must be of ferrous material and conform to size, wall thickness and weight/foot parameters set out in subsection (1)(E), for high yield and bedrock irrigation wells.

(D) The casing must be grouted full-length with neat cement grout utilizing the tremie



method or one (1) of the pressure grouting methods set out in section (3).

(16) Lubricants Used During the Drilling Process. During the drilling of a well, some lubricants may be necessary to ensure protection of the drilling machine. The lubricants used must not adversely affect the groundwater quality and must be biodegradable. Special care must be taken to ensure leaking hoses on the drilling machine do not allow harmful lubricants or fluids to enter the borehole.

(17) Most domestic bedrock wells drilled in the state have an eight and five-eighths-inch (8 5/8") hole drilled to casing point and a six and five-eighths-inch (6 5/8") outside diameter casing installed into bedrock. The rules state that the bottom thirty feet (30') of the annulus must be grouted. Table 1 states the minimum amount of grout required to fill the bottom thirty feet (30') of annulus taking into account the use of a six and five-eighths-inch (6 5/8") outside diameter casing, borehole size differences, type of grout utilized, and method of emplacement of the grout.



TABLE 1
Number of Bags for Minimum Amount of Required Grout for a
Domestic Bedrock Water Well

Outer Diameter of Steel/Plastic Casing: 6 5/8 Inches—Minimum Length of Grout: 30 feet

Borehole Diameter	8 5/8" *Ann.^O.H.	8 3/4" *Ann.^O.H.	9" *Ann.^O.H.	10" *Ann.^O.H.	10 5/8" *Ann.^O.H.	11" *Ann.^O.H.
Type of Grout						
CEMENT						
Portland Type I	5 11	5 11	6 12	8 15	10 17	12 18
Portland Type III	5 11	5 11	6 12	8 15	10 17	12 18
BENTONITE						
Pellets—						
1/2" Baroid Pellets	7 17	7 17	8 18	13 22	15 25	17 27
3/8" Baroid Pellets	7 17	8 18	9 19	13 23	16 27	18 28
1/4" Baroid Pellets	7 17	8 19	19 13	23 16	26 18	28 28
Wyo-Bend Tablets	8 18	8 19	9 20	14 25	17 28	19 30
Volclay 1/2"	8 19	8 19	9 20	14 25	17 28	19 30
Volclay 3/8"	8 19	8 20	10 21	14 26	18 29	20 31
Volclay 1/4"	8 20	9 20	10 22	15 27	18 30	21 32
Chips—						
Baroid HolePlug	7 18	8 18	9 19	13 24	16 27	18 29
Wyo-bend Coarse	6 15	7 15	7 16	11 20	14 22	15 24
Wyo-bend Medium	6 15	7 16	8 17	12 21	14 23	16 25
Volclay Coarse	7 16	7 17	8 18	12 22	15 25	17 27
Volclay Medium	7 17	7 17	8 18	13 23	16 26	17 27
Granular—						
Benseal	6 15	7 16	8 17	12 21	14 23	16 25
Wyo-bend No. 8	6 15	7 15	7 16	11 20	14 22	15 24
Wyo-bend No. 16	6 15	7 15	7 16	11 20	14 22	15 24
Slurry—						
Baroid	1 4	2 4	2 4	3 5	3 5	4 6
Wyo-bend	2 4	2 4	2 4	3 5	4 6	4 6
Volclay	1 3	2 4	2 4	3 5	3 5	4 6

*Ann. = Bags needed to fill Annular Space
 ^O.H. = Bags needed to fill the Open Bore Hole



(18) Most alluvial domestic wells drilled in the state have a ten and five-eighths-inch (10 5/8") hole drilled and a six and five-eighths-inch (6 5/8") outside diameter casing installed. The rules state that the top twenty feet (20') of annulus must be grouted. The following amounts of grout are necessary, at a minimum, to fill this space: Table 2 states the minimum amount of grout required to fill the top twenty feet (20') of annulus taking into account the use of a six and five-eighths-inch (6 5/8") outside diameter casing and screen, borehole size differences, type of grout utilized, and method of emplacement of the grout.

TABLE 2
Number of Bags for Minimum Amount of Required Grout for
Domestic Unconsolidated Water Wells

Outer Diameter of Steel/Plastic Casing: 6 5/8 inches—Minimum Length of Grout: 20 feet

Borehole Diameter	10 5/8" *Ann.^O.H.	12 5/8" *Ann.^O.H.	14 5/8" *Ann.^O.H.	16" *Ann.^O.H.	18" *Ann.^O.H.
Type of Grout					
CEMENT					
Portland Type I	7 11	12 16	17 21	21 26	28 32
Portland Type III	7 11	12 16	17 21	21 26	28 32
BENTONITE					
Pellets—					
1/2" Baroid Pellets	10 17	17 24	25 32	32 38	42 48
3/8" Baroid Pellets	11 18	18 25	27 33	33 40	44 51
1/4" Baroid Pellets	11 18	18 25	26 33	33 40	44 50
Wyo-Bend Tablets	11 19	19 26	28 35	35 42	46 53
Volclay 1/2"	11 19	19 27	28 36	35 43	47 54
Volclay 3/8"	12 19	20 27	29 37	36 44	48 56
Volclay 1/4"	12 20	20 28	30 38	38 45	50 57
Chips—					
Baroid HolePlug	11 18	18 25	27 34	34 41	44 51
Wyo-bend Coarse	9 15	15 21	23 28	28 34	37 43
Wyo-Bend Medium	9 15	16 22	23 29	29 35	38 44
Volclay Course	10 17	17 23	25 31	31 38	42 48
Volclay Medium	10 17	17 24	26 32	32 39	42 49
Granular—					
Benseal	9 16	16 22	23 29	29 35	39 45
Wyo-bend No. 8	9 15	15 21	23 28	28 34	37 43
Wyo-bend No. 16	9 15	15 21	23 28	28 34	37 43
Slurry—					
Bariod	2 4	4 5	6 7	7 8	9 10
Wyo-bend	2 4	4 5	6 7	7 9	10 11
Volclay	2 3	4 5	5 7	7 8	9 10

*Ann. = Bags needed to fill Annular Space

^O.H. = Bags needed to fill the Open Bore Hole



(19) When drilling in Area 2 or 3, under certain circumstances, domestic wells may be constructed where the upper forty feet (40') of annulus is grouted. This annulus is created by a ten and five-eighths-inch (10 5/8") hole and a five and one-half-inch (5 1/2") outside diameter casing. The following amounts of grout are necessary, at a minimum, to fill this space:

Grout Material	Size	Amount to Fill 40' of Annulus	
		Open-Hole Method	All Other Methods
Bentonite (50 lb.)	Medium chip	30.0 bags	21.5 bags
	Coarse chip	30.0 bags	21.5 bags
	#8 mesh (cannot be poured through water)	30.0 bags	21.5 bags
Cement Slurry (one 94 lb. bag with 6 gallons water) (must be tremmied through standing water)		23.0 sacks	16.5 sacks



(20) Domestic wells drilled in Area 5 can have casing as small as four and one-half-inch (4 1/2") outside diameter placed in a hole that is eight and five-eighths-inch (8 5/8") in diameter. To grout the upper twenty feet (20') of this type of well the following amounts of grout are necessary, at a minimum, to fill this space:

Grout Material	Size	Amount to Fill 20' of Annulus	
		Open-Hole Method	All Other Methods
Bentonite (50 lb.)	Medium chip	10.2 bags	7 bags
	Coarse chip	10.0 bags	7 bags
	#8 mesh (cannot be poured through water)	10.0 bags	7 bags
Cement Slurry (one 94 lb. bag with 6 gallons water) (must be tremmied through standing water)		7.5 sacks	5.5 sacks



*AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo 1994. * Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.040 Well Casing Seals and Connections

PURPOSE: This rule describes the types of well casing seals and connections that are to be used.

(1) Above-Grade Connections. An above-grade connection into the top or side of a well casing shall be at least one foot (1') above the finished grade surface and constructed to exclude dirt or other foreign matter by one (1) or more of the following methods, as may be applicable:

- (A) Threaded connection;
- (B) Welded connection;
- (C) Rubber expansion sealer;
- (D) Bolted flanges with rubber gaskets;
- (E) Overlapping well cap; and
- (F) Extension of the casing at least one inch (1") into the base of a power pump.

(2) In wells that utilize an above grade connection, special attention must be paid to the sealing capabilities of the selected well casing seal. In many cases the electric wire hole, the drop pipe hole and the vent pipe hole may not be sealed adequately. The casing seal must stop all bacteria from entering the well through the seal. It is recommended that these holes be caulked, with silicone caulk or equivalent, to ensure that bacteria or other contaminants are not pulled into the well when the pump is operating.

(3) The practice of cutting the rubber well seal to make removal and reinstallation easier is strictly prohibited.

(4) Below-Grade Connection. A connection to a well casing made below ground, or less than one foot (1') above the finished surface grade, shall be protected by a pitless adapter or pitless unit. The pitless adapter or pitless unit shall be composed of material of sufficient strength to withstand normal operating stress. A below-ground connection shall not

be submerged in water at the time of installation. Holes cut in the casing through which the pitless adapters are installed must be sized and constructed so as to guarantee a watertight seal with the pitless adaptor in place. Native materials shall be packed tightly around the casing and pitless adapter or pitless unit after installation.

(5) Well Caps for Wells Using Pitless Adapters. Well caps used on wells that have a pitless adapter or pitless unit must have a screened vent hole pointing downward at least one-half inch (1/2") in diameter and must seal tightly against the casing to exclude dirt, insects or any foreign matter from entering the well. Hub cap type well caps that are secured to the casing by set screws that leave an opening allowing contaminants to enter are not approved for use.

(6) Other methods. Any other method of connection to a well casing shall be specifically approved by the division before installation.

(7) Wells drilled in floodplains must have casing that terminates at least two feet (2') above the maximum known floodwater elevation or when flooding is eminent, the well vent must be sealed and the well discontinued from operation until the floodwater subsides.

*AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991. * Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.050 Pump Installation

PURPOSE: This rule sets specific standards as to the proper procedures for the installation of pumps for wells.

(1) Pumps and Pumping Equipment.

(A) A pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist. A hand pump, hand pump head, stand or similar device shall have a closed spout directed downward and a pump rod that operates through a stuffing box. A power driven pump shall be attached to the casing or approved suction or discharge line by a watertight connection, including flange connections, hose clamp-type connections or other flexible couplings.

(B) Priming Requirements. A pump shall be designed, installed and maintained so that priming is not required for ordinary use. Pumps installed for use only on a well water irrigation system are exempted but priming water shall be clear water, free of contamination and carrying a chlorine residual. An irrigation well equipped with a centrifugal pump may be primed without chlorination when the pump is filled with water taken directly from the well.

(C) Backflow Prevention for Chemical Injection Systems on Irrigation Wells. A chemical injection system may not be connected to a well used for human consumption.

1. Where a chemical injection system is connected directly to a well used for irrigation and which is not used as a potable water supply, a single check-spring loaded backflow prevention shall be installed between the point of chemical injection on the pump discharge piping and the water well in accordance with the manufacturer's instructions and shall have the following:

- A. Valving so that water can be drained from the system to prevent freezing;
- B. A vacuum relief valve to prevent back-siphoning of chemicals into the well;
- C. An automatic low pressure drain at least three-quarters inch (3/4") in diameter, positioned so that when draining occurs liquid will run away from the well. The automatic low pressure drain shall quickly drain the check valve body of water when operation of the irrigation pump is discontinued;
- D. A watertight seal around the check valve;
- E. An inspection port at least four inches (4") in diameter to allow inspections of the inside of the check valve; and
- F. The check valve shall withstand a minimum hydraulic pressure of one hundred fifty (150) pounds per square inch (psi) without leaking. Valve shall be galvanized, epoxy coated or similar material that resists corrosion.

2. The irrigation well pump and the chemical injection pump shall be electrically or mechanically connected so that when the well pump stops, the chemical pump will shut off automatically.

(D) Temporary Pump Removal. If the pump is removed temporarily from the well for any reason, the well shall be capped with a watertight seal strong enough to prevent entry of contamination or foreign objects.

(E) Pump Bearing Lubrication. Lubrication of bearings of power driven pumps shall be with water or oil which will not adversely affect the groundwater.



1. Water lubrication. If a storage tank is required for lubrication water, it shall be designed to protect the water from contamination.

2. Oil lubrication. The reservoir shall be designed to protect the oil from contamination with a shutoff valve to stop oil flow when not pumping.

(F) Electrical Installation. All electrical installations shall be performed and maintained in accordance with the existing electric codes. A permitted well installation contractor or pump installation contractor must perform all electric wiring which impacts the operation of the pump or pumping system. This includes wiring from the pump to the control boxes to the main power supply such as the breaker box in a house. The electric wire must never be run through the pitless adapter.

(G) All plumbing or water supply distribution from the well to the point of entry hookup shall be installed and maintained in accordance with existing plumbing codes. A permitted well installation contractor or pump installation contractor must perform all plumbing which impacts the distribution of water from its source, through the pressure system to the point of entry inside or outside of the structure or building being served. This includes, but is not limited to, pressure tanks, water treatment equipment and any other materials needed to complete the initial installation of the water system, inside and outside of the structure, except as exempted in section 256.607, RSMo.

(2) Operational domestic and multifamily wells must have a pump, either surface mounted or submersible. Wells must have a watertight seal at the top of the well to prevent contamination from entering the well from the top. Water may not be withdrawn from a drilled well by use of a well bucket that is lowered down the well for the purpose of retrieving water for human consumption or for nonhuman uses.

(3) Water Suction Lines. A water suction line shall be constructed of galvanized iron or steel, cast iron or plastic pipe as approved by the division or other material given approval by the division. Aluminum pipe is acceptable for well water irrigation systems in addition to the previously mentioned materials. When connecting metallic pipes or casing of dissimilar types, care must be taken so that electrolysis does not occur. If the pump is located next to the well with the pump suction line emerging from the top of the well, a well seal or equivalent shall be installed between the well casing and suction pipe to provide a watertight closure.

(4) Pump Discharge Lines.

(A) A buried discharge line between the well casing and the pressure tank in any installation, including a deep well turbine or a submersible pump, shall not be under negative pressure at any time. If a check valve is installed in a buried water line between the well casing and the pressure tank, the water line between the well casing and the check valve shall meet the requirements for a suction line unless equipped with an air release valve.

(B) Pump discharge ports on irrigation wells shall be covered when not in use.

(5) Drop Pipe. The pipe used to hang the pump in a well must be composed of thermoplastic acrylonitrile-butadiene-styrene (ABS) or polyvinyl chloride (PVC) materials that have Schedule 80 (SCH 80) or thicker walls or if metallic drop pipe is used, a wall thickness of at least Schedule 40 (SCH 40) is required.

(6) Vents. All wells shall be vented with watertight caps terminating at least two feet (2') above the regional flood level (see 10 CSR 23-3.010(1)(A)6. for exception) or one foot (1') above the finished grade surface or the floor of a pump room, well room, whichever is higher. The casing vent shall be a minimum one-half inch (1/2") in diameter, screened and point downward. Vents may be offset provided they meet the provisions of this section. Any submersible pump shall be installed with a vented cap on the top of the well casing to prevent drawing near surface contamination into the well. When a well with a submersible pump kicks on and pumps water from the well, the drawdown of the water in the well creates a vacuum pulling air into the well. If the well is not vented properly, air will be pulled from around the drop pipe, through the electric wire hole, from around the well seal, and the like. If a well is not vented properly, it could be contaminating itself every time the pump kicks on by pulling near surface contaminants into the well.

(7) Disinfection.

(A) A new, repaired or reconditioned well or pump installation shall be thoroughly pumped to waste until the water is as clear as is reasonably possible, dependent upon groundwater conditions in the area. After that the well and pumping equipment shall be disinfected with chlorine so applied that a concentration of at least one hundred (100) parts per million (ppm) of chlorine shall be obtained in all parts of the well and plumbing system. The chlorine solution shall be introduced into the well in a manner to flush the well surfaces above the static water level with

chlorine solution. A minimum contact period of two (2) hours (overnight is better) shall be provided before pumping the well to waste and flushing the chlorine solution from the distribution system. The well owner shall be instructed by the permittee concerning these procedures and can be responsible for pumping and flushing of the well following disinfection. A permittee shall be responsible for disinfecting the work performed on the well, pump or pumping equipment. Disinfection in a well repair operation may be accomplished at the beginning of the operation with chlorine applied to obtain a concentration of two hundred (200) ppm for the period of the well repair operation. The water shall be pumped to waste prior to the taking of water samples or use being made of the water. Caution: The chlorinated water must not leave the owner's property. If it does, the owner must report to the Water Pollution Control Program, Division of Environmental Quality.

(B) Special care must be exercised when replacing a pump because bacteria can easily contaminate what is pulled from the well (pump, drop pipe, electric wire) and it is difficult to disinfect the portions of the electric wire and drop pipe that are above water level. When pulling a pump, the electric wire should not be allowed to touch the ground. This may be accomplished by laying plastic on the ground or utilizing a mechanical system that winds up the electric wire as it is withdrawn from the well or other appropriate means. The drop pipe should be placed on pipe racks or other precautions should be taken to keep it from contacting the ground. If contamination does occur, special care must be taken to disinfect the contaminated areas.

(C) The following table will help in determining how much chlorine to add during disinfection of the well. First you will need to determine height of the water column in the well.

1. Formula to find height of water column: (total depth of well) minus (static water level) equals (height of water column). Example: (216 ft. well depth) - (37 ft. water level) = (179 ft. of water column). Then using the table find the casing size of the well, read across to the corresponding chlorine product column and use these amounts in the following formula:

2. Formula to find amount of chlorine product needed to disinfect well: (height of water column) times (amount of product from table) equals (amount of product needed to disinfect well) Example: For a six inch (6") casing using 5.25% Clorox product: (179 ft.) \times (0.381) = 68 oz. or about one-half (1/2) gallon.



Table 1

Disinfection Table

(Produces a 100 mg/liter chlorine solution per-foot of casing size)

Casing Size Nominal Diameter (Inches)	Gallons of Water Per One Foot Of Casing Size (Gal/Ft/Case Size)	Ounces of Product Added To Disinfect One (1) Foot of Water Per Casing Size		
		5.25% to 6.0% Chlorine PRODUCT: Clorox, Purex, Sno-White Kandu, Topco, Action, White Magic, Surefine and MC ₂ or other brand names (sodium hypochlorite) (Fluid Ounces)	10% Chlorine PRODUCT: Liquid Bleach. Purchased from a chemical supply company (sodium hypochlorite) (Fluid Ounces)	70% Chlorine PRODUCT: High- Test Calcium Hypochlorite. Purchased from a chemical company (calcium hypochlorite) (Dry Ounces)
1.25	0.06	0.015	0.008	0.0011
1.50	0.09	0.023	0.012	0.0017
2	0.16	0.041	0.021	0.0031
2.5	0.25	0.064	0.033	0.0048
3	0.37	0.094	0.049	0.0071
3.5	0.50	0.127	0.067	0.0095
4	0.65	0.165	0.087	0.0124
5	1.02	0.259	0.136	0.0194
6	1.50	0.381	0.200	0.0286
8	2.60	0.660	0.347	0.0495
10	4.08	1.036	0.544	0.0777
12	5.87	1.490	0.782	0.1118
14	8.00	2.031	1.066	0.1523
16	10.44	2.650	1.391	0.1988
18	13.21	3.354	1.761	0.2515
24	23.50	5.966	3.132	0.4474
30	36.70	9.317	4.891	0.6988



(D) When placing the chlorine into the well it must be thoroughly mixed with the existing water to disperse the chlorine throughout the water column. This is best done by batch dumping large volumes of chlorinated water into the well or by placing chlorine tablets in a porous bag and lowering it and raising it within the entire water column until the chlorine is dissolved.

(E) A practical alternative is to divide the amount of needed chlorine product calculated using the Disinfection Table into liquid and tablet form. Then—

1. Pour the tablets into the well which will dissolve near the bottom of the well;

2. Pour liquid chlorine product into the well being sure to wash down all surfaces that are above the static water level;

3. Circulate water into the house by running cold water until chlorine smell is detected, turning off cold, then running hot until chlorine smell is detected, in each faucet in the house. Proper ventilation must be maintained during this step and step 5 (see paragraph (7)(E)5.) to avoid overpowering potentially toxic chlorine fumes;

4. Stop circulating water and let set at least two (2) hours (preferably overnight); and

5. Flush system by running water until no chlorine odor is detected.

AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.060 Certification and Registration Reports

PURPOSE: This rule sets required standards for certification and registration report form submittal.

(1) The certification process involves the review of the certification report form to be sure that the well meets all construction requirements necessary for the specific area the well has been drilled. The minimum construction standards were written to protect Missouri's groundwater and to help ensure that the construction of the wells does not constitute a threat to this resource. Due to the varied quantity and quality of groundwater in Missouri, the certification number does not necessarily indicate that the well produces potable water or usable quantities of water.

(2) A certification report form, supplied by the division, shall be used to report new well construction, new pump installation (initial pump set in newly drilled well), monitoring well construction (see 10 CSR 23-4) and heat pump well construction (see 10 CSR 23-5). The certification report form shall be completed and submitted to the division by the permittee within sixty (60) days after completion of any well. If the well installation contractor does not set the pump, the well installation contractor is responsible to submit a certification report form documenting work performed, otherwise the certification report form will reflect all areas of reporting. The pump installation contractor is responsible for submitting a certification report form documenting work performed. The certification report form shall be accompanied by the certification fee. The permittee shall furnish the well owner one (1) copy, the division one (1) copy and retain one (1) copy in the permittee's files. The report form shall contain all available required information. A certification report form shall be submitted for a dry hole, but no certification fee is required.

(3) The registration process involves the documentation of certain types of activities according to the requirements and reported on forms supplied by the division.

(4) A registration report form, supplied by the division, shall be used to report plugging of wells, raising of casing, lining of wells, drilling of jetted wells (unless exempted), deepening of wells, major repairs and alteration of wells and must be submitted to the division by the permittee within sixty (60) days after completion of the appropriate operations. Records for replacement pumps will not be required unless requested by the division. Pump replacement cannot change status of the well from domestic to multifamily or from domestic to high yield. The registration report form shall be accompanied by the registration fee, if required. The permittee shall furnish the well owner one (1) copy, the division one (1) copy and retain one (1) copy in the permittee's files. The report form shall contain all available required information.

(5) Certification report forms and registration report forms submitted for well construction, well reconstruction, new pump installation, monitoring well construction (see 10 CSR 23-4), heat pump well construction (see 10 CSR 23-5), and test hole (see 10 CSR 23-6) shall include the geographic location of the well, boring or test hole. The geographic location shall have a format in degrees, minutes and seconds for latitude and longitude relative to the North American Datum 1983

(NAD83) geodetic datum. Location accuracy shall be at least one (1) place after the seconds decimal point: i.e., latitude 38°59'59.9"N, longitude 94°01'01.0"W. Devices that can provide such measurements include, but are not limited to, handheld Global Positioning System (GPS) receivers that are wide area augmentation system (WAAS) capable.

(6) If work is performed by the landowner, following strict requirements under section 256.607, RSMo, the landowner must submit all required forms and fees and is subject to all laws and rules as if a permitted entity.

AUTHORITY: sections 256.606, 256.614, 256.623 and 256.626, RSMo 2000. Original rule filed April 2, 1987, effective July 27, 1987. Emergency rescission and emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Rescinded and readopted: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed March 30, 2005, effective Oct. 30, 2005.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.623, RSMo 1985, amended 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.070 Plastic Well Casing

PURPOSE: This rule designates special standards for the use of plastic casing in the water well.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Standards.

(A) Approved Materials. Any thermo-plastic pipe used for well casing shall meet the standards of the American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103, which are referenced as ASTM F-480 *Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80.*



Acceptable casings used for wells that produce potable water must be composed of certain classes of polyvinyl chloride (PVC) or acrylonitrile-butadiene-styrene (ABS) thermoplastics accepted by ASTM for well casings. Other casing may be used if advance written approval is obtained by the division.

(B) Standard dimension ratio (SDR) is determined by the following (outside diameter divided by wall thickness equals SDR). Casing must have SDR ratings of SDR 26, SDR 21, SDR 17 or SDR 13.5 to be acceptable for usage. Schedule 40 (SCH 40) is the most commonly used casing for wells producing potable water and is acceptable.

(C) A minimal nominal casing size for domestic wells is six inches (6") in diameter (average actual size is six and six hundred twenty-five thousandths inches (6.625")).

(D) The thermoplastic well casing must have the following markings displayed on the casing according to ASTM standards. If a casing does not have these markings, it is not permitted for use unless given advance written approval by the division.

(E) Well casing may be joined by solvent weld, mechanical joints such as splined couplings, threaded or other types of joints approved in advance by the division. All

joints must be watertight. Solvent welded joints are not permitted for monitoring wells.

Example

1	2	3	4	5	6	7	8	9
ABC Plastics	6"	Well Casing	PVC 1120	SDR 21	IC-1	F480	SF-WC	C9APIE4

1 Manufacturer's name or trademark.
2 Nominal Casing Size. Must be six inches (6") or larger.
3 Intended application for product. Must state "Well Casing" to be used as casing.
4 Type of material. Must be PVC or ABS material.
5 SDR—Standard Dimension Ratio. Must be SDR 26, SDR 21, SDR 17, SDR 13.5 or SCH 40.
6 Impact Classification. Must have IC-0, IC-1, IC-2 or IC-3.
7 ASTM Specification Number. Must have F-480 = Standard for Plastic Well Casing.
8 National Sanitation Foundation Logo. Must have NSF-WC = Well Casing. This is an independent laboratory's seal of approval.
9 Manufacturer's Code Number.



(2) Storage, Handling and Components. The installer—

(A) Shall store pipe in such a manner to prevent sagging or bending;

(B) Shall inspect pipe and couplings carefully for cuts, gouges, deep scratches, damaged ends and other major imperfections and shall not use any plastic pipe or coupling which has these defects or imperfections;

(C) Shall use solvent cement meeting the requirements of the specifications for the particular plastic used. The cement used shall provide sufficient open time for making good joints but the installer shall complete joints immediately upon applying the solvent cement;

(D) Shall use only pipe and coupling combinations that give close and satisfactory interference fits which will readily mate when the solvent cement is applied and the pieces are joined. The pipe shall enter the socket to between two-thirds (2/3) and full depth of the socket depth when inserted and turned;

(E) May use plastic pipe coupling with molded or formed threads but must use only the thread lubricant which is suitable for the particular type of plastic being used and the lubricant must not be a source of contamination to the water; and

(F) Shall use a coupling appropriate for the specific transition intended when connecting plastic pipe to a non-plastic well screen.

(3) Technique for Joining Solvent Weld Plastic Well Casing.

(A) Cutting. The installer shall use fine-tooth blades with little or no set for when cutting the pipe is necessary. Pipe ends shall be cut square. A plastic pipe cutter equipped with extra-wide rollers and thin cutting wheels may be used. Standard steel pipe or tubing cutters shall not be used for cutting plastic pipe.

(B) Cleaning. The installer shall clean all dirt, dust, moisture and burrs from pipe ends and couplings. The installer may use only chemical or mechanical cleaners which are suitable for the particular plastic material being used.

(C) Primer. The installer shall use a primer when, because of the type of plastic material being used, the pipe and coupling surfaces must be softened and dissolved in order to form a continuous bond between the mating surfaces or when the particular type of solvent cement being used requires one, or both.

(D) Cement Application. The installer shall apply a moderate and even coat of cement to the inside of the coupling to cover the distance of the joining surface only. The installer shall then quickly apply an even coat

of cement to the outside of the pipe being joined to a distance which is equal to the depth of the pipe coupling socket. Caution should be used when handling solvent cement to avoid skin contact or inhalation of vapors.

(E) Assembly. The installer shall—

1. Make the joint as quickly as possible after application of the cement and before it dries;

2. Reapply cement before assembling if the cement dries partially;

3. Insert the pipe into the coupling socket, turning the pipe to ensure even distribution of cement;

4. Make sure that the pipe is inserted to the full depth of the coupling socket;

5. Remove excess solvent cement from the exterior of the joint with a clean, dry cloth;

6. Tighten a threaded joint by no more than one (1) full turn using a strap wrench;

7. Not disturb the coupling joint until after the cement has set, in order to avoid damage to the joint and loss of fit; and

8. Allow sufficient time for the joint to develop good handling strength based on manufacturer's specifications (usually two to seven (2-7) minutes). When temperatures exceed one hundred degrees Fahrenheit (100°F), difficulty in proper bonding may be experienced because the active solvent agent evaporates too rapidly. The ends of the casing to be joined should be cooled below one hundred degrees Fahrenheit (100°F) before they can be solvent cemented. Keeping casing in the shade will help. When temperatures fall below forty degrees Fahrenheit (40°F), the use of specially formulated cements may be advisable to ensure optimum strength development.

(F) Drilling Inside of Plastic Casing. An installer should use extreme care if drilling inside the plastic casing is required when drilling any kind of well because the drilling process can fracture or abrad the plastic casing.

(G) Grouting of Plastic Casing.

1. Rapid-setting cement is not to be used. Because of its high heat of hydration, grout made of rapid-setting cement is not permitted for use in wells which are cased with PVC or ABS pipe. The following shows the strength of PVC at various temperatures based on 73.4 degrees Fahrenheit being one hundred percent (100%) of its test strength:

A. 50 degrees Fahrenheit, 114 percent;

B. 60 degrees Fahrenheit, 107 percent;

C. 70 degrees Fahrenheit, 101 percent;

D. 80 degrees Fahrenheit, 95 percent;

E. 90 degrees Fahrenheit, 88 percent;

F. 100 degrees Fahrenheit, 83 percent;

G. 110 degrees Fahrenheit, 77 percent;

H. 120 degrees Fahrenheit, 72 percent;

I. 130 degrees Fahrenheit, 65 percent;

J. 140 degrees Fahrenheit, 40 percent;

and

K. 150 degrees Fahrenheit, 10 percent.

2. Bentonite and bentonite slurry grout is encouraged. The use of chip bentonite or bentonite slurry grout is encouraged when grouting the annulus of wells utilizing plastic casing because these grouts do not increase in temperature during the curing process.

3. Cement slurry is usable with some restrictions. The use of neat cement slurry can cause problems in certain situations. During the curing process of neat cement slurry temperature increases are a by-product. In a typical well with a two inch (2") annulus, temperature increases in the range of seventeen to thirty-five degrees (17°-35°) are normal. When annular spaces are larger resulting in thicker grout, the temperature increase that results may cause the casing to fail. The addition of two to nine percent (2-9%) bentonite powder to the cement slurry will reduce the rate at which heat is generated allowing the heat to be dissipated, resulting in less potential damage to the casing. If cement slurry is used, it is recommended that bentonite be added or that cold water be circulated in the casing while the grout is curing. Maximum grout hydration temperatures in wells with annular spaces less than five inches (5") are reached between seven and ten (7-10) hours after mixing.

(H) Cavernous Rock Walls. As a general rule, plastic well casing is not recommended to be used as casing in wells cased and grouted through cavernous rock formations. However, in these cases, plastic casing will work. This determination will be made by the well installation contractor.

(I) Use of Screws. When extra strength is desired in solvent weld joints, stainless steel screws may be used, but must not penetrate through to the inside of the casing. The use of any type of rivets that penetrate to the inside of the casing is prohibited.

(J) Screws Required on Unconsolidated Material Irrigation Wells. When PVC or ABS casing is used that requires gluing, at least four (4) stainless steel screws must be used in each coupling. The screws shall not penetrate through to the inside of the casing.

(K) PVC and ABS casing may never be used when known gasoline or solvent contamination exists within one hundred (100) yards of the well being repaired or drilled. When gasoline or solvent contamination levels do not present a potential threat to the integrity of the casing, the use of PVC or ABS pipe material will be considered on a case-by-case basis. Approval must be received in advance.



AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.080 Liners

PURPOSE: This rule sets guidelines for the use of liners in wells in Missouri.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Use of Liners. Liners are generally used for three (3) purposes. They are used to—

(A) Hold the well bore open when caving or spalling rock is encountered. These liners are usually slotted to allow water to enter the well from the aquifer; or

(B) Seal out problem areas below the existing casing or to correct inadequate grouting seals of the casing annulus and other problems arising concerning contamination of subsurface waters. Plastic liners may be used effectively to solve iron bacteria problems on steel casings. If a plastic liner is installed to seal out an iron bacteria problem, it must extend from the bottom of the steel casing and must have its upper end no deeper than ten feet (10') below the top of the well casing. The liner must also be grouted as stated in subsection (3)(B) of this rule; or

(C) If the liner is just used to solve a rust problem in the casing, a packer must be placed within five feet (5') of the bottom of the rusted casing interval. The liner must extend from the bottom of the steel casing to a point less than 10 feet (10') from the surface. The packer must be inside the casing and no grout is required.

(2) General Specifications and Guidelines.

(A) Liners may be composed of either steel or thermoplastic.

1. Steel liners must be new and have an inside diameter at least four inches (4") and have a minimum wall thickness not less than .188 inches.

2. Plastic liners must meet American Society for Testing and Materials (ASTM) standards concerning thermoplastic well casing and be composed of polyvinyl (PVC) or acrylonitrile-butadiene-styrene (ABS) materials formulated for well casing.

A. The inside diameter must not be smaller than four inches (4").

B. The Standard Dimension Ratio (SDR) ratings allowable for liner is SDR 26, SDR 21, SDR 17 and SDR 13.5. Schedule ratings allowable are SCH 40 and SCH 80.

(B) All liners used to seal out potential groundwater contamination areas below the existing casing or to correct inadequate grouting seals of the casing annulus, and other problems arising concerning the contamination of subsurface water must have their upper end set no deeper than ten feet (10') below the top of the well casing. The liner must be secured in the hole.

(C) Packers shall be secured on plastic liners with screws (making sure they do not penetrate the liner) or other methods and on steel liners the packer shall be welded or mechanically attached so that it will not move during liner placement. Packers are not required on liners used only to hold open the well bore.

(D) Whenever a liner is needed it is recommended that the bottom of the liner be at the bottom of the well. This will help prevent potential future problems with pump replacement.

(3) Method of Installation.

(A) When liners are used only to hold open the well bore they may be placed in the well following normal industry installation procedures.

(B) All other liners must be sealed into place following these procedures:

1. The liner must have a rubber packer (first packer) secured near the bottom of the interval to be grouted. Another rubber packer (the second packer) must be secured about twenty feet (20') above the first packer. This will result in two (2) rubber packers spaced about twenty feet (20') apart on the liner. These packers must hold the grout in place. Grout must be placed between the first and second packer and completely fill this interval as the liner is being installed into the casing. Grout must also be placed on top of the second packer filling it to at least a point twenty feet (20') above the third packer. Care must be taken by the well installation con-

tractor when selecting the type of grout used, keeping in mind the time of liner installation and grout set-up time. The liner shall be placed into the well casing being careful not to damage the packers or liner, or two (2) packers must be placed close together near the bottom of the liner and grouted after the liner is set by pressure grouting through a tremie pipe. The bottom sixty feet (60') of annulus created when installing a four and one-half-inch (4 1/2") or five-inch (5") outside diameter liner must be grouted. If a liner must be grouted, a minimum annulus of one-half inch (1/2") must be present. Tables 5 and 6 state the required amount of grout to fill the annulus sixty feet (60'); or

2. Alternate grouting procedures will be considered on a case-by-case basis. Written approval in advance by the division is required.

(4) Permittee Responsibility to Seal Liner. In wells that have a liner used for any purpose, other than holding the well bore open, it is the responsibility of the permittee to ensure that the annulus between the well bore and the liner is sealed.

(5) PVC and ABS liners may never be used when known gasoline or solvent contamination exists within one hundred (100) yards of the well being repaired or drilled. When gasoline or solvent contamination levels do not present a potential threat to the integrity of the pipe or liner, the use of PVC or ABS pipe material will be considered on a case-by-case basis. Approval must be received in advance.



TABLE 5

**Number of Bags for Minimum Amount of Required Grout for
Lining Water Wells**

Outer Diameter of Plastic Liner: 4 1/2 inches—Minimum Length of Grout: 60 feet

Borehole Diameter	6		8		10	
	*Ann.	^O.H.	*Ann.	^O.H.	*Ann.	^O.H.
Type of Grout						
CEMENT						
Portland Type I	5	11	13	19	24	30
Portland Type III	5	11	13	19	24	30
BENTONITE						
Pellets—						
1/2" Baroid Pellets	7	16	19	29	36	45
3/8" Baroid Pellets	7	17	21	30	37	47
1/4" Baroid Pellets	7	17	17	20	37	47
Wyo-bend Tablets	8	17	22	32	39	49
Volclay 1/2"	8	18	22	32	40	50
Volclay 3/8"	8	19	23	33	41	52
Volclay 1/4"	8	19	23	34	42	53
Chips—						
Baroid HolePlug	7	17	21	30	38	47
Wyo-bend Coarse	6	14	17	25	32	40
Wyo-bend Medium	6	15	18	26	33	41
Volclay Coarse	7	16	19	28	35	44
Volclay Medium	7	16	20	29	36	45
Granular—						
Benseal	6	15	18	26	33	41
Wyo-bend No. 8	6	14	17	25	32	40
Wyo-bend No. 16	6	14	17	25	32	40
Slurry—						
Baroid	2	3	4	6	8	10
Wyo-bend	2	4	4	7	8	10
Volclay	1	3	4	6	7	9

*Ann. = Bags needed to fill Annular Space

^O.H. = Bags needed to fill the Open Bore Hole



TABLE 6

Number of Bags for Minimum Amount of Required Grout for Lining Water Wells

Outer Diameter of Plastic Liner: 5 inches—Minimum Length of Grout: 60 feet

Borehole Diameter	6 *Ann.^O.H.	8 *Ann.^O.H.	10 *Ann.^O.H.
Type of Grout			
CEMENT			
Portland Type I	3 11	12 19	23 30
Portland Type III	3 11	12 19	23 30
BENTONITE			
Pellets—			
1/2" Baroid Pellets	5 16	18 29	34 45
3/8" Baroid Pellets	5 17	19 30	35 47
1/4" Baroid Pellets	5 17	18 30	35 47
Wyo-bend Tablets	6 18	19 32	37 49
Volclay 1/2"	6 18	20 32	38 50
Volclay 3/8"	6 19	20 33	39 52
Volclay 1/4"	6 19	21 34	40 53
Chips—			
Baroid HolePlug	5 17	19 30	36 47
Wyo-bend Coarse	5 14	16 25	30 40
Wyo-bend Medium	5 15	16 26	31 41
Volclay Coarse	5 16	17 28	33 44
Volclay Medium	5 16	18 29	34 45
Granular—			
Benseal	5 15	16 26	31 41
Wyo-bend No. 8	5 14	16 25	30 40
Wyo-bend No. 16	5 14	16 25	30 40
Slurry—			
Baroid	1 3	4 6	7 10
Wyo-bend	1 4	4 7	8 10
Volclay	1 3	4 6	7 9

*Ann. = Bags needed to fill Annular Space

^O.H. = Bags needed to fill the Open Bore Hole



AUTHORITY: sections 256.606 and 256.626, RSMo 1994. Original rule filed April 2, 1987, effective July 27, 1987. Emergency rescission and emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expire April 9, 1994. Rescinded and readopted: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.090 Regionalization

PURPOSE: This rule sets specific additional standards for certain regions in Missouri.

Editor's Note: Area maps mentioned in this rule may be found following 10 CSR 23-3.110.

PUBLISHER'S NOTE: The secretary of state has determined that the publication of the entire text of the material which is incorporated by reference as a portion of this rule would be unduly cumbersome or expensive. Therefore, the material which is so incorporated is on file with the agency who filed this rule, and with the Office of the Secretary of State. Any interested person may view this material at either agency's headquarters or the same will be made available at the Office of the Secretary of State at a cost not to exceed actual cost of copy reproduction. The entire text of the rule is printed here. This note refers only to the incorporated by reference material.

(1) Area 1. All persons engaged in drilling domestic wells in Area 1, a limestone or dolomite area (Figure 1 and 8) shall—

(A) Set no less than eighty feet (80') of casing, extending not less than thirty feet (30') into bedrock. Example: if sixty feet (60') of residual (weathered rock) material is encountered in drilling before bedrock, then ninety feet (90') of casing must be set.

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point.

(C) Install new, steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic).

(D) Install and seal casing as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout material and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings

used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space—

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

B. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

C. The following times must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours.

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours; and

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(E) If the well is to be drilled as an alluvial well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger than the casing to be placed into it. Well casing must be at least six inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural gravels in the formation being drilled can be allowed to cave back against the screen;

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(2) Area 2. All persons engaged in drilling domestic wells in Area 2, Central Western Missouri (Figure 2) shall—

(A) Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock. Areas where Cherokee Group sediments are present; set casing through caving zones and into waterbearing sands. In some instances this might require several hundred feet of casing. Liners may be used with minimum amount of casing listed for this area;

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel or plastic casings as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic).

(D) Install and seal casing as follows: Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout material. Drill cuttings may be placed above the grouted interval to fill in the annular space—

1. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

2. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

3. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(E) In areas where shale or shaley material is present above the waterbearing zones, casing or liner shall be set so as to exclude intervals which would cave into the drill hole or cause muddy water to be pumped;

(F) If the well is to be drilled as an alluvial well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet



(20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required;

(G) Five-Inch (5") Casing Wells. A well may be completed using a five-inch (5") nominal casing if the following standards are met:

1. The casing must be set full length and be slotted across the producing horizons.

2. The drill hole must be eight and five-eighths inches (8 5/8") in diameter with the upper forty feet (40') to be reamed out to ten and five-eighths inches (10 5/8") in diameter; and

3. The upper forty feet (40') of annular space must be grouted and the remainder of the borehole below the grout must be gravel packed.

(3) Area 3. All persons engaged in drilling domestic wells in area 3, northwest Missouri area, (Figure 3) shall—

(A) If the well is to be drilled as a glacial drift or alluvial well;

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen;

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(B) If the well is to be drilled as a bedrock well—

1. Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic); and

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings

used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(C) If usable amounts of water are not expected to be available in deeper bedrock horizons and water is only available from the upper, fractured and weathered portion of bedrock, and if the water is coming from a zone that is at least forty feet (40') deep, you must set a minimum of forty feet (40') of casing but only one foot (1') of this casing need be set into the bedrock. This allows the use of shallower water horizons under some circumstances; and

(D) Five-Inch (5") Casing Wells. A well may be completed using a five-inch (5") nominal casing if the following standards are met:

1. The casing must be set full-length and be slotted across the producing horizons;

2. The drillhole must be eight and five-eighths inches (8 5/8") in diameter with the upper forty feet (40') to be reamed out to ten and five-eighths inches (10 5/8") in diameter; and

3. The upper forty feet (40') of annular space must be grouted and the remainder of the borehole below the grout must be gravel packed.

(4) Area 4. All persons engaged in drilling domestic wells in Area 4, northeast Missouri area, (Figure 7) shall—

(A) If the well is to be drilled as a bedrock well—

1. Set no less than forty feet (40') of casing, extending not less than fifteen feet (15') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic); and

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(B) If the well is to be drilled as an unconsolidated materials well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of ten and five-eighths inches (10 5/8") in diameter being at least four inches (4") larger in diameter than the casing to be placed into it. Well casing must be at least six-inch (6") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.



(C) If usable amounts of water or water of acceptable quality are not expected to be available in deeper bedrock horizons and water is only available from the upper, fractured and weathered portion of bedrock, and if the water is coming from a zone that is at least forty feet (40') deep, a minimum of forty feet (40') of casing must be set but only one foot (1') of this casing need be set into the bedrock. This allows the use of shallower water horizons under some circumstances.

(5) Area 5. All persons engaged in drilling domestic wells in area 5, Missouri Bootheel and all major stream alluvial areas (Figure 5) shall—

(A) If the well is to be drilled as a bedrock well—

1. Set no less than eighty feet (80') of casing, extending not less than thirty feet (30') into bedrock;

2. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

3. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

4. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications;

(B) If the well is to be drilled as an unconsolidated materials well—

1. No less than twenty feet (20') of casing shall be set above the screened or perforated interval of the well;

2. The drill hole shall be constructed a minimum of four inches (4") larger than the casing to be placed into it. Well casing must be at least four-inch (4") nominal diameter. Graded, chlorinated gravel may be placed into the annular space adjacent to the well screen or natural (native) gravels in the formation being drilled can be allowed to cave back against the screen; and

3. Full-length grout is preferred (above the screened interval) and will ensure a better annular seal but sealing the upper twenty feet (20') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required.

(C) Shallow unconsolidated wells located in Area 5, the Missouri Bootheel (Figure 8) and all major stream alluvial areas may be exempted from this rule. If the wells and drillers of the wells meet the following specifications they are exempted:

1. Wells are drilled, jetted, driven, washed or constructed in other ways;

2. Wells are constructed in unconsolidated materials; and

3. Well casing diameters are no larger than two inches (2").

(6) Area 6. All persons engaged in drilling domestic wells in Area 6, St. Francois Mountain area (Figure 6) shall—

(A) Where granite or igneous rock is within one hundred feet (100') below the surface, set no less than forty feet (40') of casing extending not less than fifteen feet (15') into bedrock—

1. Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

2. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

3. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required

to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications.

(B) In areas where granite is more than one hundred feet (100') below the surface, set no less than eighty feet (80') of casing not less than thirty feet (30') into bedrock.

1. Construct the drillhole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point.

2. Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

3. Install and seal casing as follows:

A. Full-length grout is preferred and will ensure a better annular seal, but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above the grouted interval to fill in the annular space;

(I) If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

(II) If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

(III) The following times must be followed for curing grout when no packer is used:

(a) Hi-early cement—minimum set time of twelve (12) hours;

(b) Portland Type I cement—minimum set time of seventy-two (72) hours;

(c) Chipped bentonite—minimum hydration time of four (4) hours; and

(d) High solids bentonite slurry—varies based on additives and manufacturer's specifications.



AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.100 Sensitive Areas

PURPOSE: This rule sets specific additional construction standards for sensitive areas shown on the map that have been designated on the basis of either naturally occurring problems caused by unique groundwater chemistry, anthropogenic contamination, or because they are located in a fragile groundwater environment which is experiencing rapid population growth or urbanization.

(1) Sensitive Area A. All persons engaged in drilling wells in this area (Figure 8) and encounter Pennsylvanian shales and/or sandstones shall—

(A) Set no less than eighty feet (80') of casing extending not less than thirty feet (30') into bedrock where Pennsylvanian shale and sandstone are not present and no less than one hundred fifty feet (150') of casing extending not less than thirty feet (30') into bedrock where the Pennsylvanian shale and sandstone are present;

(B) Construct the drillhole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel or plastic casing as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(D) Install and seal casing as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space—

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes; and

B. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

2. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications.

(2) Sensitive Area B. Wells drilled within one-quarter (1/4) mile of the major lakes in Missouri (Figure 8) (see list of lakes) must be cased so that they do not produce lake water into their wells. Wells drilled within one-quarter (1/4) mile of the major lakes that are not drilled below normal pool level of the lake are not required to meet sensitive Area B requirements. These wells must be constructed to Area 1 requirements stated in 10 CSR 23-3.090(1). The following specifications shall be followed:

(A) List of Lakes—

1. Truman;
2. Stockton;
3. Table Rock;
4. Bull Shoals;
5. Lake of the Ozarks;
6. Wappapello;
7. Pomme de Terre;
8. Norfolk; and
9. Clearwater.

(B) If the well is to be drilled closer than one-quarter (1/4) mile to the shoreline of the lake, casing must be set to a point fifty feet (50') below the bottom of the lake. The deepest part of the lake within one-quarter (1/4) mile radius from the well location shall be used in this determination. Example: If the drill site is located one thousand feet (1,000') from the lake, is located fifty feet (50') higher in elevation than the shoreline and the deepest estimated bottom of the lake within one-quarter (1/4) mile from the well is thirty feet (30') deep, then one hundred and thirty feet (130') of casing must be set. Fifty feet (50') (elevation above lake) + thirty feet (30') (depth of water) + fifty feet (50') (below lake bottom) = one hundred thirty feet (130') casing;

(C) It is highly recommended that before a well is drilled that is located closer than one-quarter (1/4) mile to the shoreline of any major lake, a casing point request form (supplied by the division) be submitted to the division. The casing point request form will be used to establish the required amount of casing and will supply information on requested water yield amounts and corresponding total depth of well. To ensure the

location of the proposed drill site a copy of the landowner's property deed showing detailed location information and a copy of the landowner's plat (if available) showing proposed drilling site location, must be attached to completed casing point request form. The casing point request form will be processed quickly and returned to the landowner or driller, or both. After the well is drilled the casing point request form must be submitted with the certification form. If a well is drilled within one-quarter (1/4) mile of one (1) of the lakes contained in section (2) and less than the required amount of casing is set, the well installation contractor must bring the well up to the standards set in this rule and will be subject to disciplinary action deemed necessary by the division;

(D) A minimum of eighty feet (80') of casing must be set;

(E) The drill hole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(F) The new steel or plastic casing shall be installed as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(G) The casing shall be installed and sealed as follows:

1. Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

A. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

B. If plastic casing is used, a packer, coupling or inverted bell is required near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes;

C. The following time must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours;

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours; and

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(H) In areas that have water quality problems that would be aggravated by the use of steel casing, plastic casing is recommended. If it is necessary to set steel casing due to



geologic reasons, the following may substitute for casing:

1. Set no less than eighty feet (80') of casing; and

2. Liner must be set through the casing to point as determined in subsection (1)(C). Example: If the casing point was determined to be one hundred and eighty feet (180'), one hundred and eighty feet (180') of liner must be set. The liner must meet all requirements as stated in 10 CSR 23-3.080, including grouting.

(3) Sensitive Area C. The Springfield area is one in which urbanization is occurring at a rapid rate in an extremely sensitive and fragile geologic and hydrologic setting. The area is underlain by fractured, and cavernous limestone and pollutants are able to migrate quickly, both vertically and horizontally. Because of these factors, it is necessary to treat this area differently than surrounding areas and have stricter well construction standards. All persons engaged in drilling of wells in the sensitive area C (Figure 8) shall—

(A) The casing shall be set as determined by Area C casing depth map. When drilling in Sensitive Area C, it is strongly recommended that a casing point request be submitted so that the exact amount of casing can be set, limiting the amount of grout required. Approval must be obtained before drilling begins. Area C casing depth map sets the minimum amount of required casing that will extend at least ten feet (10') below the Northview Shale. Due to surface elevation changes within the quarter (1/4) section (one-quarter (1/4) mile), the amount of casing stated on the casing depth map may extend more than ten feet (10') below the bottom of the Northview Shale. In those instances, where the casing extends more than ten feet (10') below the bottom of the Northview Shale, more than thirty feet (30') of grout is required to seal off the Northview Shale. See 10 CSR 23-3.100(3)(D);

(B) The drillhole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) New steel or plastic casing shall be installed as specified in 10 CSR 23-3.030 (steel) or 10 CSR 23-3.070 (plastic);

(D) Full-length grout is preferred and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required if the casing does not go more than ten feet (10') below the bottom of the Northview Shale. Due to surface elevation changes within the quarter (1/4) section (one-quarter (1/4)

mile), the amount of casing required is calculated at the highest elevation. Therefore, if a well is drilled in a lower elevation area, the required casing will go more than ten feet (10') below the bottom of the Northview Shale. In many cases, thirty feet (30') of grout will not seal off the Northview Shale since the bottom of the casing is much deeper. The Northview Shale interval must be grouted from ten feet (10') below to the top of the shale regardless of the amount of casing set. A minimum of thirty feet (30') of grout is required. Drill cuttings and a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space. Install and seal casing as follows:

1. If steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure before drilling resumes;

2. If plastic casing is used, a packer, coupling or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. No packer, coupling or inverted bell is required if grout is allowed to cure before drilling resumes; and

3. The following times must be followed for curing grout when no packer is used:

A. Hi-early cement—minimum set time of twelve (12) hours;

B. Portland Type I cement—minimum set time of seventy-two (72) hours;

C. Chipped bentonite—minimum hydration time of four (4) hours; and

D. High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

(E) In areas that have water quality problems that would be aggravated by the use of steel casing, plastic casing is recommended. If it is necessary to set steel casing due to geologic reasons, the following may substitute for casing:

1. No less than one hundred feet (100') of casing shall be set. The drill hole shall be constructed a minimum of eight and five-eighths inches (8 5/8") in diameter and new six-inch (6") inside diameter steel casing shall be installed as specified in 10 CSR 23-3.030. A six-inch (6") hole is then drilled to total depth and a plastic liner having an outside diameter no greater than four and one-half inches (4 1/2") shall be secured into place. No variances will be issued for this requirement; and

2. Liner must be set through the casing to the required casing point. The liner must be set to the casing depth as determined by Area C casing depth map. The liner must meet all requirements as stated in 10 CSR 23-

3.080 concerning liners, including grouting. More than sixty feet (60') of grout may be required as stated in 10 CSR 23-3.100(3)(D).

(4) Special Area. Due to the unique and varied geological conditions present because the bedrock is deeply weathered and often highly fractured, openings filled with mud may extend deep into the bedrock. Caving-in of the hole during drilling and after well construction is a problem. The following rules are the minimum that are required but in many cases much more steel casing may be necessary to secure the well bore. Also, in some cases plastic liner is not strong enough to hold the well bore open and steel should be used. All persons engaged in the drilling of a domestic well in special area 1 (see Figure 1 and Figure 7 included herein) shall—

(A) Set no less than eighty feet (80') of casing. The hole shall be cased fifteen feet (15') below residuum, broken rock, or mud pockets into solid bedrock or if rock is not encountered within one hundred and fifty feet (150') consult the division for further instructions concerning a variance, unless casing will be set into deeper bedrock;

(B) Construct the drill hole a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

(C) Install new steel casing as specified in 10 CSR 23-3.030. Plastic casing of any type will not be allowed in this area; and

(D) Install and seal casing as follows:

1. Full-length grout is highly recommended and will ensure a better annular seal but sealing the lowermost thirty feet (30') of casing using approved grout materials and procedures set out in 10 CSR 23-3.030 is required. Drill cuttings with a drive shoe or drill cuttings used by themselves are not approved grout materials. Drill cuttings may be placed above grouted interval to fill in the annular space;

2. A drive shoe is required except on wells where the grout is allowed to cure before drilling resumes.

A. The following times must be followed for curing grout when no packer is used:

(I) Hi-early cement—minimum set time of twelve (12) hours;

(II) Portland Type I cement—minimum set time of seventy-two (72) hours;

(III) Chipped bentonite—minimum hydration time of four (4) hours;

(IV) High solids bentonite slurry—varies based on additives and manufacturer's specifications; and

3. If drilling conditions do not permit a bottom seal, then the casing must be driven and grouting material introduced around the



outside casing while the casing is being driven. If the casing cannot be sealed to prevent surface contamination from entering the well, a liner must be set and sealed according to 10 CSR 23-3.080.

(E) In areas where poor drilling conditions exist and it is necessary to drive multiple strings of smaller diameter casing through the surface casing, each succeeding liner should extend into the preceding liner or casing at least twenty feet (20') and the annulus created between the casing and liner must be grouted.

(F) In wells where it is necessary to set casing below static water levels, it may be advisable to set plastic liner as stated in 10 CSR 23-3.080 from the surface to a point below the pumping water level to avoid excessive iron in the produced well water.

(5) Special Area 2 Definitions.

(A) "Lower aquifer" means that portion of transmissive, water-bearing geologic material extending from the Cotter Dolomite to igneous bedrock. The lower aquifer includes all formations constituting the Ozark Aquifer and the St. Francois Aquifer in the southwestern portion of the state.

(B) "Low-permeability bedrock" means that portion of geologic material between the lower aquifer and upper aquifer that does not readily transmit water in sufficient quantities to supply a well. The Northview Formation, the Chattanooga Shale, and the upper thirty feet (30') of the Cotter Dolomite shall constitute the low-permeability bedrock. The low-permeability bedrock serves as a natural barrier to groundwater mixing between the upper aquifer and lower aquifer. See Figure 7A included herein for an illustration of geology in Special Area 2.

(C) "Upper aquifer" means that portion of the transmissive, water-bearing geologic material above the top of the low-permeability bedrock. The upper aquifer includes all formations constituting the Springfield Plateau Aquifer in the southwestern portion of the state.

(D) "Maximum contaminant level (MCL)" is the maximum permissible concentration of a contaminant in drinking water as listed by the National Primary Drinking Water Regulations (NPDWR).

(E) "Action level (AL)" is the maximum permissible concentration of lead in drinking water as specified in the *Code of Federal Regulations*. ALs are levels used for contaminants that do not have established MCLs.

(F) "TCE" shall mean the organic chemical trichloroethylene (a common solvent) and its known degradation products, including but

not limited to dichloroethylene and vinyl chloride.

(G) "Impact area" is defined as that land surface area that is underlain or surrounded by water-bearing units that contain groundwater above the MCL or AL for at least one (1) contaminant of concern (lead, cadmium, TCE or TCE degradation products, or other contaminants of the NPDWR). Standard contouring methodology shall be used to delineate the MCL and AL isoconcentration line, which will define the geographic limit of an impact area.

(6) Special Area 2. All of Newton County and Jasper County shall be listed as Special Area 2 (Figure 7B included herein) due to the contamination of portions of the upper aquifer by one (1) or more of the following: lead, cadmium, TCE, TCE degradation products or other contaminants of the NPDWR. The upper aquifer and lower aquifer are separated by a thickness of low-permeability bedrock (Figure 7A). This low-permeability bedrock limits migration of groundwater and any associated contamination from the upper aquifer to the lower aquifer. Wells that penetrate the low-permeability bedrock without an adequate length of surface casing which has had the annulus sealed by approved methods through the low-permeability bedrock may place the lower aquifer at risk to future contamination. Due to chemical and metal contamination present in the upper aquifer in portions of this area, it is necessary to require more stringent well construction standards for new wells that are drilled into the lower aquifer, to cease construction of additional upper aquifer wells in impact areas, and to limit deepening of existing upper aquifer wells in impact areas. New wells constructed outside of the impact area shall be constructed to standards that are no less stringent than the minimum well construction requirements for Area 1. All persons engaged in drilling wells in Special Area 2 shall—

(A) Before beginning construction of the well, determine if the well to be drilled is located within the impact area as shown on maps provided by the division or as determined by division staff. If data indicate change in impact area status, the impact area map may be modified by the division during January of the calendar year and that map will be maintained and available at: Department of Natural Resources, PO Box 250, Rolla, MO 65402-0250.

(B) Drill new wells within the impact area to a depth required to produce water from the lower aquifer. All new wells drilled in the impact area shall have steel or plastic casing properly installed and grouted to the depth determined by the Special Area 2 casing depth map.

1. The drill hole shall be a minimum of eight and five-eighths inches (8 5/8") in diameter to the surface casing point;

2. New steel casing shall be installed as specified in 10 CSR 23-3.030 (steel);

3. The well must be sealed by positive displacement grouting with high-solids bentonite slurry. The annulus between the casing and the borehole wall shall be grouted from the base of the borehole. The volume of grout shall be no less than the calculated volume necessary to accomplish full-length grouting of the annulus. Alternatively, full-length pressure grouting (10 CSR 23-3.030(3)(A)4.) with high-solids bentonite slurry or neat cement meets the requirements of this rule. In addition, casing must be sealed as follows:

A. When steel casing is used, a drive shoe is required except on wells where the grout is allowed to cure as specified in subparagraph (6)(B)3.C. of this rule before drilling resumes;

B. If plastic casing is used, a drill hole shall be constructed a minimum of ten inches (10") in diameter to the casing point. Plastic casing shall be installed as specified in 10 CSR 23-3.070 (plastic) and, a packer, coupling, or inverted bell is required to be secured near the bottom of the casing and must hold the grout in place while drilling continues. PVC and ABS plastic casing shall not be used when known gasoline or solvent contamination exists within the impact area. The annular space shall be sealed as specified in paragraph (6)(B)3. of this rule. No packer, coupling, or inverted bell is required on wells where the grout is allowed to cure as specified in subparagraph (6)(B)3.C. of this rule before drilling resumes; and

C. The following times must be allowed for curing grout when no packer is used:

(I) High-solids bentonite slurry—varies based on additives and manufacturer's specifications. At least one hour of curing after initial slurry placement is suggested. This amount of curing time should elapse during casing placement.

(C) Uncontaminated upper aquifer wells in impact areas of Special Area 2 existing before the date of this rule may be deepened to the top of the low-permeability bedrock.

(D) Water from all new wells and deepened old wells throughout Special Area 2 shall be sampled and analyzed for lead and cadmium, plus TCE and its degradation products within TCE impact areas. Where indicated by objective factors, the division may require sampling and analysis for other contaminants listed in the NPDWR. Qualified and properly trained persons must complete sample collection. The laboratory that analyzes the sample



must be approved by the EPA for such analysis. A copy of the chain of custody form shall be submitted to the division with the well certification report form to document sampling has occurred. An appropriate chain of custody form will be available from the division.

1. In order to ensure proper well development, the well pump must run continuously for five (5) hours or until the water clears, whichever occurs first, but in no case shall the well be pumped less than two (2) continuous hours.

2. After proper well development, water samples shall be collected from the tap nearest the well.

3. All new and deepened old wells in Special Area 2 shall be constructed with a sampling port or tap within ten feet (10') of the wellhead. Water must be purged from the sampling port prior to collection of a sample.

4. Water from all new wells in Special Area 2 with less than three (3) times the applicable maximum contaminant level (MCL) or action level (AL) may be retested over a one (1)-month period following pump installation and development to assess water quality changes that may have resulted from drilling and/or well construction. The well cannot be used for human consumption until contaminant levels are below MCLs or ALs. Qualified and properly trained persons must complete sample collection. The laboratory that analyzes the sample must be approved by the EPA for such analysis. A copy of the chain of custody form shall be submitted to the division with the well certification report form to document sampling has occurred. An appropriate chain of custody form will be available from the division. The division may require any new well, whose contaminant levels do not fall below MCLs or ALs after the retest period, to be plugged.

5. Properly constructed new lower aquifer wells that are determined to be contaminated may be allowed to use water treatment systems on a variance basis, if other domestic water sources are not available at the time of well construction. Otherwise, the well must be plugged by using full-length, high-solids bentonite grout emplaced by tremie pipe which extends to within twenty-five feet (25') of the bottom of the borehole. Grout, extending from the bottom of the borehole to within two feet (2') of land surface and finished per 10 CSR 23-3.110(2)(A)3.G., is preferred; in any case, the minimum volume of grout shall be no less than the volume calculated as necessary to accomplish full length plugging of the well.

6. Existing wells that extend uncased and/or unsealed through the low-permeability bedrock and that are found to be contaminated with lead, or cadmium, or TCE, TCE degradation products, or other contaminants

of the NPDWR may be required to be plugged full-length with high-solids bentonite grout, emplaced by tremie pipe, which extends to within twenty-five feet (25') of the bottom of the borehole. Grout, extending from the bottom of the borehole to within two feet (2') of land surface and finished per 10 CSR 23-3.110(2)(A)3.G., is preferred; in any case, the minimum volume of grout shall be no less than the volume calculated as necessary to accomplish full-length plugging of the well.

(7) Special Area 3. Portions of Franklin County within and south of the city of New Haven shall be listed as Special Area 3 (Figures 7B and 7C included herein) due to the contamination of portions of the aquifer by one (1) or more of the following chemicals of concern: tetrachloroethylene (PCE), trichloroethylene (TCE), perchloroethylene (PCE) degradation products, TCE degradation products or other contaminants of the National Public Drinking Water Regulations (NPDWR). In this area it is necessary to utilize more stringent well construction standards for new wells that are drilled into the aquifer and to limit the deepening of existing upper aquifer wells.

(A) The division shall be consulted before constructing a new well in Special Area 3. The division will provide specific guidance on well drilling protocol and construction specifications on a case-by-case basis. The division must provide written approval for all new wells prior to construction.

(B) Before deepening a well in Special Area 3, groundwater sampling and analysis for the chemicals of concern must be conducted by qualified and properly trained individuals and the data submitted within sixty (60) days of the sampling event by the well installation contractor to the division. The division must provide written approval for the deepening of all new wells in Special Area 3. Wells that have been sampled and analyzed and are contaminated with chemicals of concern exceeding maximum contaminant levels (MCLs) and/or action levels (ALs) shall not be deepened.

(C) In addition to specific instructions that are provided by the division pursuant to 10 CSR 23-3.100(7)(A) and (B), the following must be performed at all new wells installed in Special Area 3:

1. All drilling-derived fluids and solid materials shall be containerized and sampled before disposal in an appropriate location based on analytical results;

2. All new and deepened old wells in Special Area 3 shall be constructed with a sampling port or tap within ten feet (10') of the wellhead. Water must be purged from the sampling port prior to collection of a sample;

3. After proper well development, water from all new wells located in Special Area 3 shall be sampled and analyzed for the chemicals of concern, as determined by the division. Qualified and properly trained persons must complete sample collection. In order to document sampling has occurred, a copy of the chain of custody form shall be submitted by the pump installation contractor to the division within sixty (60) days of pump installation; and

4. The data report from all analyses shall be made available by the pump installation contractor to the division and the well owner within sixty (60) days of the sampling event.

(D) At any well being drilled, per division guidance, in which PCE and/or TCE is encountered in a pure-product phase (also known as dense non-aqueous phase liquid or DNAPL), drilling shall cease and the division shall be notified immediately. The division will determine further action.

(E) Properly constructed new or deepened wells that, upon sampling and analysis, are contaminated at levels exceeding MCLs or ALs shall:

1. Be plugged full-length using high-solids bentonite slurry, six percent (6%) bentonite cement or neat cement grout placed under pressure via tremie pipe which extends to within twenty-five feet (25') of the bottom of the borehole. Grout shall extend from the bottom of the borehole to within two feet (2') of land surface. Prior to plugging, all pumps and debris must be removed from the wells. Any liner must be removed or perforated if possible. Casing must be cut at least three feet (3') below ground surface. A registration report and fee (if required) must be submitted within sixty (60) days of abandonment; or

2. With approval from the division, the well owner shall be allowed to install a water treatment system that is designed to properly treat the chemical(s) of concern. The well shall not be used for human consumption until sampling and analysis demonstrates that the water treatment system reduces contaminant levels below MCLs and/or ALs for all chemicals of concern. The division shall be provided a copy of the post-treatment analytical data by the pump contractor within sixty (60) days of the sampling event.

(8) Special Area 4. Portions of St. Charles County west of the city of Weldon Spring shall be listed as Special Area 4 (Figure 7D included herein) due to the contamination of portions of the aquifer by one (1) or more of the following chemicals of concern: trinitrotoluene (TNT) and dinitrotoluene (DNT) at the U.S. Army Corps of Engineers (COE) site, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, dinitrobenzene (1,3-DNB), nitrobenzene (NB),



nitrate, uranium, and trichloroethylene (TCE) at the Department of Energy (DOE) Main Site, uranium, and 2,4-DNT, at the DOE Quarry, or other contaminants of the National Public Drinking Water Regulations (NPDWR). In this area it is necessary to utilize more stringent well construction standards for new wells that are drilled into the aquifer and to limit the deepening of existing upper aquifer wells.

(A) The division shall be consulted before constructing a new well in Special Area 4. The division will provide specific guidance on well drilling protocol, construction specifications and groundwater sampling on a case-by-case basis. The division must provide written approval for all new wells prior to construction.

(B) Before deepening a well in Special Area 4, groundwater sampling and analysis for the chemicals of concern must be conducted by qualified and properly trained individuals and the data submitted within sixty (60) days of the sampling event by the well installation contractor to the division. The division must provide written approval for the deepening of all new wells in Special Area 4. Wells that have been sampled and analyzed and are contaminated with chemicals of concern exceeding maximum contaminant levels (MCLs), action levels (ALs), and/or remediation goals included in the DOE/COE Record of Decision (ROD) for the Weldon Spring sites shall not be deepened.

(C) In addition to specific instructions that are provided by the division pursuant to 10 CSR 23-3.100(8)(A) and (B), the following must be performed at all new wells installed in Special Area 4:

1. All new and deepened old water wells in Special Area 4 shall be constructed with a sampling port or tap within ten feet (10') of the wellhead. Water must be purged from the sampling port prior to collection of a sample;

2. After proper well development, water from all new wells located in Special Area 4 shall be sampled and analyzed for the chemicals of concern, as determined by the division. Qualified and properly trained persons must complete sample collection. Sampling qualifications and training requirements will be determined in advance of sampling by the division and approval will be issued in written format. In order to document sampling has occurred, a copy of the chain of custody form shall be submitted by the pump installation contractor to the division within sixty (60) days of pump installation; and

3. The data report from all analyses shall be made available by the pump installation contractor to the division and the well

owner within sixty (60) days of the sampling event.

(D) Properly constructed new or deepened wells that, upon sampling and analysis, are contaminated at levels exceeding MCLs, ALs, and/or remediation goals included in the DOE/COE ROD for the Weldon Spring sites shall:

1. Be plugged full-length using high-solids bentonite slurry, six percent (6%) bentonite cement or neat cement grout placed under pressure via tremie pipe which extends to within twenty-five feet (25') of the bottom of the borehole. Grout shall extend from the bottom of the borehole to within two feet (2') of land surface. Prior to plugging all pumps and debris must be removed from the wells. Any liner must be removed or perforated if possible. Casing must be cut at least three feet (3') below ground surface. A registration report and fee (if required) must be submitted within sixty (60) days of abandonment; or

2. With prior approval from the division, the well owner shall be allowed to install a water treatment system that is designed to properly treat the chemical(s) of concern. The well shall not be used for human consumption until sampling and analysis demonstrates that the water treatment system reduces contaminant levels below MCLs, ALs, and/or remediation goals included in the DOE/COE ROD for the Weldon Spring sites for all chemicals of concern. The division shall be provided a copy of the post-treatment analytical data by the pump contractor within sixty (60) days of the sampling event.

(E) Notwithstanding these provisions, the federal government does not waive its rights and authority under federal law, regulations, or executive order within the boundaries and applicable jurisdiction of federal property.

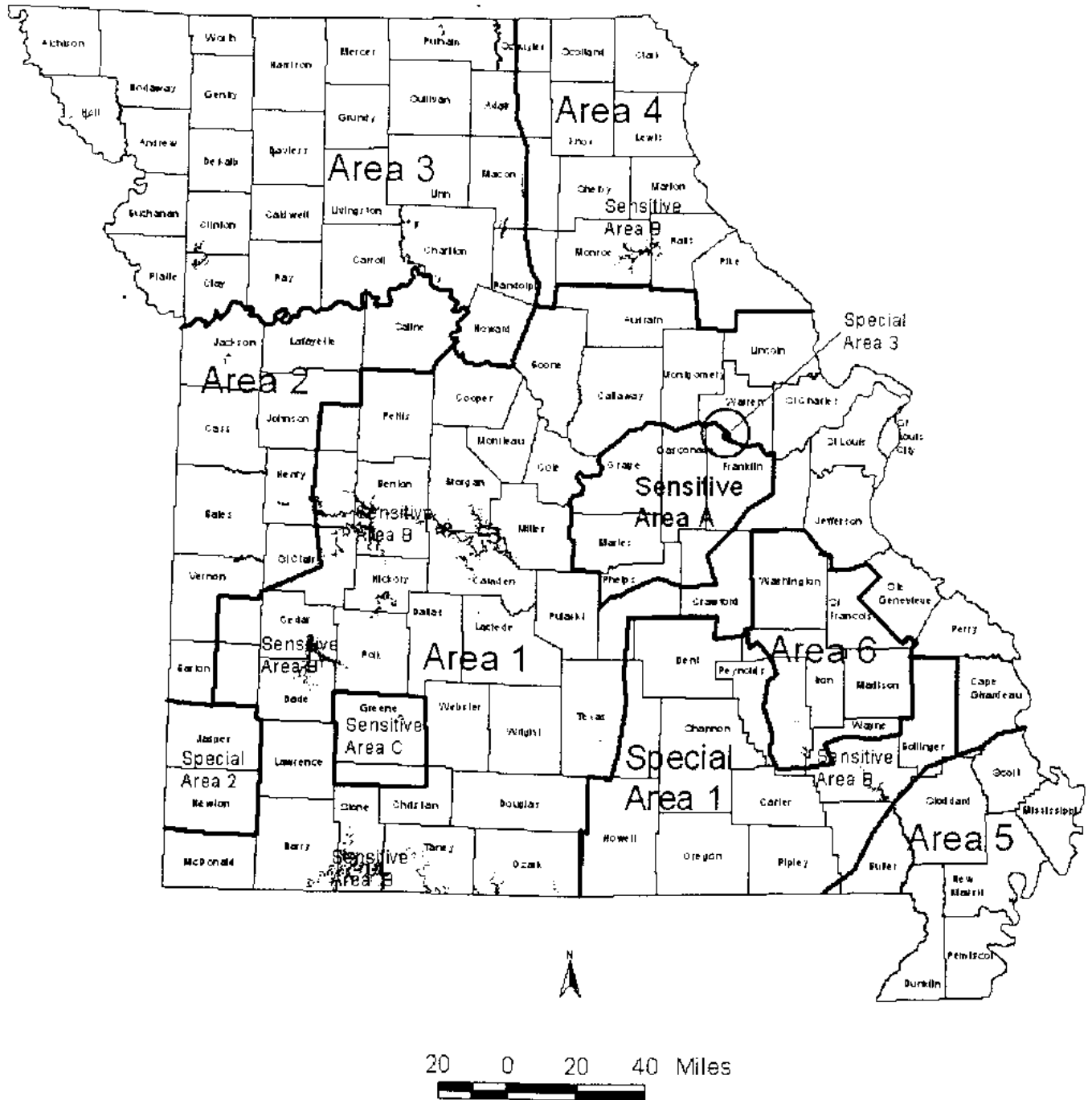


Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on the following pages.

Special Area 1

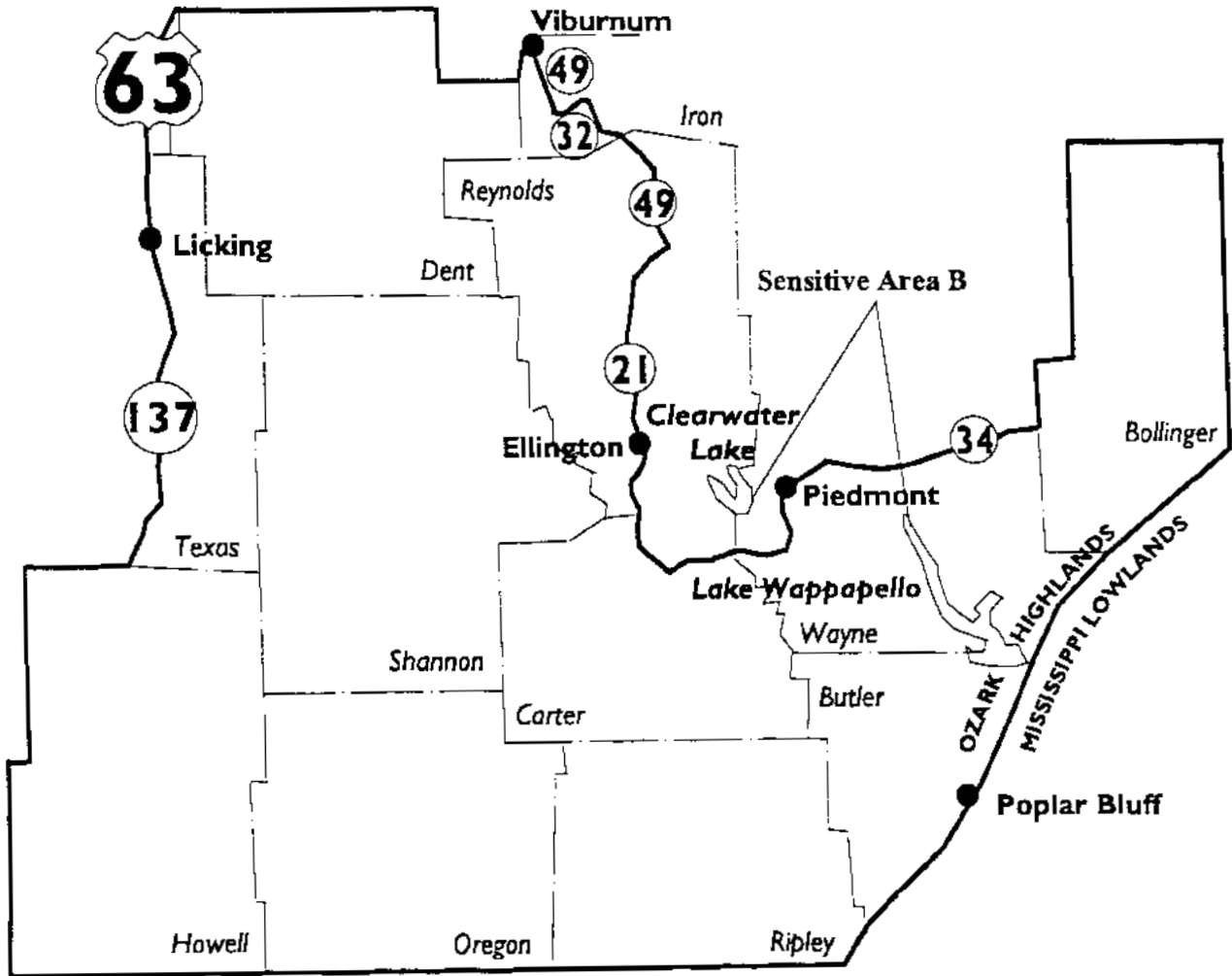


Figure 7. Enlargement of Special Area 1 and part of Sensitive Area B map.

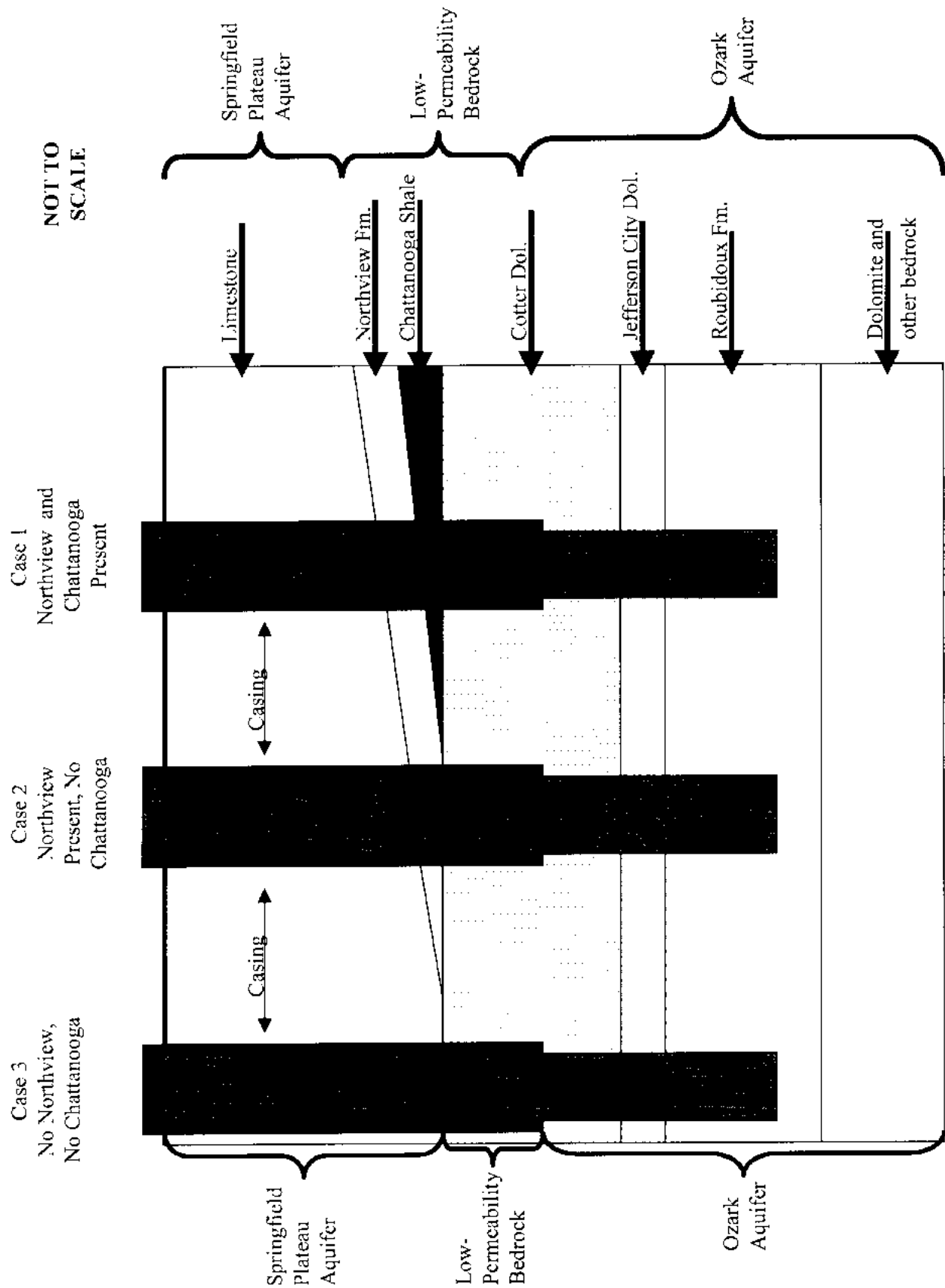


Figure 7 A. Special Area 2 Geology and Well Casing

Missouri Well Construction Rules (5-01)

Area 1, Special Areas 2 and 3 and Sensitive Areas A, B, and C

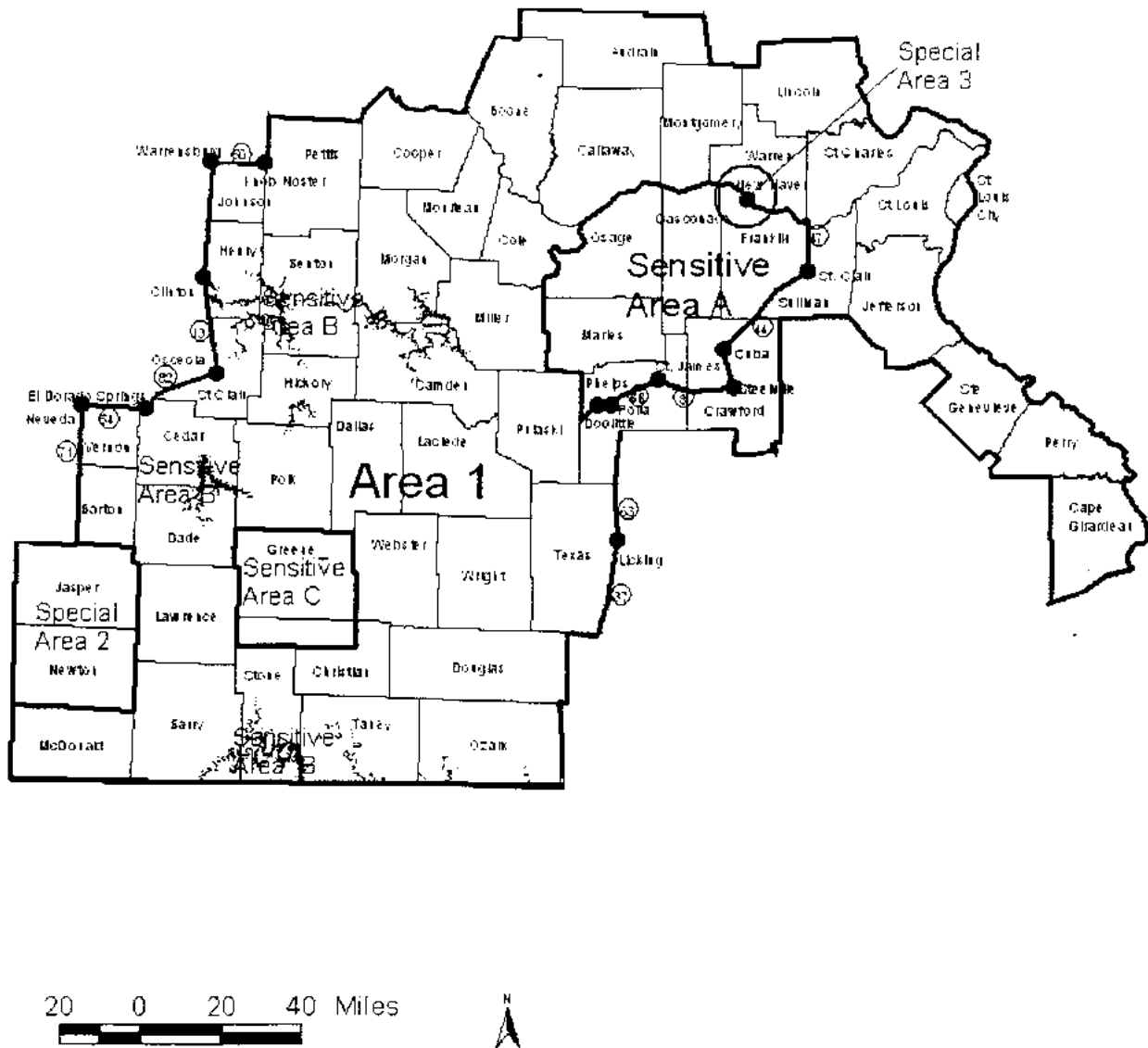


Figure 7B. Area 1, Special Areas 2 and 3, Sensitive Areas A, B, and C map.

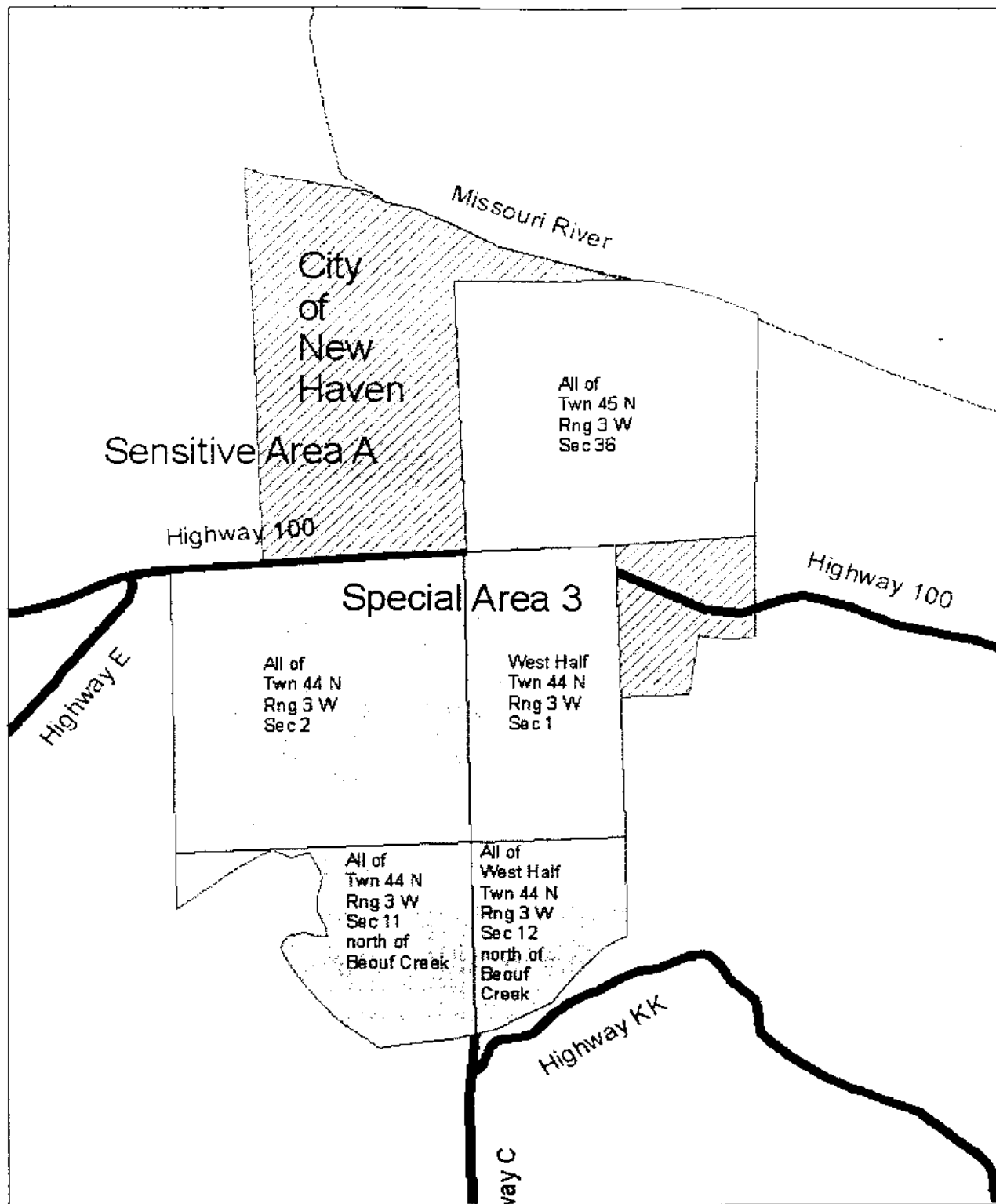


Figure 7C. Special Area 3 and Sensitive Area A

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Missouri Well Construction Rules (2-05)

Special Area 4

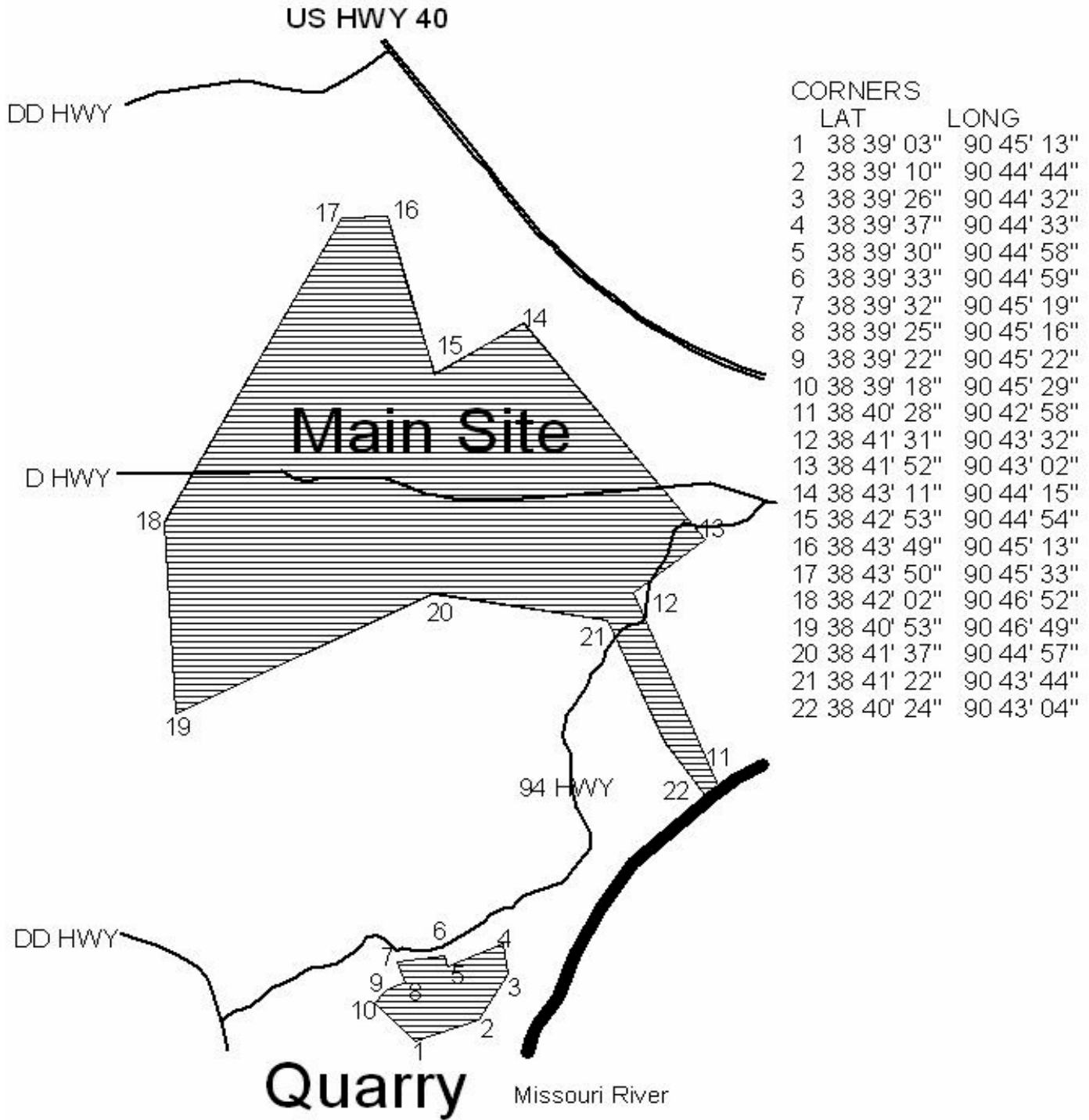


Figure 7D. Special Area 4, Weldon Spring Federal Area



AUTHORITY: sections 256.606 and 256.626, RSMo 2000. Original rule filed April 2, 1987, effective July 27, 1987. Emergency amendment filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Amended: Filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed April 23, 2001, effective Dec. 30, 2001. Emergency amendment filed March 21, 2005, effective April 1, 2005, expired Sept. 27, 2005. Amended: Filed Sept. 27, 2005, effective April 30, 2006. Amended: Filed Jan. 4, 2007, effective Aug. 30, 2007.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-3.110 Plugging of Wells

PURPOSE: This rule establishes criteria for the proper plugging procedures to be followed when abandoning a well. Plugging procedures for monitoring wells are contained in 10 CSR 23-4.080, for heat pump wells in 10 CSR 23-5.080 and for test holes in 10 CSR 23-6.050.

Editor's Note: This rule was originally filed as part of 10 CSR 23-3.020 General Protection of Groundwater. It is proposed as a separate rule because of added emphasis given to abandonment procedures in the amendment to the law.

(1) Any well which is to be abandoned must be plugged in accordance with these rules. If a well has been determined to present a threat to groundwater, the division may order that the well be permanently plugged. If a well is in such a state of disrepair (such as the pump has been removed or the water line disconnected) that continued use for purposes of obtaining groundwater is impractical and the well has not been in use for a period of two (2) years or more, the division may order that the well be permanently plugged.

(2) Permanent Abandonment of Wells.

(A) Plugging the Well.

1. A well that is to be permanently abandoned shall be disconnected from the water distribution system and the hole filled to prevent contaminating materials from entering the subsurface water-bearing formations and groundwater from one (1) aquifer mixing with that of another aquifer. Bentonite or cement grout shall be used for grouting material. If the well is so large that the use of these materials is not practical, the division will determine a proper plugging schedule.

All materials, debris and obstructions that may interfere with plugging operations shall be removed from the well. Liner pipe shall be removed or perforated when necessary to assure placement of an effective plug.

2. The division must be consulted for instruction in case of abandonment of a contaminated well or where there is a question of proper procedure. Sampling of the fluids in the well may be required. A permitted well installation or pump installation contractor must be utilized to plug the well.

(B) An abandoned well shall be plugged by one (1) of the following methods in this section in accordance with the materials penetrated, in such a manner as to prevent it from acting as a channel for pollution. A report of the method of plugging shall be filed with the division on a registration report form that is provided by the division.

(C) Plugging requirements contained in 10 CSR 23-3.010–10 CSR 23-3.100 do not pertain to bedrock irrigation wells and public water supply wells which include community, noncommunity and nontransient noncommunity type wells. Plugging requirements for these types of wells will be determined on a case-by-case basis by the division and must be performed by a permitted contractor, and may be more stringent than those for domestic and multifamily wells.

1. Hand dug wells and bored wells no deeper than eighty feet (80'). To plug this type of well, the following steps must be followed (see Figure 9):

A. Remove all pumps, pipe, debris and surface coverings or concrete cap;

B. Push in top three feet (3') of well lining. Lining may be composed of rock, brick or tile. If lining is composed of any other material consult the division for further instructions;

C. Fill well to within three feet (3') from the surface with clean fill such as gravel, sand, varied sized agricultural lime or other approved material;

D. Disinfect fill material. If there is water in the well, chlorine must be added to bring its concentration to at least one hundred (100) parts per million (ppm) (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect the fill material before it is placed into the well;

E. Fill the remaining hole with clay or clay-rich soil. Soil should be mounded slightly at the top to help offset settling; and

F. Submit the registration report form and fee to the division.

2. Wells completed in unconsolidated deposits. This type of well includes alluvial wells, glacial drift wells and nonbedrock wells. To plug this type of well, the following steps must be followed:

A. Remove all pumps, pipe and debris from well;

B. Dig around casing and remove top three feet (3') of casing. The remaining hole must be at least two feet (2') in diameter larger than the existing casing (see Figure 10);

C. Fill well from total depth to fifty feet (50') from surface with clean fill such as gravel, sand, varied sized agricultural lime or other approved material;

D. Disinfect fill material. If there is water in the well, you must add chlorine to the water bringing it to a concentration of at least one hundred (100 ppm) (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect the fill material before it is placed into the well;

E. Place a grout plug that fills the upper fifty feet (50') of casing and extends into the larger excavated area, at least one foot (1'). In agricultural or yard settings the remaining hole above the grout plug must be filled with soil. In other settings, the remaining hole above the grout plug may be filled with clean fill if the well site is to be paved; and

F. Submit registration report form and fee to the division.

3. Wells completed in bedrock. This type of well includes any domestic well that produces water from bedrock aquifers (see Figure 11). To plug this type of well, the following steps must be followed:

A. Remove all pumps, pipe and debris from well. Any liner must be removed or perforated if possible;

B. Dig around casing and remove top three feet (3') of casing. The remaining hole must be at least two feet (2') in diameter larger than the existing casing;

C. Fill well from total depth to fifty feet (50') below bottom of casing with clean fill such as gravel, sand, varied sized agricultural lime or other approved fill material;

D. Disinfect fill material. If there is water in the well, you must add chlorine to the water bringing it to a concentration of at least one hundred (100) ppm (see Table 1 in 10 CSR 23-3.050). As the fill material is poured into the well, it is disinfected as it comes in contact with the chlorinated water. If there is no water in the well to be plugged, disinfect any fill material used before it is placed into the well;



E. Place cement or bentonite from a point fifty feet (50') below the bottom of the casing to two feet (2') from the surface making sure the grout extends into the excavated area at least one foot (1'). If the water level is above a point fifty feet (50') below the bottom of the casing, then bentonite chips must be used or the cement or bentonite slurry must be emplaced through a tremie pipe lowered through the water level to the top of the fill. Under no circumstances may cement or bentonite slurry be poured through large columns of water without the use of a tremie pipe (see paragraph (2)(C)6. for alternative cement plugging technique);

F. May plug the well, if the well has one hundred fifty feet (150') or more of casing, by filling the well with clean aggregate to a point fifty feet (50') below the bottom of the casing, placing a grout plug from this point extending up into the casing thirty feet (30'). From this point to within fifty feet (50') of the surface, clean aggregate fill may be used. From fifty feet (50') to two feet (2') must be filled with grout making sure the grout extends into the excavated area at least one foot (1');

G. Cut casing off at top of bedrock, if bedrock is encountered when digging around the casing, and fill remaining hole with cement slurry. In agricultural or yard settings, the plug must terminate at least two feet (2') below the finished surface grade and the remaining hole filled with soil. In other settings, the remaining hole may be filled with clean fill if the well site is to be paved; and

H. Submit registration report form and fee to division.

4. For those wells which casing depth, water level and total depth are not known and cannot be determined, plugging instructions will be determined on a case-by-case basis and may be more stringent.

5. As clean fill is being placed into a well, periodic measurements should be taken to ensure that the fill does not reach a point closer than fifty feet (50') below the bottom of the existing casing. If fill is placed above this point, plugging schedules will be determined by the division and may result in removal of fill material.

6. When plugging a well that contains water that is above a point of fifty feet (50') below the bottom of the casing or liner, whichever is deeper, cement slurry may be poured into the well if a tremie pipe is placed in the well to near the bottom and acts as a conduit for the water to escape through as the cement slurry is poured into the well casing from the surface. The cement slurry must be poured in one (1) continuous operation. Mixing small batches and pouring is not permitted.

7. The flow in a flowing well shall be confined, if possible, and the well plugged in accordance with well plugging requirements supplied by the division which will be determined on a case-by-case basis. Proper judgment shall be exercised in the feasibility of plugging flowing wells. In some cases the confining formation may have been so badly disturbed that plugging may only cause the flow to discharge in a less appropriate location. In other situations, the flow may have eroded so much material that the landscape has taken on the appearance of a natural spring. The plugging in this case may be impractical, if not impossible.

(3) Owners Responsibility for Plugging Well. The owner shall be responsible for the permanent plugging of an abandoned well except when the permittee improperly locates, constructs or completes the well. The permittee shall then be responsible for the plugging of the well.

(4) Wells Abandoned by Landowners. Wells abandoned by landowners after August 28, 1991, shall be plugged or cause to be plugged, in accordance with this rule. Landowners may plug their own wells located on property they own or lease, if the wells were intended for use only in single-family houses which are their permanent residences, or were intended for use only for farming purposes on their farms, and where the waters that were produced were not intended for use by the public or in any residence other than their own. If a landowner pays someone to assist with the plugging of the well, that person must hold a current Missouri well installation contractor permit or Missouri pump installation contractor permit except as stated in 10 CSR 23-1.090(2) concerning hand dug wells. If the division makes a finding that certain unusual conditions exist at a well that is to be plugged, the division may require that the well be plugged by a permitted well installation contractor or a permitted pump installation contractor. Unusual conditions exist at a well that is to be plugged if the total depth, amount of casing and water level are not known; a liner is in the well; foreign objects are stuck in the well; the well is contaminated with pollutants other than bacteria; or other conditions determined by the division on a case-by-case basis.

(5) A permittee or landowner who permanently abandons any well that is removed from service shall report the abandonment to the division on a registration report form provided by the division. A permittee or landowner shall report to the division any unplugged abandoned wells existing on

his/her property (landowner) or property on which a permittee is hired to perform well drilling repair or pump installation.

(6) All wells may be plugged by filling the well via tremie or pressure grouting with cement slurry, bentonite or bentonite slurry from total depth to two feet (2') from the surface, if this method exceeds other minimum standards.

(7) If the division finds that certain conditions for high potential of groundwater contamination exist at a well, the division may require that a permitted well installation contractor or pump installation contractor be contracted to plug the well.

AUTHORITY: sections 256.606, 256.614, 256.615 and 256.626, RSMo Supp. 1991. This rule was previously filed as 10 CSR 23-3.020(3)-(9). Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; 256.615, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

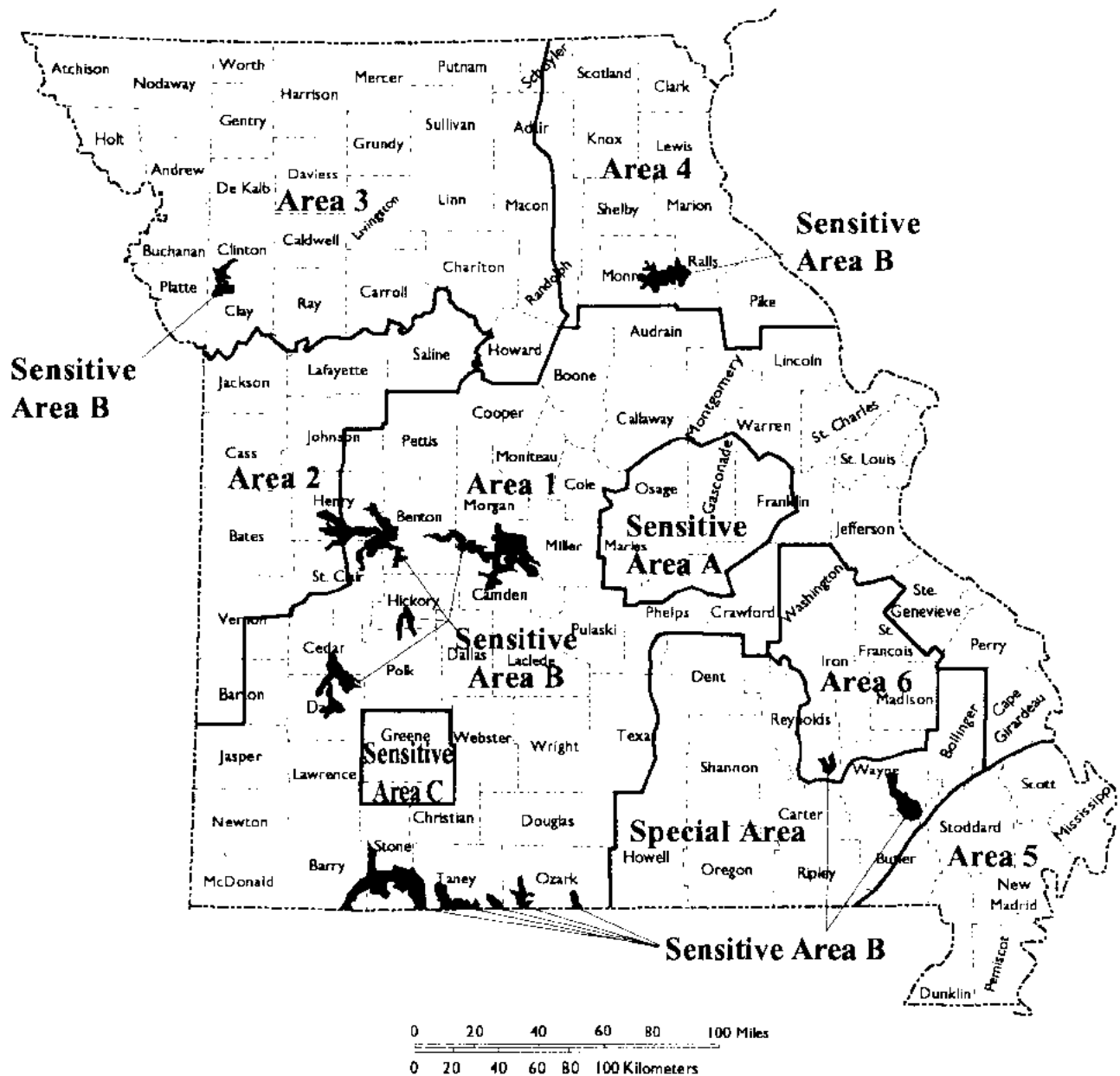


Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on following pages.

Area 2

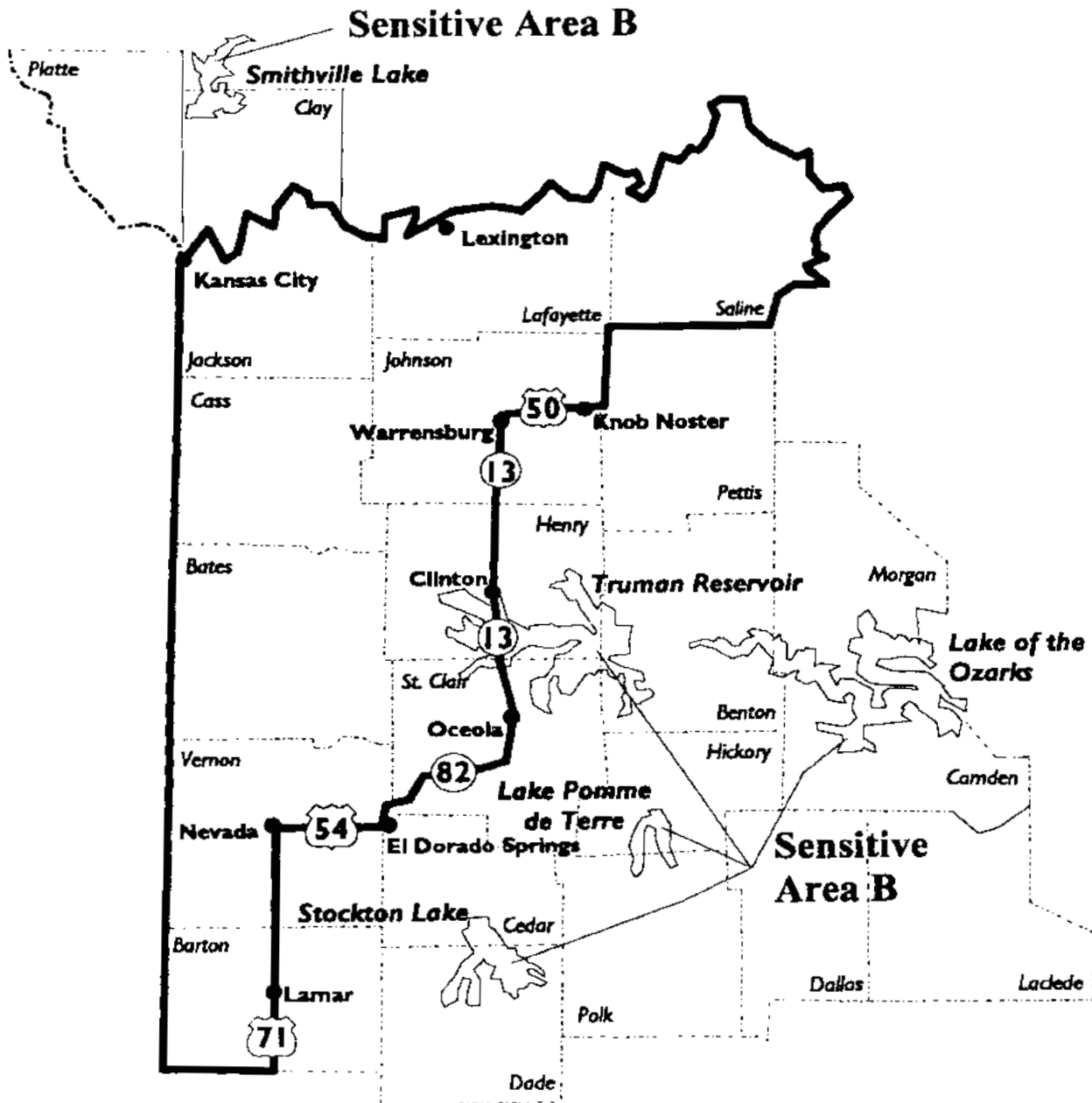


Figure 2. Enlargement of Area 2 and Sensitive Area B map.



Area 3

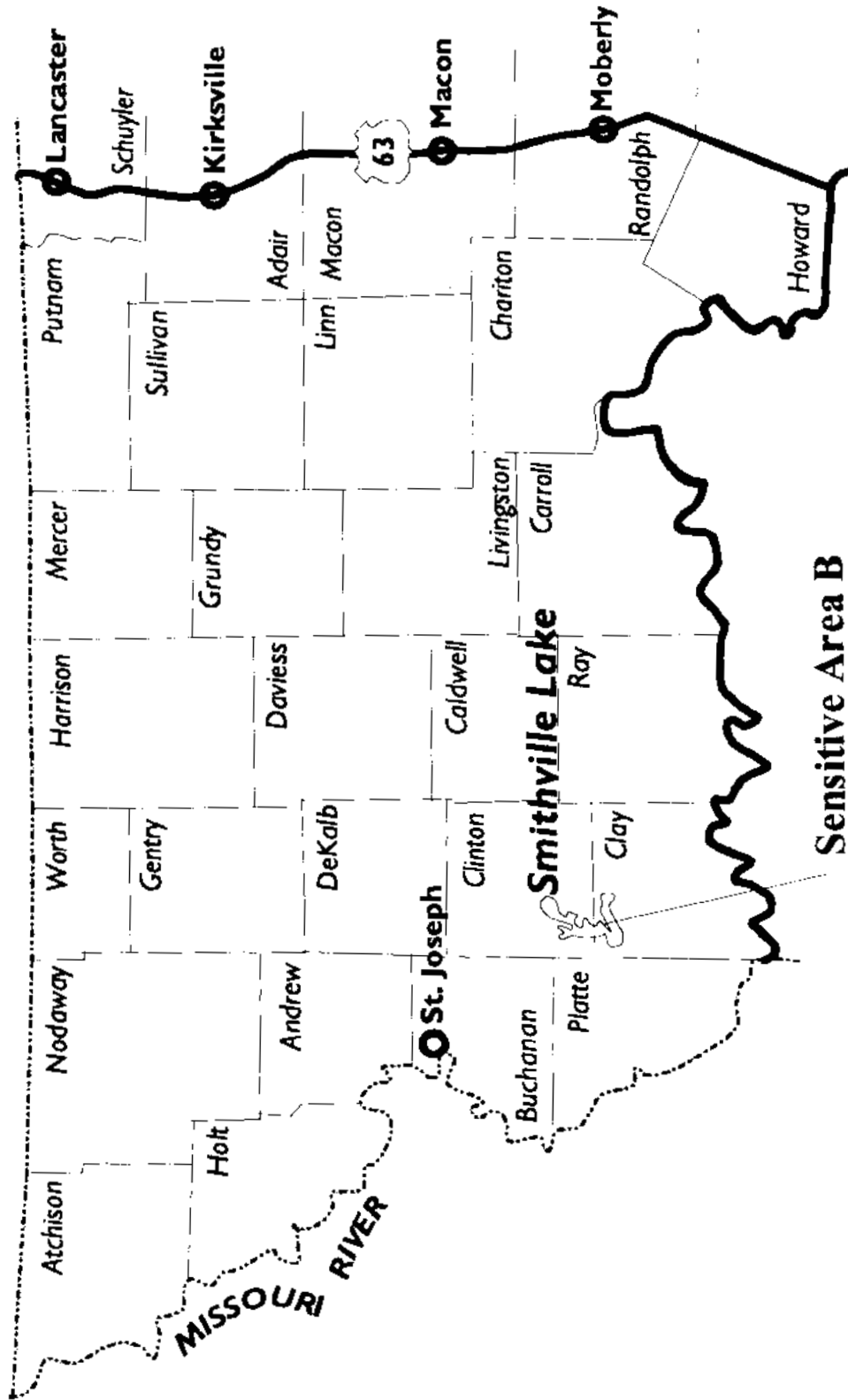


Figure 3. Enlargement of Area 3 and part of Sensitive Area B map.

Area 4

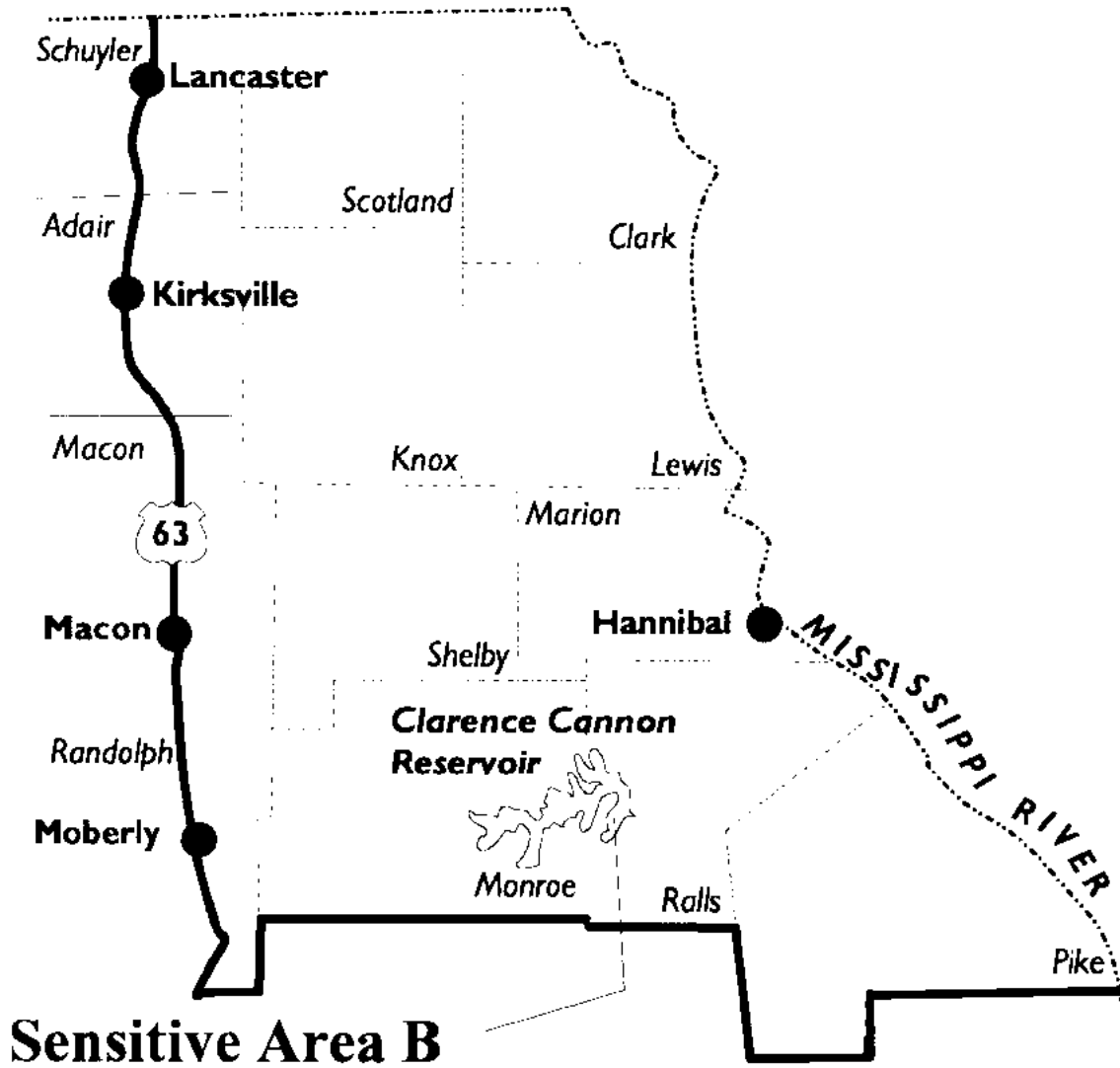


Figure 4. Enlargement of Area 4 and part of Sensitive Area B map.



Area 5

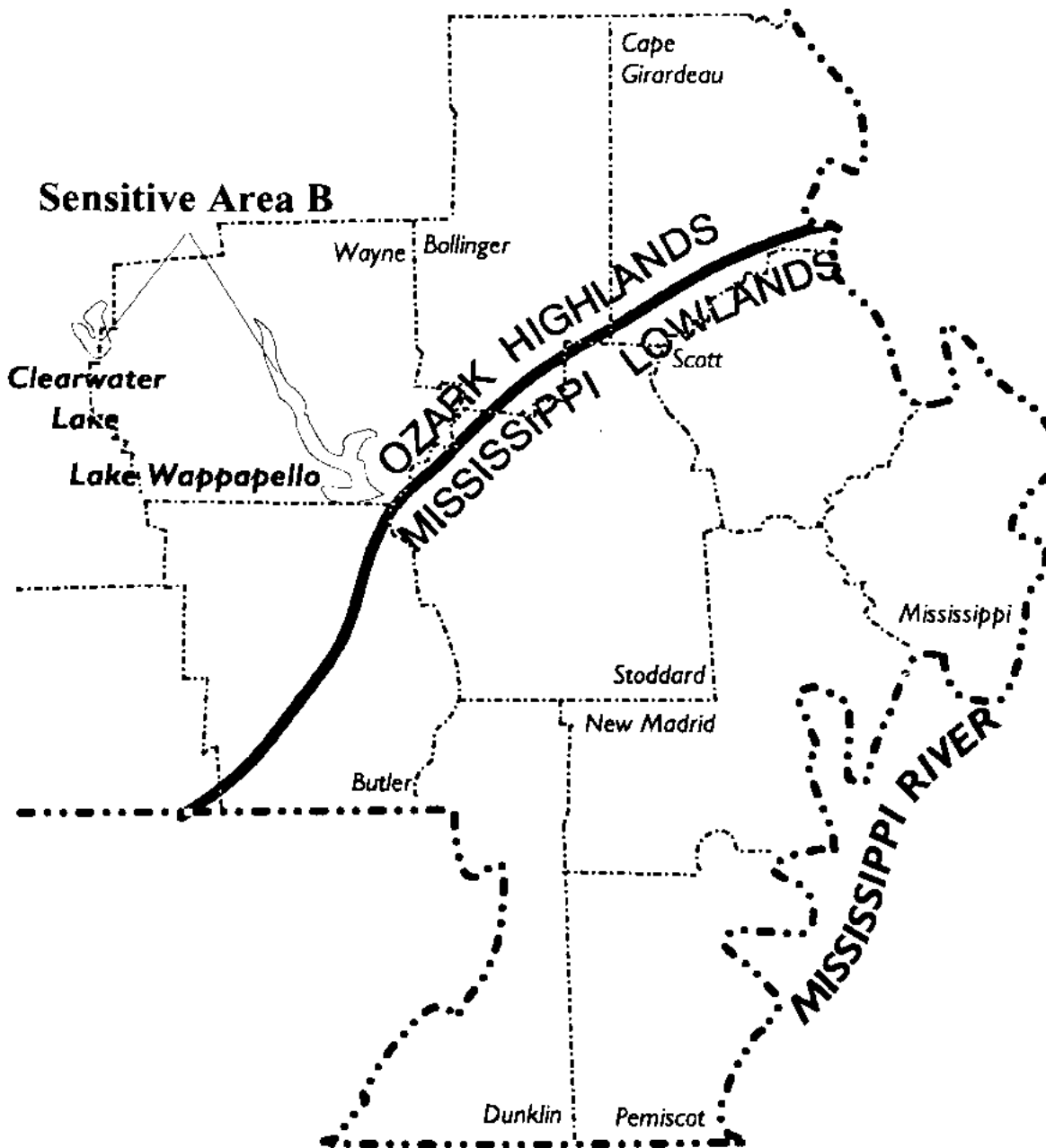
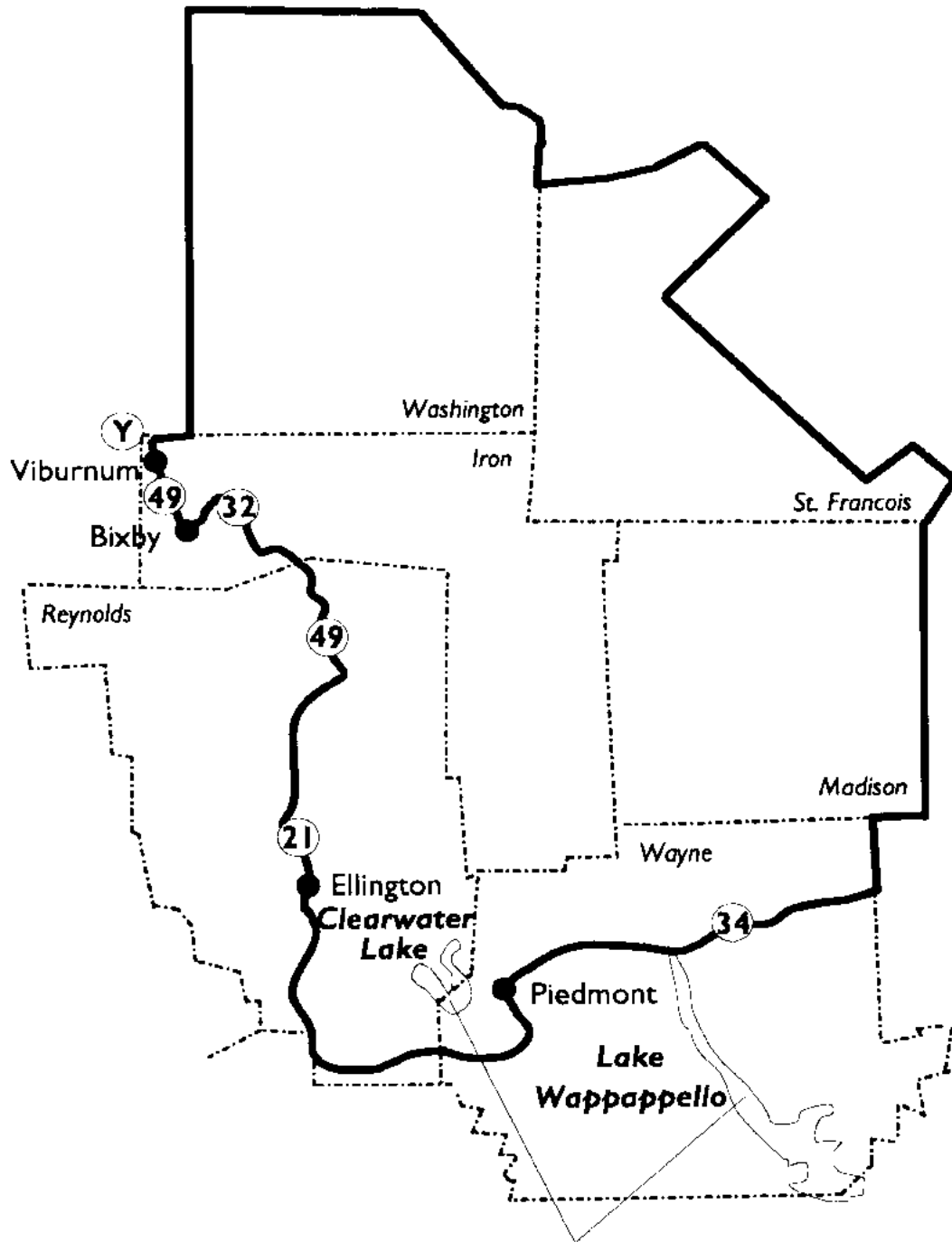


Figure 5. Enlargement of Area 5 and part of Sensitive Area B map.

Area 6



Sensitive Area B

Figure 6. Enlargement of Area 6 and part of Sensitive Area B map.



Special Area

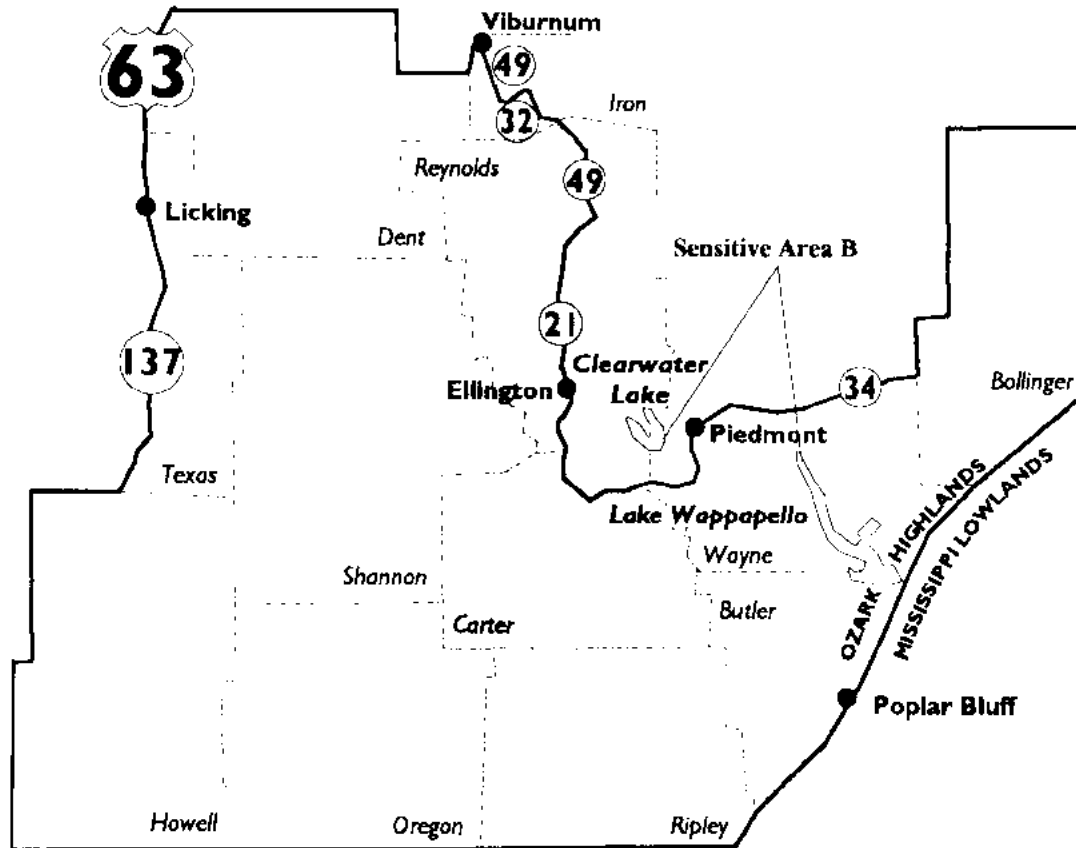


Figure 7. Enlargement of Special Area and part of Sensitive Area B map.

Area 1 and Sensitive Areas A, B, and C

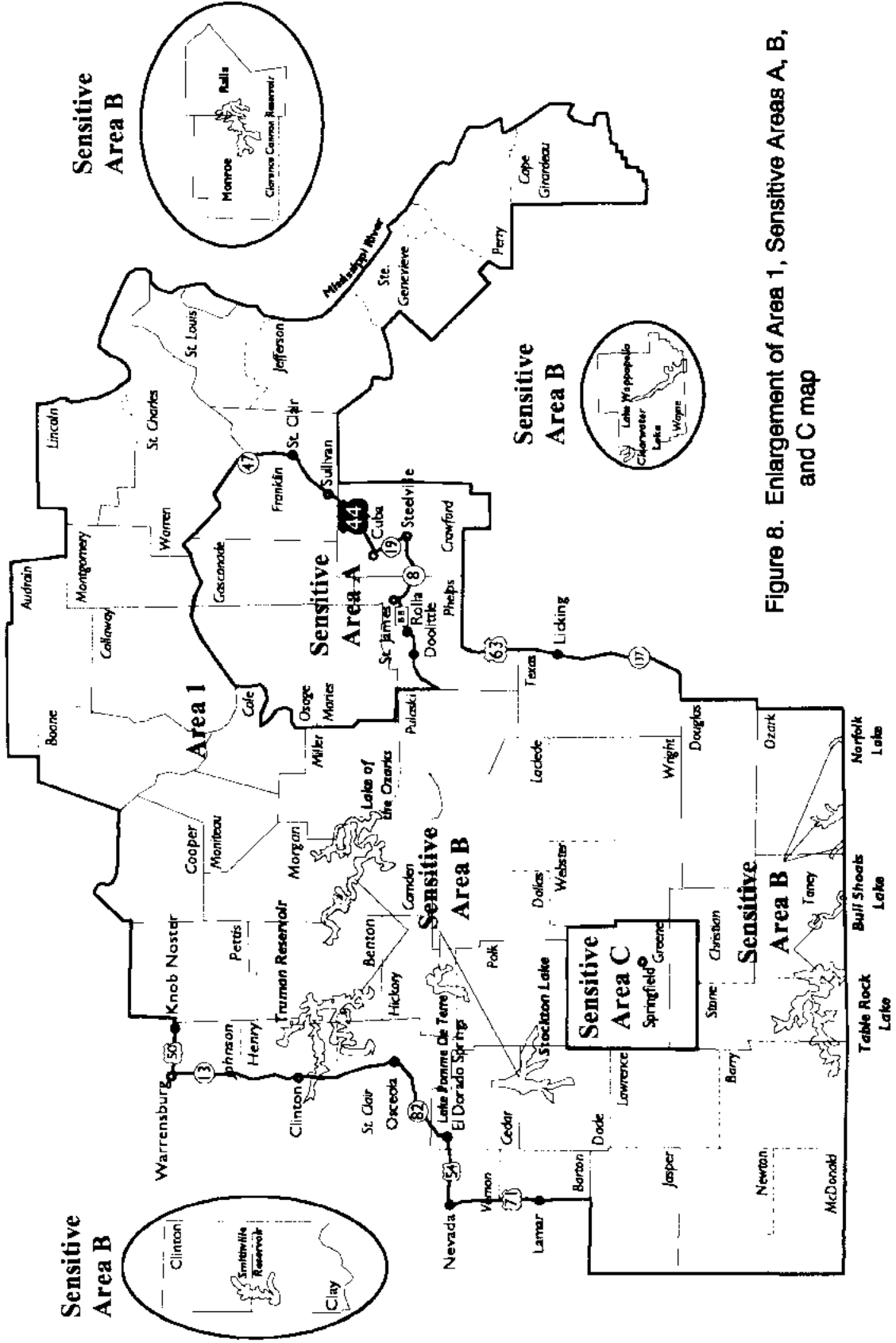


Figure 8. Enlargement of Area 1, Sensitive Areas A, B, and C map

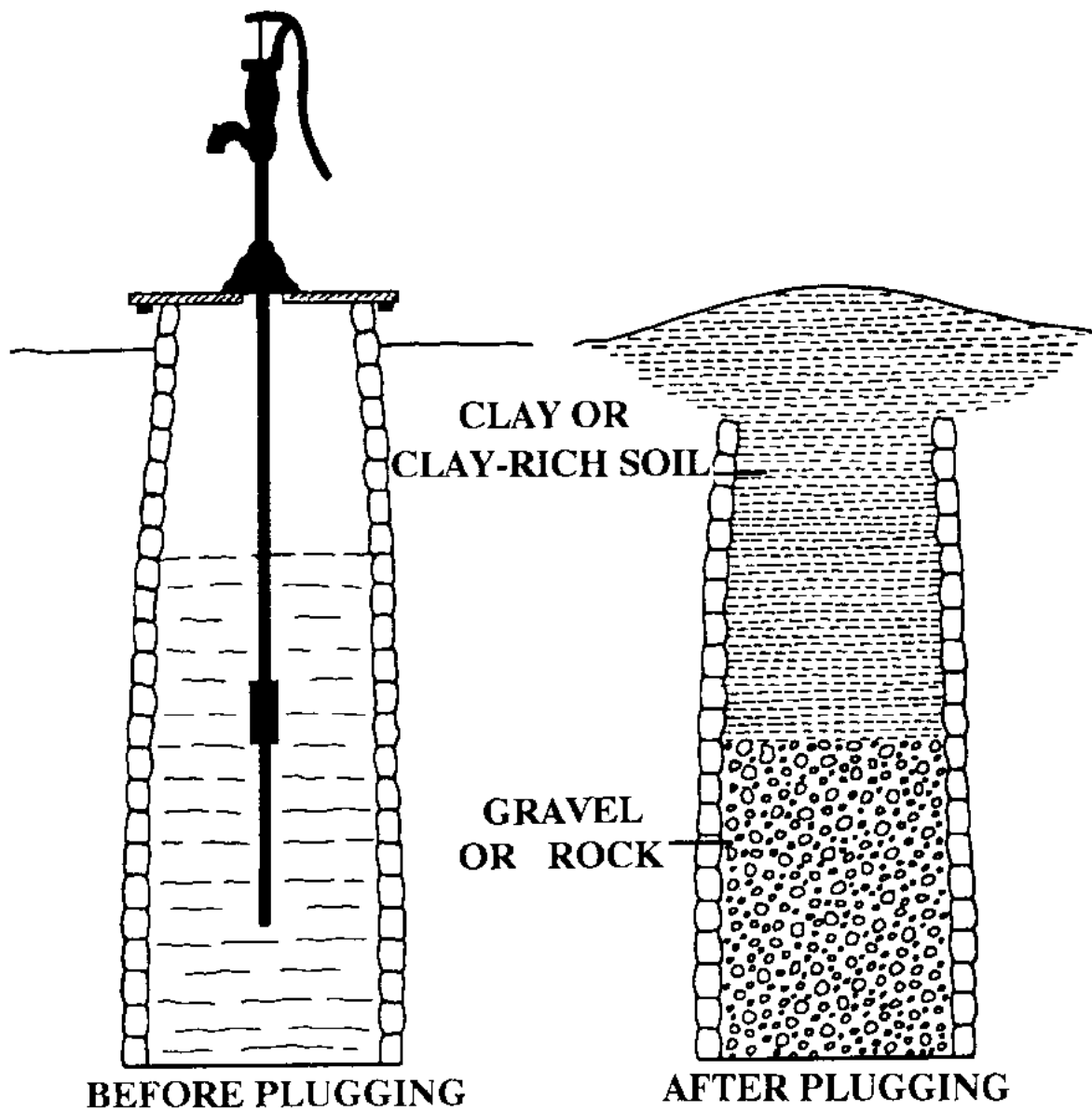


Figure 9 - Plugging diagram for dug wells.

PLUGGING DOMESTIC WELLS IN UNCONSOLIDATED DEPOSITS

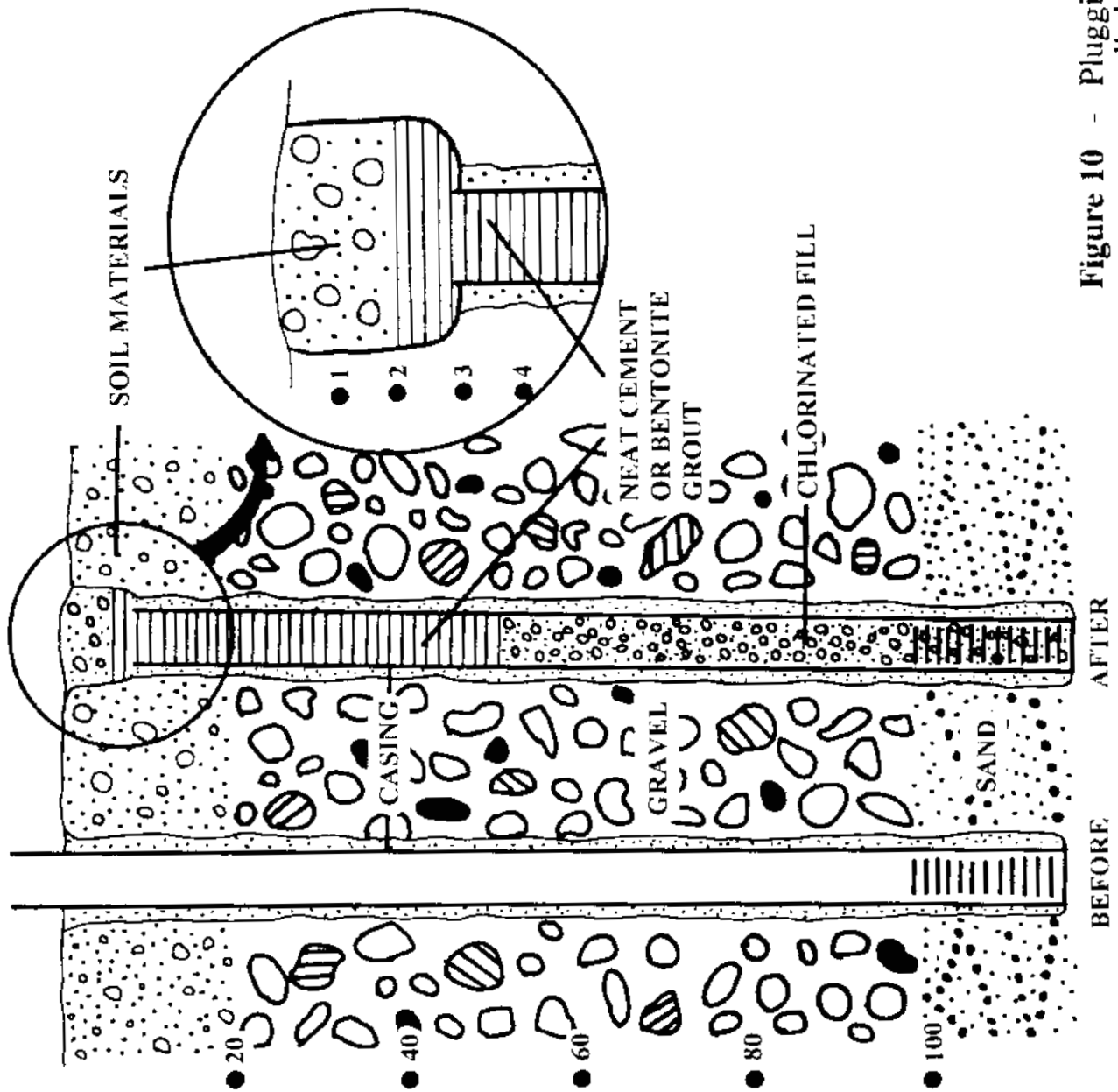


Figure 10 - Plugging diagram for domestic wells in unconsolidated deposits.



PLUGGING DOMESTIC WELLS IN BEDROCK

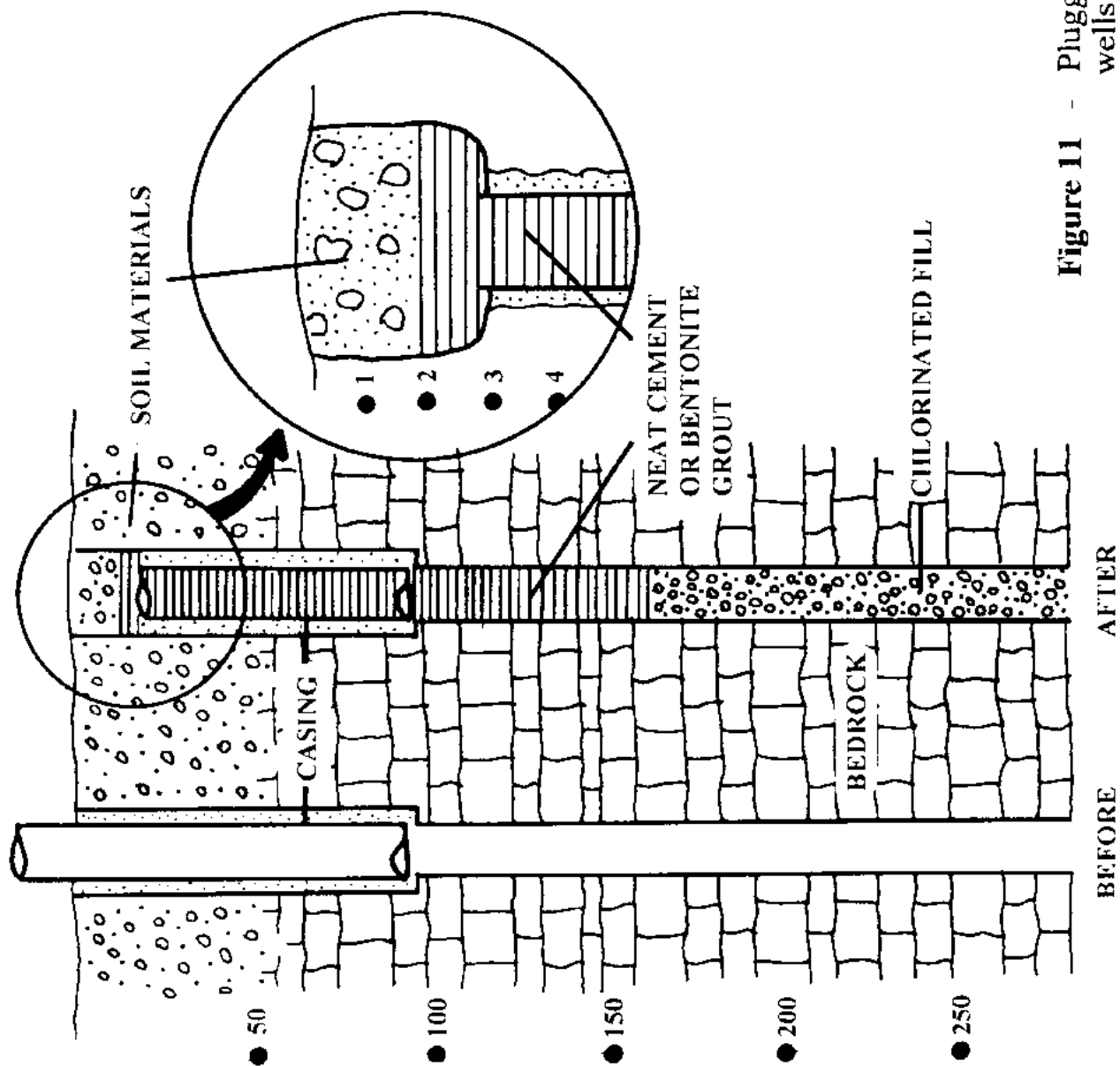


Figure 11 - Plugging diagram for domestic wells in bedrock.