ATTACHMENT D

Demolition of Parcel #6

Well Plugging, Removal and Abandonment

William Wilder /SC/MODOT
12/11/2006 03:18 PM

To Rolla F Rentz/D3/MODOT@MODOT
cc
bcc
Subject Well Abandonment

Here is a tech bulletin from DNR that describes the process:

http://www.dnr.mo.gov/pubs/pub682.pdf

This is the actual regulations. 10 CSR 23-3.110 Plugging of Wells on p 35 gives the details.

http://www.sos.mo.gov/adrules/csr/current/10csr/10c23-3.pdf

Note that this work must be done or overseen by a certified well installer.

Missouri Department of Natural Resources

Eliminating an Unnecessary Risk: Abandoned Wells and Cisterns

Water Pollution Program fact sheet 11/2006

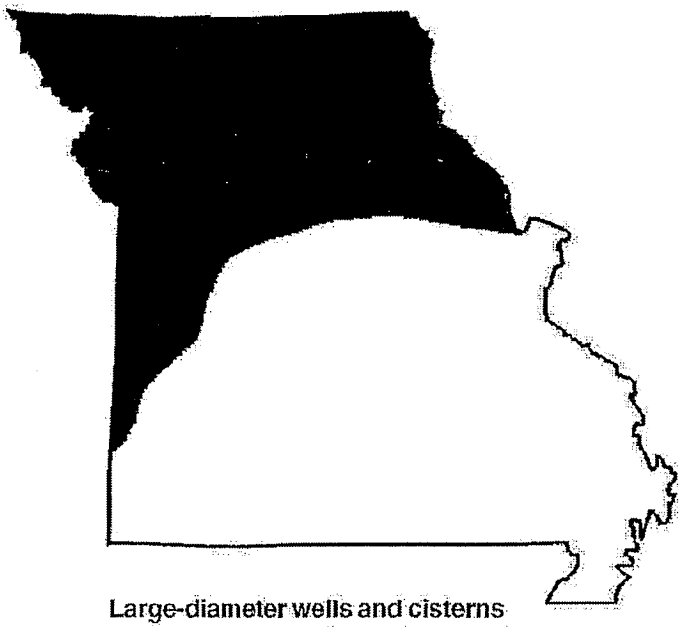
Many things have changed since Missouri's early settlement days more than 150 years ago, but one that has not is the need for a dependable supply of water. Springs and springfed streams draining from thick bedrock aquifers provided water to many of the early settlers in the Ozarks region. But springs are rare in northern and western Missouri, and most streams here cease flowing during dry weather. Even in the Ozarks there are areas devoid of springs and year-round flowing streams, so early residents in these parts of the state had to construct wells and cisterns to supply them water.

The early wells and cisterns constructed in Missouri bear little resemblance to their modern counterparts. Built before drilling machines were invented or commonly available, these early wells and cisterns were dug and constructed by hand with pick and shovel. Their means of construction account for their size; the hole had to be large enough for a person to work.

Most hand-dug wells and cisterns are from three to six feet in diameter. Unlike modern wells, they do not contain casing. Brick or field stones were used to line the well, holding the materials in place while allowing water to enter.

Their depths are variable; if ample water was encountered at a shallow depth there was little need to dig deeper. Some bottomed no more than 10 feet below land surface, while others are more than 30 feet deep. Though they were dug to produce groundwater, many did not. Instead of abandoning a hole that took weeks to dig and trying again elsewhere, many were finished to use as cisterns.

Unlike wells, cisterns do not produce water but simply store it. Runoff from rooftops is caught by gutters and channelled through downspouts to the cistern to supply water between rains. If necessary, water is hauled from other sources to refill cisterns during very dry



Large-diameter wells and cisterns are most common in northern and western Missouri. Drilled wells, while most common in the Ozarks region, are found in all parts of the state.

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weather. Dug wells that produce groundwater are referred to as "living wells" while cisterns are often called "wells" even though they are only a storage structure.

Originally, dug wells and cisterns were a valuable asset to any landowner; a farm with wells was more valuable than one without any water supply. Nearly every northern and western Missouri farmstead had one or more wells or cisterns. Before community water supplies were developed, wells and cisterns also supplied people living in towns.

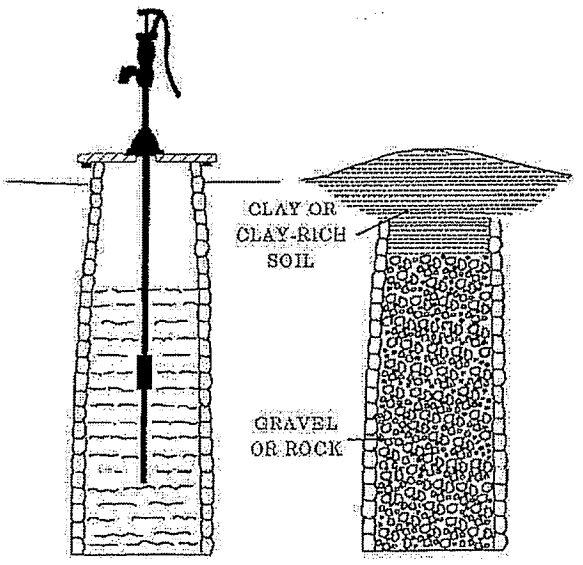
Water supply is as important today as ever, but many things have changed since the days of the hand-dug well. Most rural communities have public water supplies. Rural public water supply districts supply many farms and rural residents, and ponds are widely used for watering livestock. Farms have also increased in size, so there are fewer people and farmsteads to supply. As a result, many of the wells and cisterns that were so important a few decades ago are no longer used or needed. In fact, they are no longer an asset but a serious liability.

Deadly Traps

Abandoned large-diameter dug wells and cisterns are a very real and deadly threat to the residents of rural Missouri. If kept in good repair, they present little threat to human safety, but many well and cistern covers were constructed from wood, which can be weakened or destroyed by the elements. Even those with concrete covers are subject to deterioration. Abandoned wells have received much notoriety in the press when they have claimed the lives of children who have fallen into them and drowned. Many dug wells and cisterns are still in use. When properly maintained they present little risk, but when abandoned they become potential traps and are an unnecessary risk to human life.

There are several types of abandoned wells in Missouri. Abandoned small-diameter drilled wells are found throughout the state and threaten groundwater quality. They can allow contaminants to enter aquifers, but usually do not present a threat to the immediate safety of small children. Large-diameter dug wells and their more modern counterpart, bored wells, present less risk to groundwater quality than drilled wells, but if not properly covered or plugged, can kill.

While all types of abandoned wells can cause groundwater contamination, cisterns, being subsurface water-storage "tanks," do not present as much of a contamination threat. However, they are just as deadly as dug and bored wells if abandoned and left uncovered or unplugged.



Large diameter wells and cisterns can be plugged by filling the well to within two feet of the surface with chlorinated clean fill, and the upper portion of the well with compacted clay or clay-rich soil.

Plugging Abandoned Wells

Dug Wells and Cisterns

Dug wells commonly are three to six feet in diameter, often larger at the bottom than at the top, and may be from ten feet to more than 30 feet deep. Usually they are lined with brick or field stone, and typically produce less than three gallons of water per minute. Because of their large volume, they can store several thousand gallons of water, enough to meet household and livestock demands.

Cisterns are generally used for private water supply in areas where groundwater resources are poor, or too expensive to develop. Modern cisterns are usually concrete or fiberglass tanks buried in the ground, but older cisterns were dug and constructed by hand. These commonly were three to six feet in diameter, 15 to 30 feet deep, and lined with stone, brick, or concrete. The top of the cistern was capped with a concrete slab or wooden cover.

Dug wells and cisterns are most common in northern and western Missouri but may be found in any part of the state. They were once an important source of water but today most are abandoned, and have become silent traps that can easily ensnare small children and even adults. Potential tragedies can be avoided simply by plugging abandoned dug wells and cisterns.

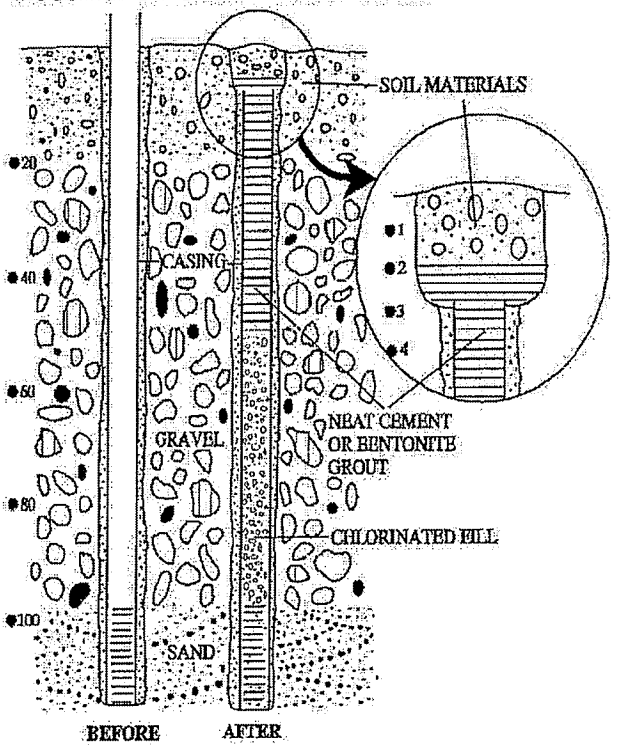
Dug wells and cisterns still in service should have a sturdy cover, preferably made of reinforced concrete. The covers should be securely fastened, or be heavy enough to keep curious children from removing them. Abandoned dug wells and cisterns can be plugged by pushing in the upper few feet of well lining, and filling the well to within three feet of the surface with chlorinated clean fill such as course gravel or rock, varied sized agricultural lime or sand. The remainder of the well should be filled with clay or clay-rich soil. Soil should be mounded slightly at the top and compacted to help offset settling. If a dug well is quite shallow, it can be pumped out and destroyed with a bulldozer.

Bored Wells

Bored wells are constructed with an auger, scoop, dragline, or some similar machine. They are the modern equivalent of the old, hand-dug wells. These wells are relatively large-diameter, usually two to four feet, and may be 20 to 80 feet deep. Older bored wells are commonly lined with sections of clay pipe; newer bored wells are usually lined with concrete pipe. If properly constructed and covered, they can provide a satisfactory water supply and present no special hazard. Abandoned, they are as dangerous as dug wells and cisterns, and should be plugged.

Bored wells can be plugged using the same methods as those described for dug wells and cisterns. As with dug wells and cisterns, plugging bored wells is easier and more effective if as much water as possible is pumped from the well before it is filled.

PLUGGING DOMESTIC WELLS IN UNCONSOLIDATED DEPOSITS



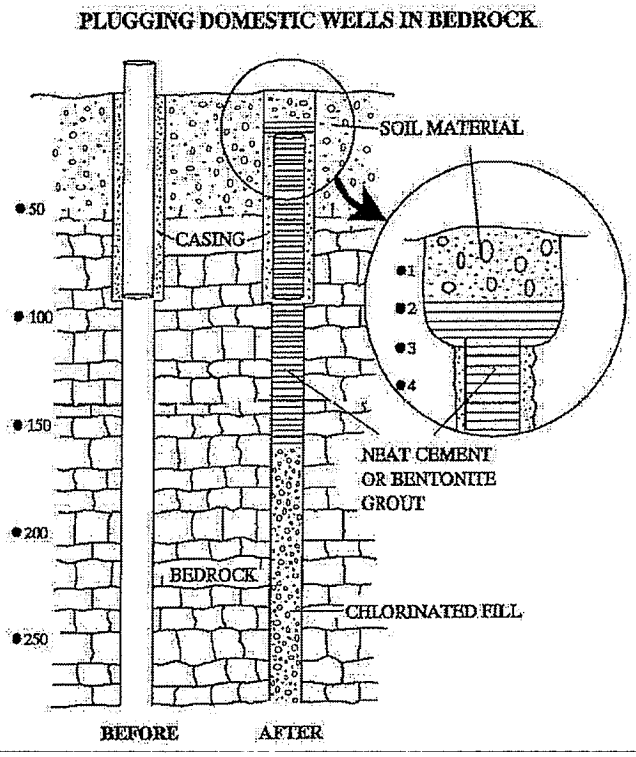
Drilled Wells

Abandoned drilled wells, though not commonly considered to be a safety hazard, do present an avenue or conduit for contaminants to enter the groundwater system. If the diameter of the casing is large enough, very small children or small animals can fall into them. Drilled wells fall into two categories: wells drilled into unconsolidated material such as glacial soil, or sand and gravel (alluvial) deposits along major streams, and wells drilled into consolidated bedrock such as limestone, sandstone and dolomite.

The best way to plug either type of well is to remove the pump or any debris in the well, cut the casing off three feet below the surface and fill the well from bottom to top with neat-cement or bentonite grout or chipped bentonite. Neat-cement grout is mixed at the ratio of no more than six gallons of water per 94-pound bag of cement. Bentonite grout is a bentonite-water slurry that contains at least 20 percent solids. Neat-cement or bentonite grout must not be poured from the surface through standing water; it must be inserted through a grout pipe placed into the well near the bottom. This fills the well, bottom to top, and the water in the well is displaced upward as the grout is pumped. Chipped bentonite is a solid bentonite that is designed to fall through water and swell into many times its size. It is recommended that a permitted driller or pump installer be contracted to plug drilled wells in this manner.

Private water supply wells drilled in unconsolidated material are usually not more than six inches in diameter, and may be from 40 to 150 feet deep. The lower portion of the well contains slotted pipe called a well screen, which allows water to enter the well. The remainder of the hole contains casing. To plug these wells, remove the pump or any debris. Dig around the casing to three feet in depth and cut the casing off. Fill the well with chlorinated clean fill as used in hand-dug wells to a point 50 feet from the surface. Place a grout plug that fills the upper 50 feet of casing and extends into the larger excavated area at least one foot.

Private water supply wells drilled in bedrock are usually six inches in diameter, and may range in depth from 40 feet to more than 500 feet. The amount of well casing (steel, wrought iron or thermoplastic pipe used to seal out surface material and shallow groundwater) depends on the location and age of the well. If the owner has information concerning well depth, the amount of casing, and depth to water, the landowner may proceed as stated. Remove the pump and any debris from the well. Dig around the casing to a depth of three feet and cut off the casing. Fill the well with chlorinated clean fill such as gravel or varied-sized agricultural lime from the bottom of the well to 50 feet below the base of the casing. Place a grout plug from this point filling the hole and casing to a point two feet from the surface. (See diagram.)



The clean fill used in filling the lower part of the abandoned well should be chlorinated to prevent bacteria from being introduced into aquifers. This can be accomplished by simply pouring ordinary household bleach into the well before the aggregate is added, or by adding sodium hypochlorite tablets to the gravel as it is being introduced into the well. These tablets can be purchased at outlets having swimming pool supplies.

Registration

Missouri requires the plugging of abandoned wells to be registered. This is accomplished by plugging the wells according to the rules set out in 10 CSR 23-3.110 (this brochure summarizes these rules) and by filling out a registration record and submitting it to the Missouri Department of Natural Resources' Division of Environmental Quality, with the proper fee. Currently, the registration fee has been eliminated to encourage the proper plugging of abandoned wells.

Once the registration record has been submitted, it will be reviewed by the division. Upon successful review, a registration number will be sent to the property owner which documents that the well has been plugged according to the minimum standards. The registration record and number are important to keep in your records because lending institutions or local governmental bodies may require proof of proper plugging upon sale or refinancing of the property.

Summary

Plugging abandoned wells is the responsibility of the land owner. An abandoned drilled well can introduce contaminants into the groundwater system, and may be responsible for contaminating your water supply, or that of your neighbors. It is far less expensive to properly plug an abandoned well than to pay the costs of cleaning up an aquifer. Costs should not be a consideration with abandoned bored wells, dug wells, cisterns, or any well that is large enough for a person to fall into because no amount of money can compensate for the loss of human life.

Landowners can plug their own wells used for domestic purposes if they follow the rules summarized in this fact sheet. The landowner must know the total depth, length of casing and depth to water to proceed in plugging their well. If the landowner does not know and cannot find out the details of how the well was constructed, the landowner may contact the Division of Environmental Quality for assistance, or use a Missouri-permitted well installation or pump installation contractor to measure or plug the abandoned well. The one exception concerns hand-dug wells. Contractors hired to plug hand-dug wells or cisterns do not have to be permitted but the landowner is responsible to see that the well is plugged according to the rules and reported as required.

For more information

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Division of Environmental Quality
Wellhead Protection Section
P.O. Box 250
Rolla, MO 65402
Phone: (573) 368-2165
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www.dnr.mo.gov/env/wpp/wellhd/

Rules of
Department of Natural Resources
Division 23—Geological Survey and Resource Assessment Division
Chapter 3—Well Construction Code

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Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 23—Geological Survey and Resource Assessment Division
Chapter 3—Well Construction Code

Editor's Note: Forms that are mentioned in this chapter may be found following 10 CSR 23-6. Area maps mentioned in the rule may be found following 10 CSR 23-3.110.

10 CSR 23-3.010 Location of Wells

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 fro leachates discharged from the waste landfi or waste stabilization ponds (lagoon). It recommended that wells not be located in a area between the landfill or waste stabiliz tion ponds (lagoons) sites and the point groundwater discharge to a surface wat source. Any well that may intercept leachat from a waste landfill or waste stabilizatic pond (lagoon) by water withdrawal from t well shall not be used for human consum tion and must be plugged unless it is used f a monitoring well.

(C) Irrigation wells require increased se backs and shall be at least two hundred fe (200') from—

1. Sewer lines, septic tanks, later fields, pit privy, seepage pits, feed lots, bar yards, fuel, fertilizer and pesticide storag Fuel, fertilizer and pesticide tanks up to o thousand gallons (1000 gals.) in capacity w be allowed at well while irrigating and chem gating but must be removed from well si when not is use; and

2. Any well producing potable water.

AUTHORITY: sections 256.606 and 256.62 RSMo 1994. Original rule filed April 1987, effective July 27, 1987. Emergen amendment filed Nov. 16, 1993, effecti Dec. 11, 1993, expired April 9, 199 Amended: Filed Aug. 17, 1993, effecti March 10, 1994. Amended: Filed Nov. 1995, effective June 30, 1996.*

**Original authority: 256.606, RSMo 1991 and 256.62 RSMo 1985, amended 1991.*

10 CSR 23-3.020 General Protection Groundwater Quality and Resources

PURPOSE: This rule is for the overall pr tection of water quality and resources Missouri.

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

(A) A well for the storage of gas or liqu under pressure may not be drilled witho first having secured a permit from t Department of Natural Resources in acco dance with the Missouri Statutes.

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

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

PURPOSE: This rule establishes requirements regarding notification by a public water supplier to the division when a well is to be abandoned in order to connect a structure to a public water supply system.

(1) Public water supplier notification requirements concerning abandoned wells (as stated in section 256.628, RSMo).

(A) A public water supplier subject to the provisions of Chapter 640, RSMo which connects to any structure or location previously serviced by any well which is not that of another public water supplier shall notify the well owner of his/her obligation to plug any abandoned well pursuant to the requirements of section 256.628, RSMo. The public water supplier shall not connect any person to the public water system until the person submits information which identifies the location of wells and attests that—

1. Existing well will remain in use and will be properly plugged when no longer used;

2. Known abandoned wells on the property have been plugged;

3. There are no known abandoned wells on the property; or

4. Any abandoned wells will be plugged within ninety (90) days.

(B) The public water supplier shall submit a copy of information to the division within sixty (60) days of connection on forms provided by the division, along with sufficient information to enable the division to locate existing and abandoned wells. The division shall inspect, within a reasonable time, any well identified in paragraph (1)(A)4. of this rule. If the division determines that an abandoned well has not been plugged, it shall order the owner to have it plugged by a permitted well installation contractor or permitted pump installation contractor within thirty (30) days. The division shall immediately seek injunctive relief through the office of the prosecuting attorney of the county where the alleged violation occurred to enforce its order and shall notify the appropriate public water supplier who shall terminate water service to the property thirty (30) days after receipt of notice if the well has not been plugged. Any person who fails to plug an abandoned well pursuant to the provisions of this subsection shall be subject, upon conviction, to the penalties specified in section 256.637, RSMo.

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.*

**Original authority: 256.606, RSMo 1991 and 256.628, RSMo 1991.*

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 inches, 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. Casin is set into the borehole to a point about fiv feet (5') above the casing point. Grout poured into the well casing followed by drillable plug. This is designed to push a grout to the bottom of the well. If there i water in the borehole and bentonite or cemer slurry is used it must be emplaced via a trem ie to the bottom of the borehole. The plug i pushed to the bottom of the casing forcing th grout down the inside of the casing and up th annular space. The casing is then set into th bottom of the drill hole; and

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

(4) Approved Grouting Methods.

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

(B) Bentonite Grout. Sodium bentonit (swelling clay) is available in many form from granules to pellets to chips. Whe grouting annular spaces with nonslurry ben tonite, great care must be exercised to ensur the bentonite is placed properly. Flas swelling may occur and bridge off the annu lar space preventing an adequate seal whe using powdered, granular, tablets or pel letized bentonite. Therefore, only bentonit specifically designed to prevent flash hydra tion and to fall through standing water may b used. Chipped or pelletized bentonite ma not be used in annular spaces less than on inch (1"). Bentonite must be applied slowe than manufacturer's specifications. If there i no water in the annular space, the bentonit must be hydrated after each bag or wate poured into the hole before application of th bentonite.

(C) Bentonite Slurry Grout. Sodium ben tonite slurry grout is a bentonite/water mix ture. There are many additives available tha effect viscosity and set-up time. These addi tives are acceptable unless they are a poten tial contaminant. Bentonite slurry must hav a solids content of at least twenty percen (20%).

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

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

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"		8 3/4"		9"		10"		10 5/8"		11"	
	*Ann.	^O.H.	*Ann.	^O.H.	*Ann.	^O.H.	*Ann.	^O.H.	*Ann.	^O.H.	*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.	10 5/8" ^O.H.	12 5/8" *Ann.	12 5/8" ^O.H.	14 5/8" *Ann.	14 5/8" ^O.H.	16" *Ann.	16" ^O.H.	18" *Ann.	18" ^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 rules 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 adaptors 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-butadene-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 perio of two (2) hours (overnight is better) shall l provided before pumping the well to was and flushing the chlorine solution from t distribution system. The well owner shall l instructed by the permittee concerning the procedures and can be responsible for pum ing and flushing of the well following disi fection. A permittee shall be responsible fi disinfecting the work performed on the wel pump or pumping equipment. Disinfection a well repair operation may be accomplishe at the beginning of the operation with chl rine applied to obtain a concentration of tv hundred (200) ppm for the period of the we repair operation. The water shall be pumpe to waste prior to the taking of water sampl or use being made of the water. Caution: Th chlorinated water must not leave the owner property. If it does, the owner must report the Water Pollution Control Progran Division of Environmental Quality.

(B) Special care must be exercised whe replacing a pump because bacteria can easi contaminate what is pulled from the we (pump, drop pipe, electric wire) and it is di ficult to disinfect the portions of the electr wire and drop pipe that are above water leve When pulling a pump, the electric wi should not be allowed to touch the groun This may be accomplished by laying plast on the ground or utilizing a mechanical sy tem that winds up the electric wire as it withdrawn from the well or other appropria means. The drop pipe should be placed c pipe racks or other precautions should t taken to keep it from contacting the groun If contamination does occur, special car must be taken to disinfect the contaminate areas.

(C) The following table will help in dete mining how much chlorine to add during di infection of the well. First you will need t determine height of the water column in th well.

1. Formula to find height of water co umn: (total depth of well) minus (static wat level) equals (height of water column) Example: (216 ft. well depth) (37 ft. wat level) = (179 ft. of water column). The using the table find the casing size of th well, read across to the corresponding chl rine product column and use these amounts i the following formula:

2. Formula to find amount of chlorin product needed to disinfect well: (height c water column) times (amount of product fro table) equals (amount of product needed t disinfect well) Example: For a six inch (6' casing using 5.25% Clorox product: (179 ft × (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	Gallons of Water Per One Foot Of Casing 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)	10% Chlorine **PRODUCT:** Liquid Bleach. Purchased from a chemical supply company (sodium hypochlorite)	70% Chlorine **PRODUCT:** High-Test Calcium Hypochlorite. Purchased from a chemical company (calcium hypochlorite)
(Inches)	(Gal/Ft/Case Size)	(Fluid Ounces)	(Fluid Ounces)	(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°5 59.9"N, longitude 94°01'01.0"W. Devic that can provide such measurements includ but are not limited to, handheld Glob Positioning System (GPS) receivers that a wide area augmentation system (WAA capable.

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

AUTHORITY: sections 256.606, 256.61 256.623 and 256.626, RSMo 2000. Origin rule filed April 2, 1987, effective July 2 1987. Emergency rescission and emergen rule filed Nov. 16, 1993, effective Dec. 1 1993, expired April 9, 1994. Rescinded a readopted: Filed Aug. 17, 1993, effecti March 10, 1994. Amended: Filed March 3 2005, effective Oct. 30, 2005.*

**Original authority: 256.606, RSMo 1991; 256.61 RSMo 1985, amended 1991; 256.623, RSMo 198 amended 1991; and 256.626, RSMo 1985, amended 199*

10 CSR 23-3.070 Plastic Well Casing

PURPOSE: This rule designates special sta dards for the use of plastic casing in the wat well.

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

(1) Standards.

(A) Approved Materials. Any thermo-pla tic pipe used for well casing shall meet th standards of the American Society for Testir and Materials (ASTM), 1916 Race Stree Philadelphia, PA 19103, which are refe enced as ASTM F-480 *Standard Specifica tion for Thermoplastic Well Casing Pipe an Couplings Made in Standard Dimensio Ratios (SDR), SCH 40 and SCH 8*

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 abraid 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 gro is encouraged. The use of chip bentonite bentonite slurry grout is encouraged wh grouting the annulus of wells utilizing plast casing because these grouts do not increase temperature during the curing process.

3. Cement slurry is usable with son restrictions. The use of neat cement slur can cause problems in certain situation During the curing process of neat ceme slurry temperature increases are a by-pro uct. In a typical well with a two inch (2 annulus, temperature increases in the range seventeen to thirty-five degrees (17°–35°) a normal. When annular spaces are larg resulting in thicker grout, the temperatu increase that results may cause the casing fail. The addition of two to nine perce (2–9%) bentonite powder to the cement slu ry will reduce the rate at which heat is ge erated allowing the heat to be dissipate resulting in less potential damage to the ca ing. If cement slurry is used, it is recon mended that bentonite be added or that co water be circulated in the casing while t grout is curing. Maximum grout hydratic temperatures in wells with annular spac less than five inches (5") are reached betwee seven and ten (7–10) hours after mixing.

(H) Cavernous Rock Walls. As a gener rule, plastic well casing is not recommende to be used as casing in wells cased and grou ed through cavernous rock formation However, in these cases, plastic casing wi work. This determination will be made by t well installation contractor.

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

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

(K) PVC and ABS casing may never b used when known gasoline or solvent co tamination exists within one hundred (10 yards of the well being repaired or drille When gasoline or solvent contamination le els do not present a potential threat to th integrity of the casing, the use of PVC c ABS pipe material will be considered on case-by-case basis. Approval must b 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 contractor 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 *Ann.	6 ^O.H.	8 *Ann.	8 ^O.H.	10 *Ann.	10 ^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.	6 ^O.H.	8 *Ann.	8 ^O.H.	10 *Ann.	10 ^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 eight and five-eighths inches (8 5/8") diameter to the surface casing point;

(C) Install new steel or plastic casings specified in 10 CSR 23-3.030 (steel) or CSR 23.3.070 (plastic).

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

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

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

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

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

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

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

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

(E) In areas where shale or shaley mate al is present above the waterbearing zone casing or liner shall be set so as to exclu intervals which would cave into the drill ho or cause muddy water to be pumped;

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

1. No less than twenty feet (20') of ca ing shall be set above the screened or perf rated interval of the well;

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

3. Full-length grout is preferred (abo the screened interval) and will ensure a bet annular seal but sealing the upper twenty fe

(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 not 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 casi and must hold the grout in place whi drilling continues. No packer, coupling inverted bell is required if grout is allowed cure before drilling resumes; and

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

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

(b) Portland Type I cement minimum set time of seventy-two (72) hour

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

(d) High solids bentonite slu ry—varies based on additives and manufa turer's specifications.

(B) In areas where granite is more than or hundred feet (100') below the surface, set n less than eighty feet (80') of casing not le than thirty feet (30') into bedrock.

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

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

3. Install and seal casing as follows:

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

(I) If steel casing is used, a dri shoe is required except on wells where t grout is allowed to cure before drillin resumes;

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

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

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

(b) Portland Type I cement minimum set time of seventy-two (72) hour

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

(d) High solids bentonite slu ry—varies based on additives and manufa turer'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. Wappappello;
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 groutin More than sixty feet (60') of grout may b required as stated in 10 CSR 23-3.100(3)(D

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

(A) Set no less than eighty feet (80') o casing. The hole shall be cased fifteen fee (15') below residuum, broken rock, or mu pockets into solid bedrock or if rock is no encountered within one hundred and fifty fee (150') consult the division for further instruc tions concerning a variance, unless casin will be set into deeper bedrock;

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

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

(D) Install and seal casing as follows:

1. Full-length grout is highly recom mended and will ensure a better annular sea but sealing the lowermost thirty feet (30') o casing using approved grout materials an procedures set out in 10 CSR 23-3.030 i required. Drill cuttings with a drive shoe o drill cuttings used by themselves are no approved grout materials. Drill cuttings ma be placed above grouted interval to fill in th annular space;

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

A. The following times must be fo lowed for curing grout when no packer i used:

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

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

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

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

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

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, wat from all new wells located in Special Area shall be sampled and analyzed for the che icals of concern, as determined by the div sion. Qualified and properly trained perso must complete sample collection. In order document sampling has occurred, a copy the chain of custody form shall be submitt by the pump installation contractor to t division within sixty (60) days of pun installation; and

4. The data report from all analys shall be made available by the pump install tion contractor to the division and the we owner within sixty (60) days of the samplii event.

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

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

1. Be plugged full-length using hig solids bentonite slurry, six percent (6%) be tonite cement or neat cement grout place under pressure via tremie pipe which extend to within twenty-five feet (25') of the botto of the borehole. Grout shall extend from t bottom of the borehole to within two feet (2 of land surface. Prior to plugging, all pump and debris must be removed from the well Any liner must be removed or perforated possible. Casing must be cut at least thre feet (3') below ground surface. A registratio report and fee (if required) must be submitte within sixty (60) days of abandonment; or

2. With approval from the division, th well owner shall be allowed to install a wate treatment system that is designed to properl treat the chemical(s) of concern. The we shall not be used for human consumptio until sampling and analysis demonstrates tha the water treatment system reduces contami nant levels below MCLs and/or ALs for a chemicals of concern. The division shall b provided a copy of the post-treatment analy ical data by the pump contractor within sixt (60) days of the sampling event.

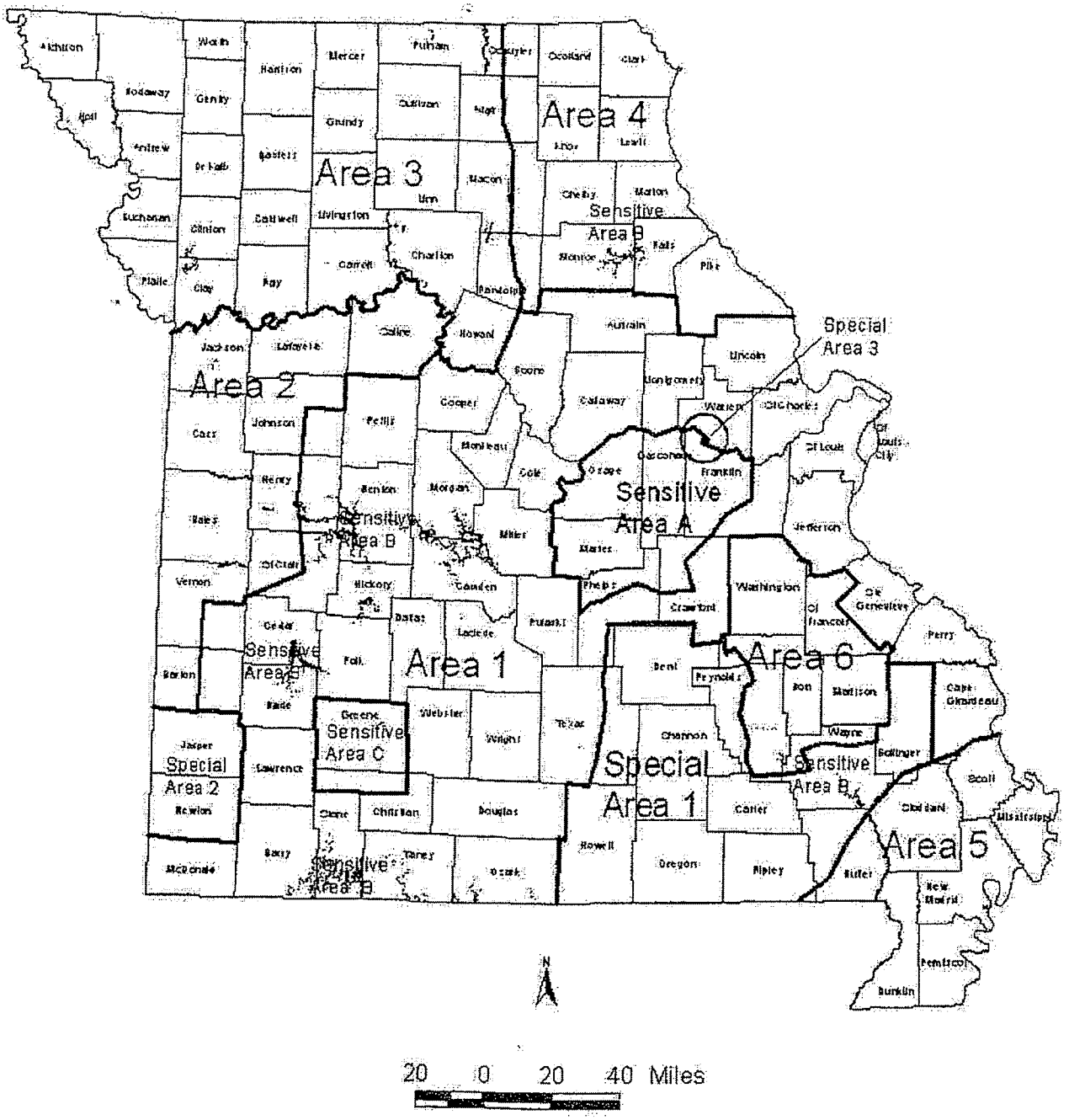

Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on the following pages.

Special Area 1

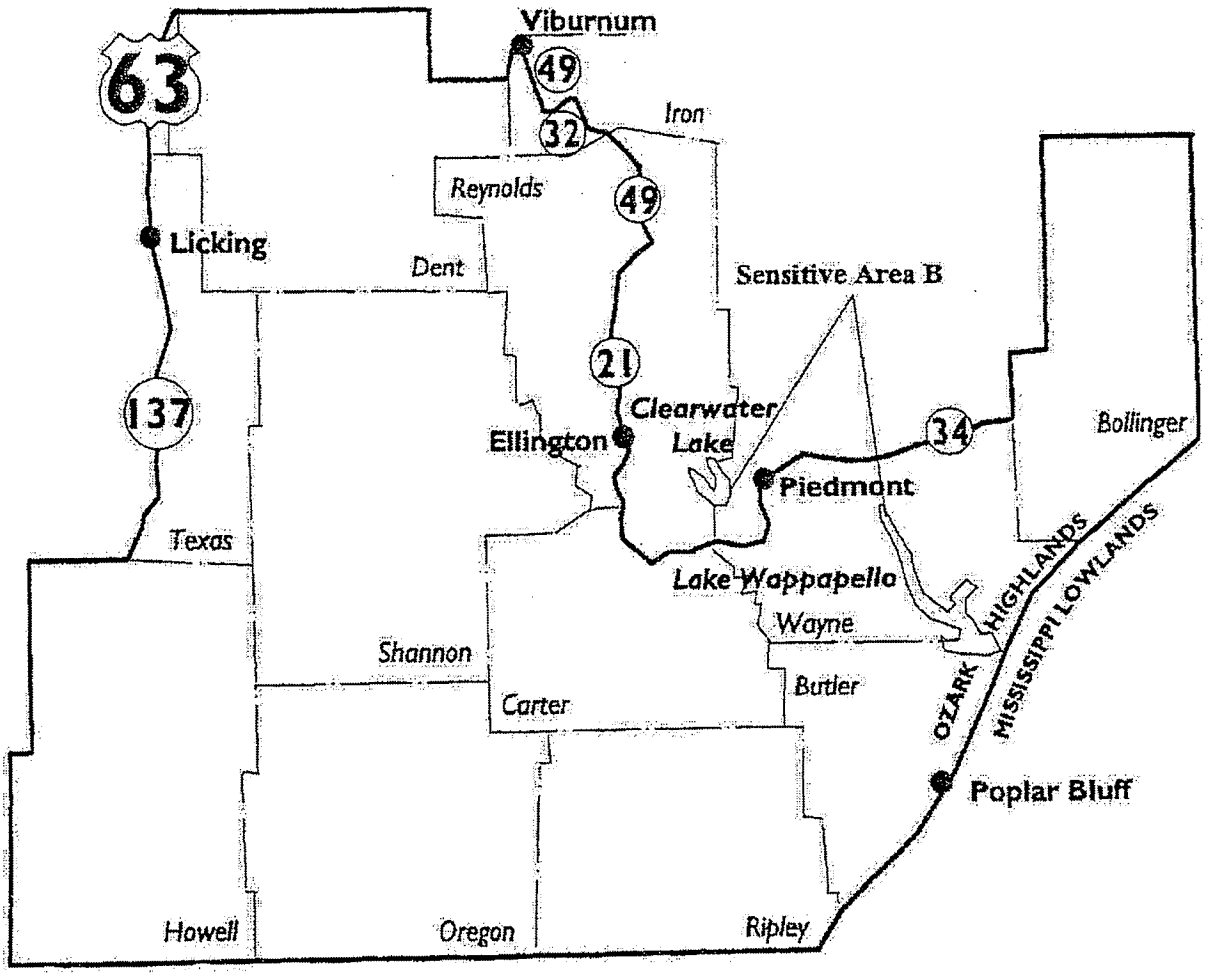

Figure 7. Enlargement of Special Area 1 and part of Sensitive Area B map.

Figure 7A. 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

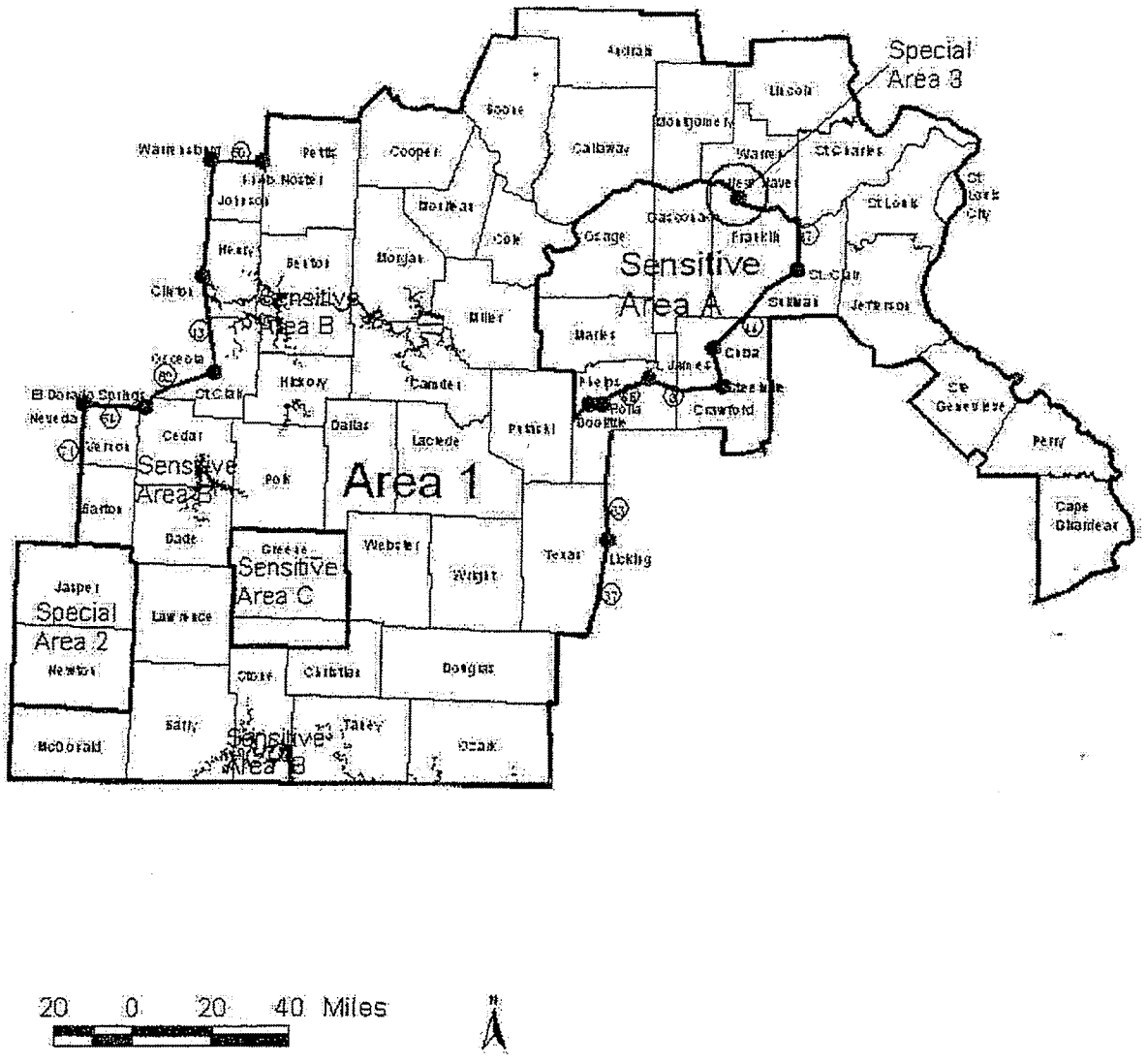

Figure 7B. Area 1, Special Areas 2 and 3, Sensitive Areas A, B, and C map.

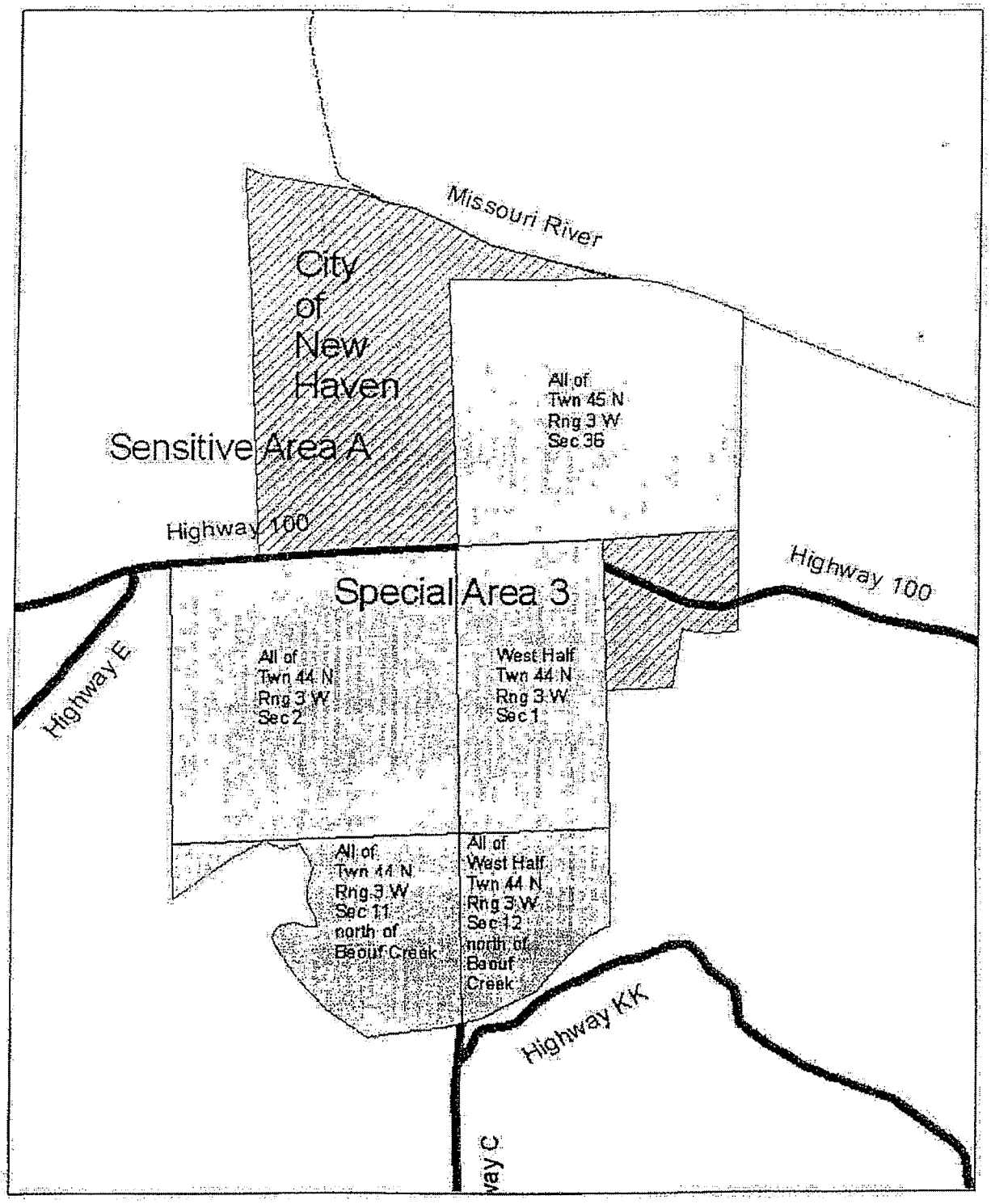

Figure 7C. Special Area 3 and Sensitive Area A

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.*

**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 nonbedro wells. To plug this type of well, the followi steps must be followed:

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

B. Dig around casing and remove t three feet (3') of casing. The remaining ho must be at least two feet (2') in diameter lar er than the existing casing (see Figure 10);

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

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

E. Place a grout plug that fills t upper fifty feet (50') of casing and exten into the larger excavated area, at least o foot (1'). In agricultural or yard settings t remaining hole above the grout plug must filled with soil. In other settings, the remai ing hole above the grout plug may be fille with clean fill if the well site is to be pave and

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

3. Wells completed in bedrock. Th type of well includes any domestic well th produces water from bedrock aquifers (se Figure 11). To plug this type of well, the fo lowing steps must be followed:

A. Remove all pumps, pipe and debr from well. Any liner must be removed or pe forated if possible;

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

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

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

E. Place cement or bentonite from point fifty feet (50') below the bottom of th

casing to two fee (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.*

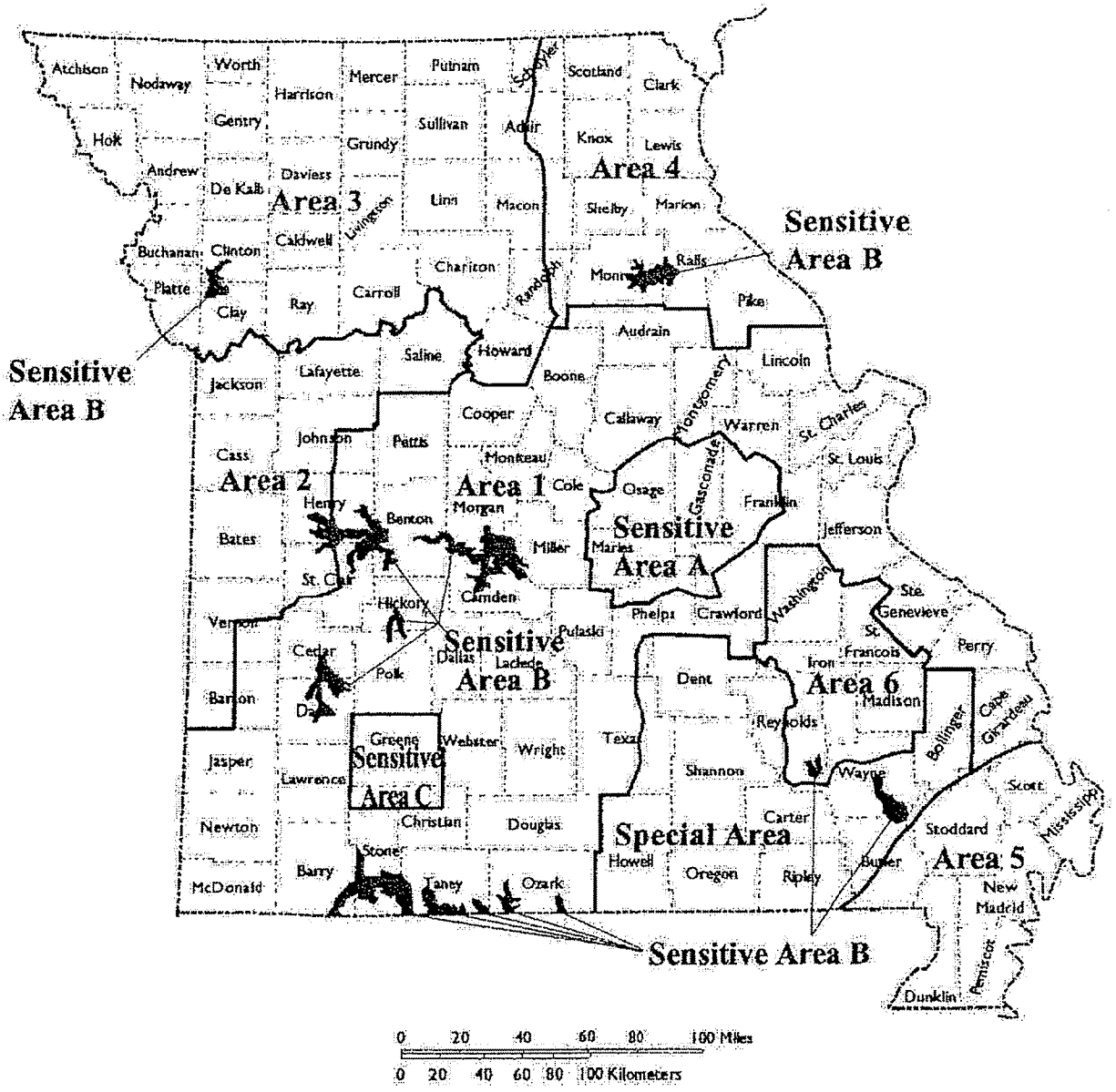

Figure 1. Map showing drilling areas for private well construction regulations. Areas are enlarged in maps on following pages.

Area 2

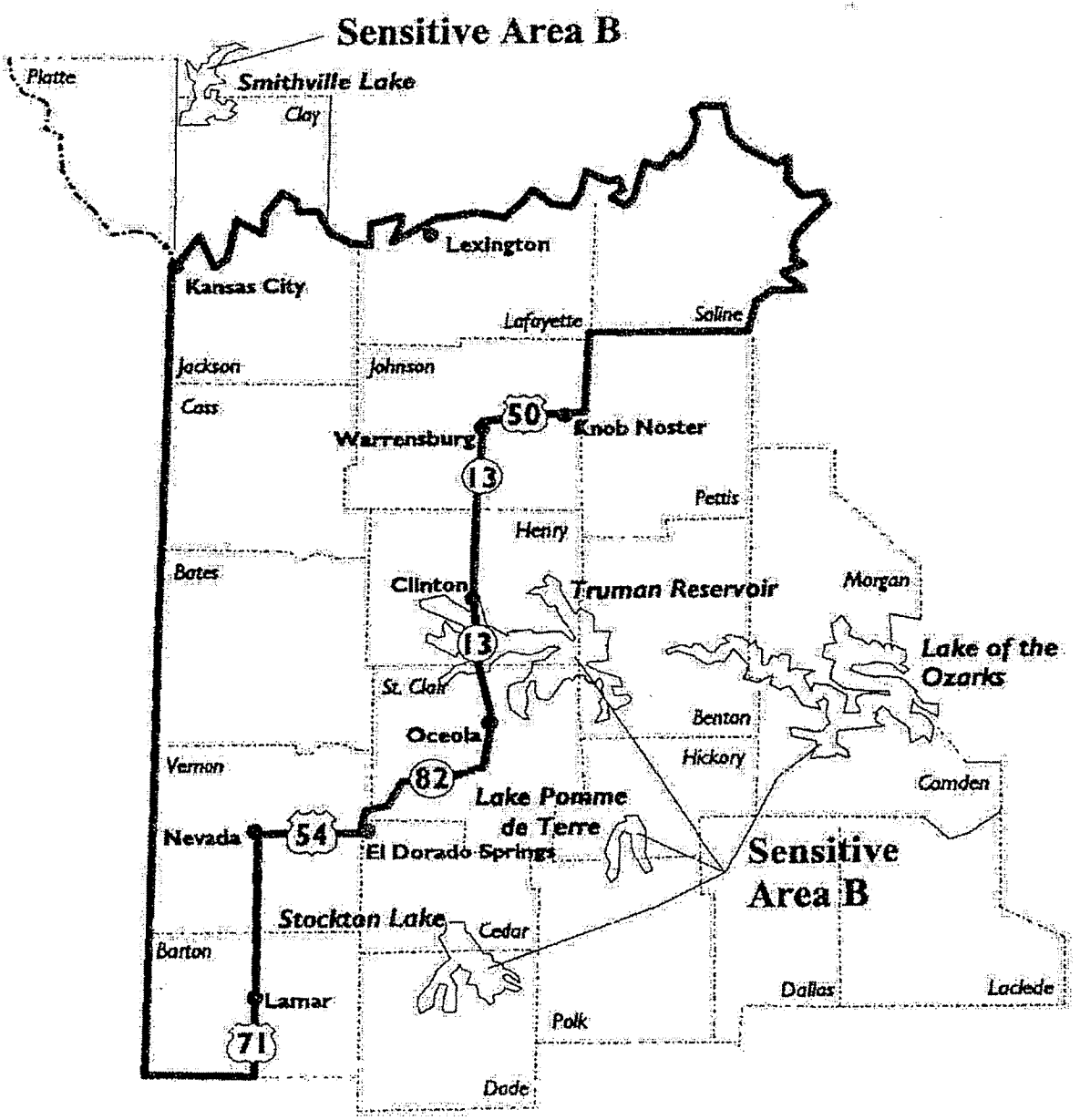

Figure 2. Enlargement of Area 2 and Sensitive Area B map.

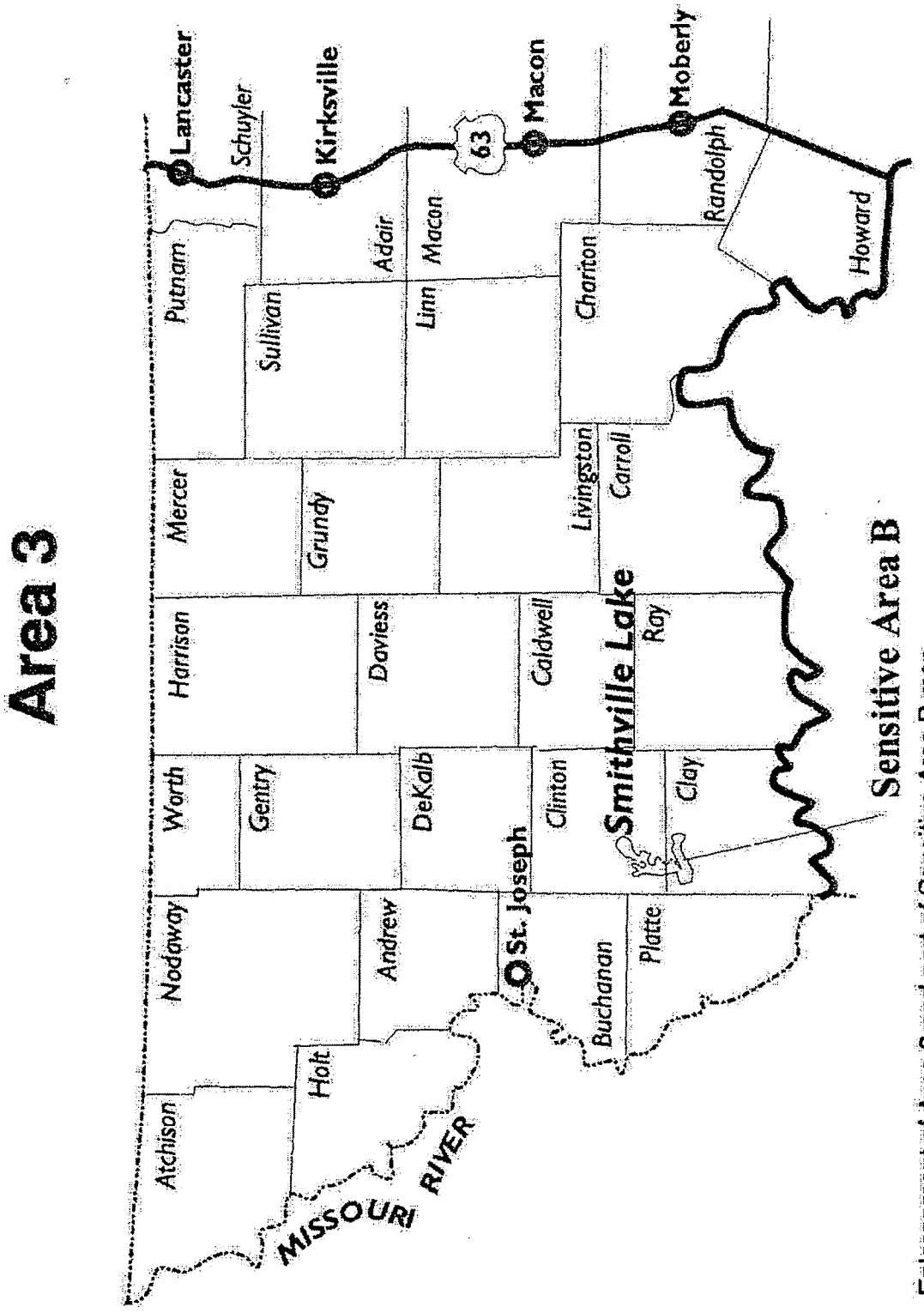

Figure 3. Enlargement of Area 3 and part of Sensitive Area B map.

Area 4

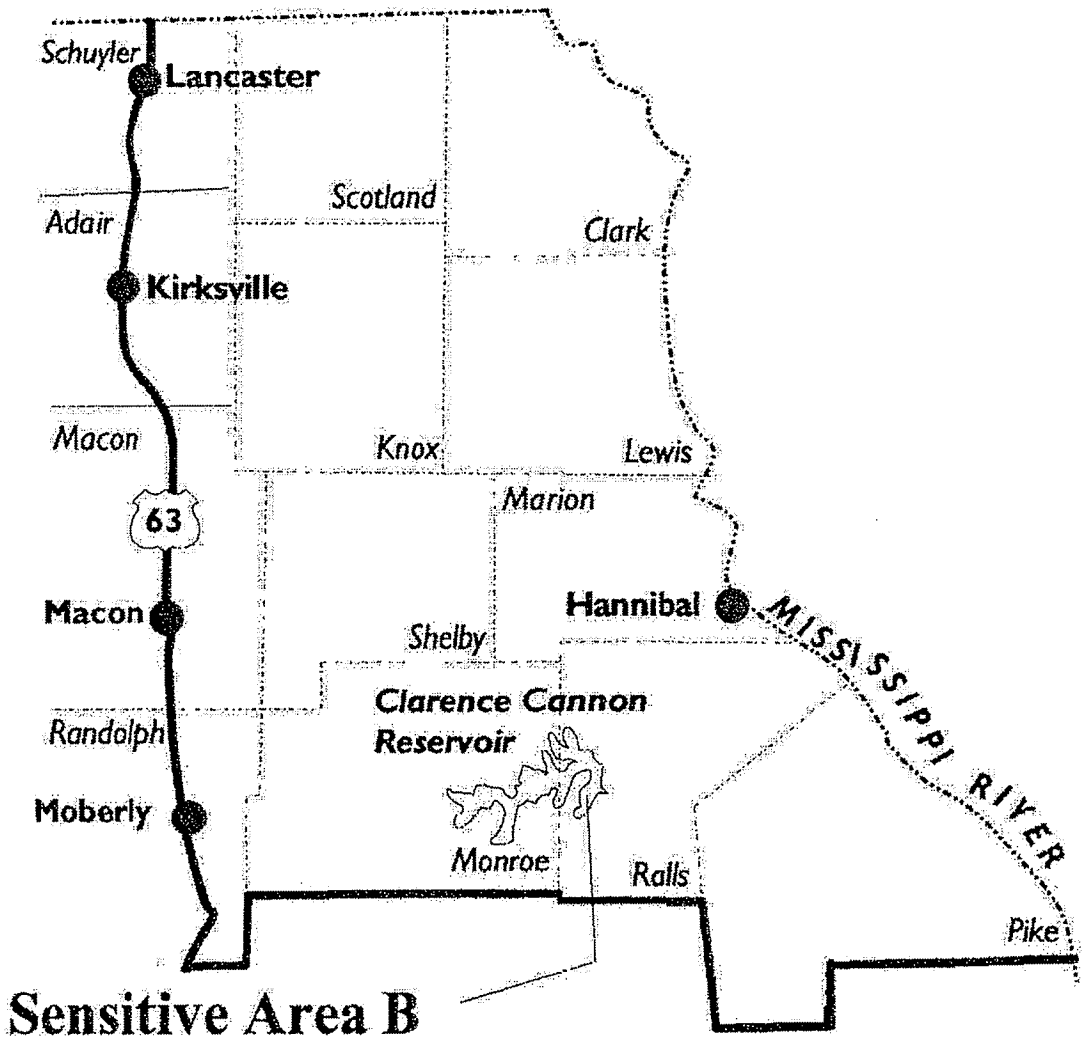

Figure 4. Enlargement of Area 4 and part of Sensitive Area B map.

Area 5

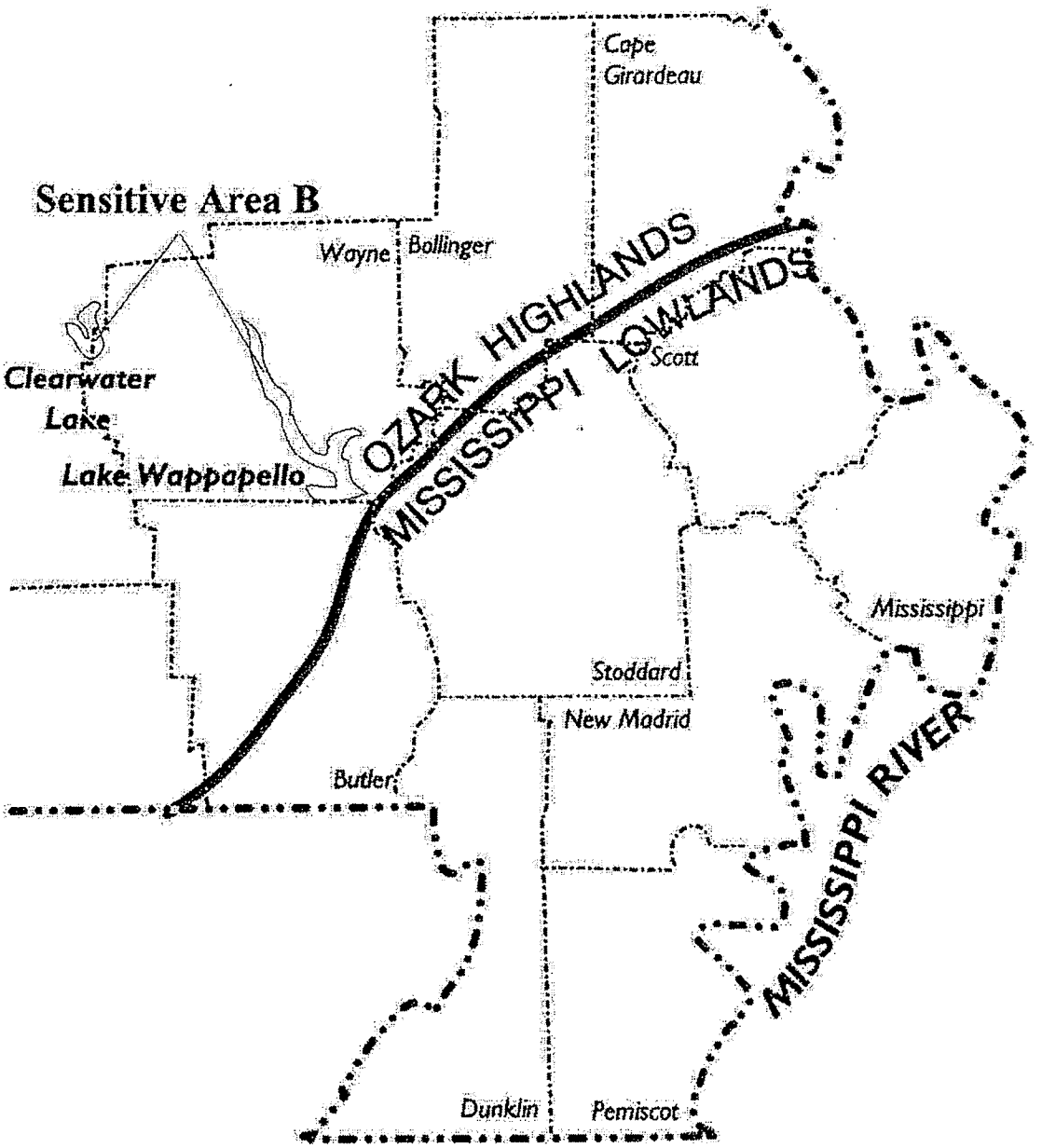

Figure 5. Enlargement of Area 5 and part of Sensitive Area B map.

Area 6

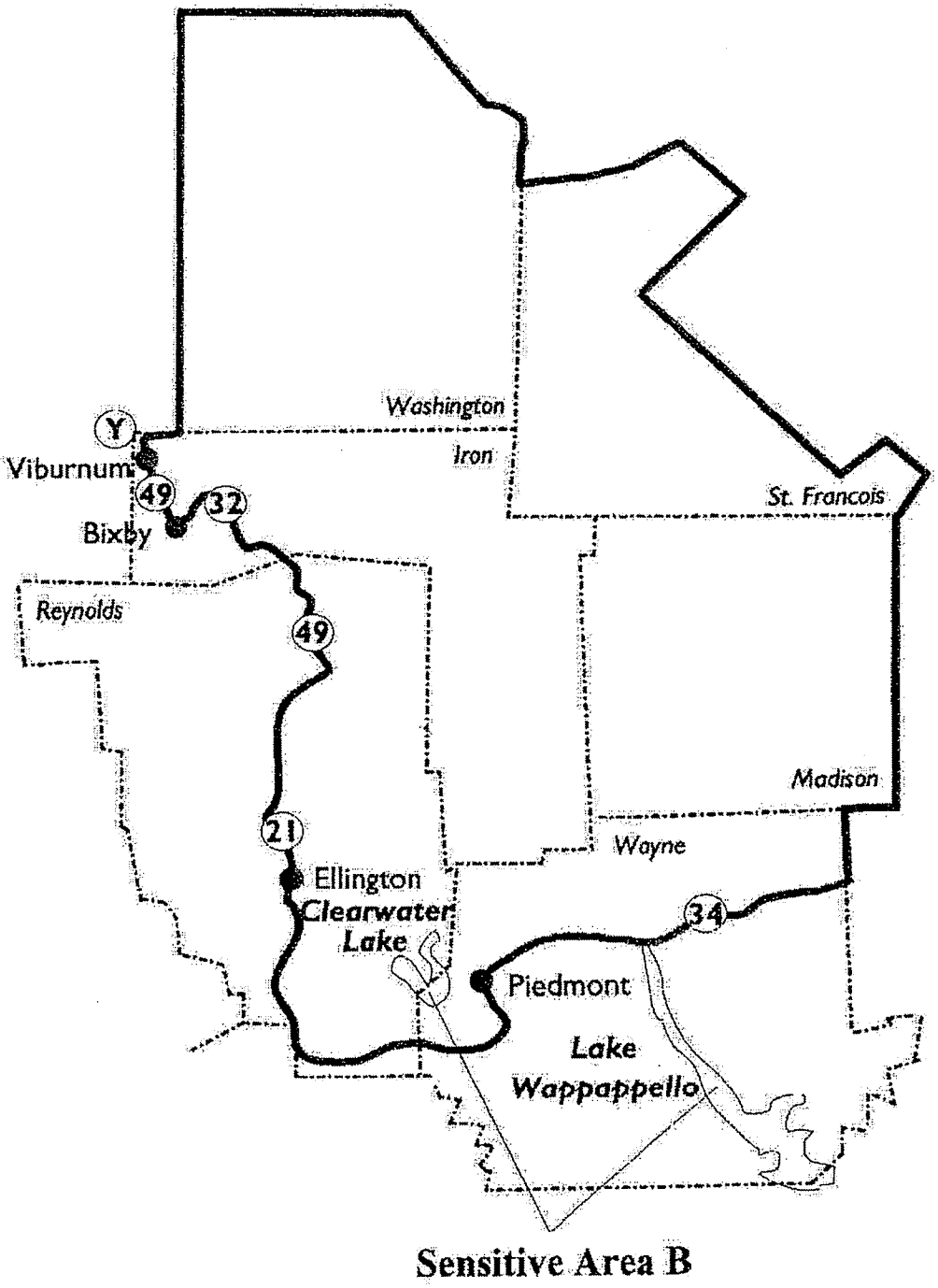

Figure 6. Enlargement of Area 6 and part of Sensitive Area B map.

Special Area

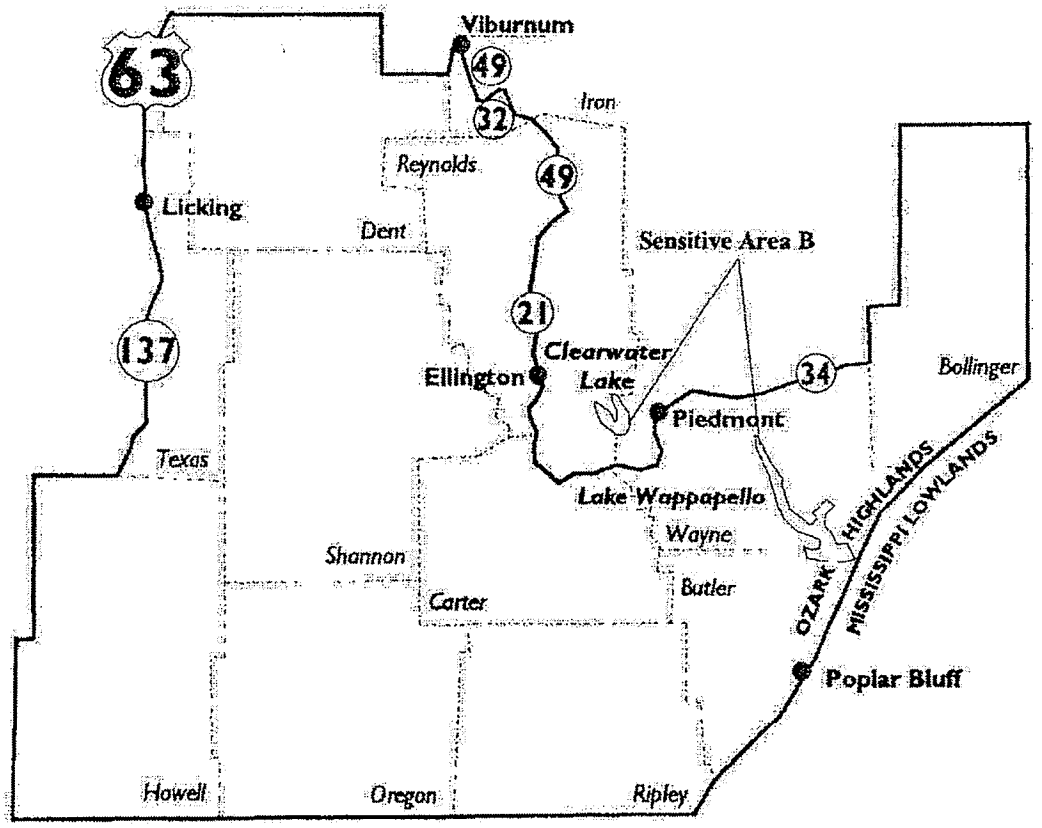

Figure 7. Enlargement of Special Area and part of Sensitive Area B map.

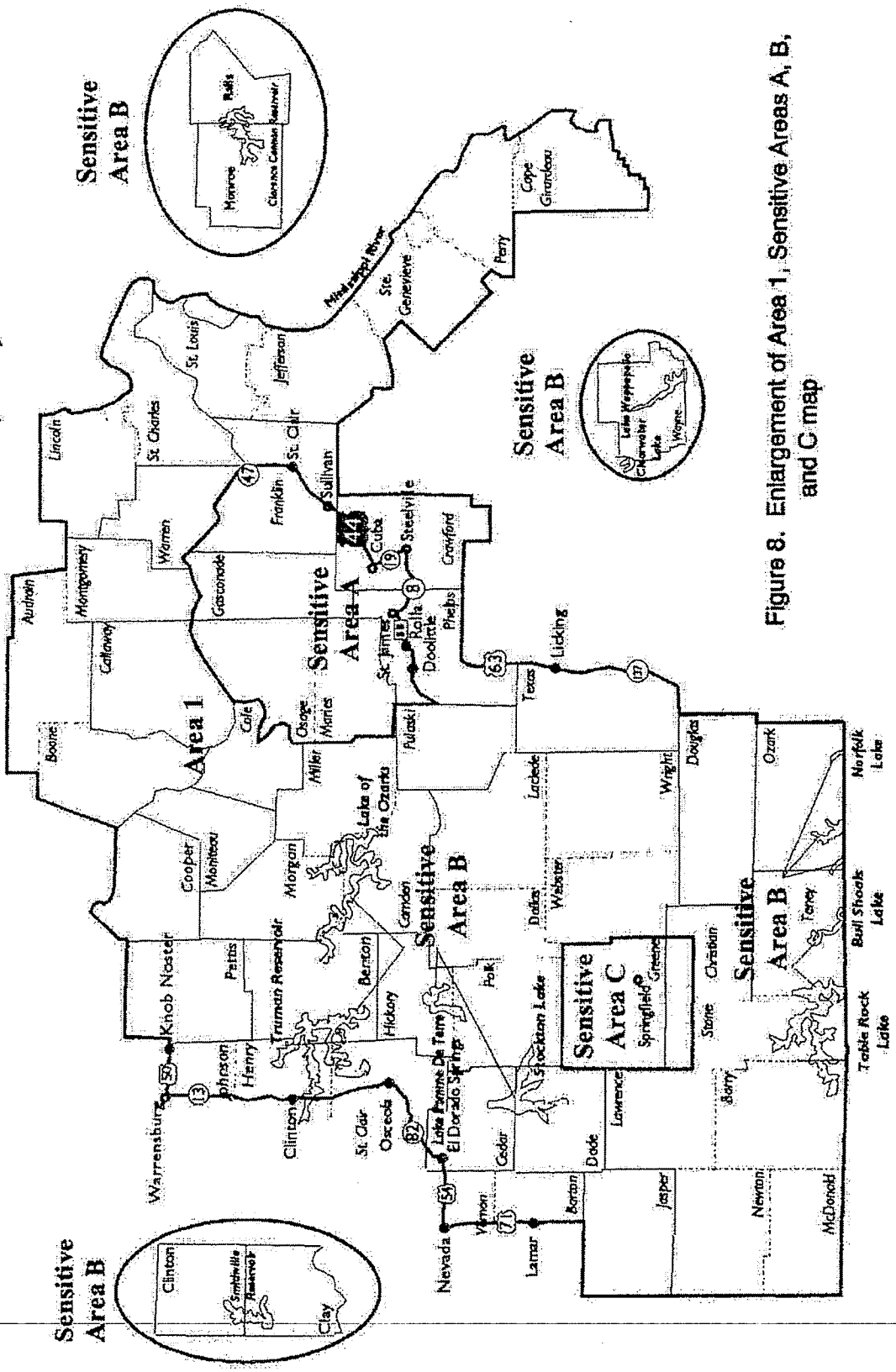

Figure 8. Enlargement of Area 1, Sensitive Areas A, B, and C map

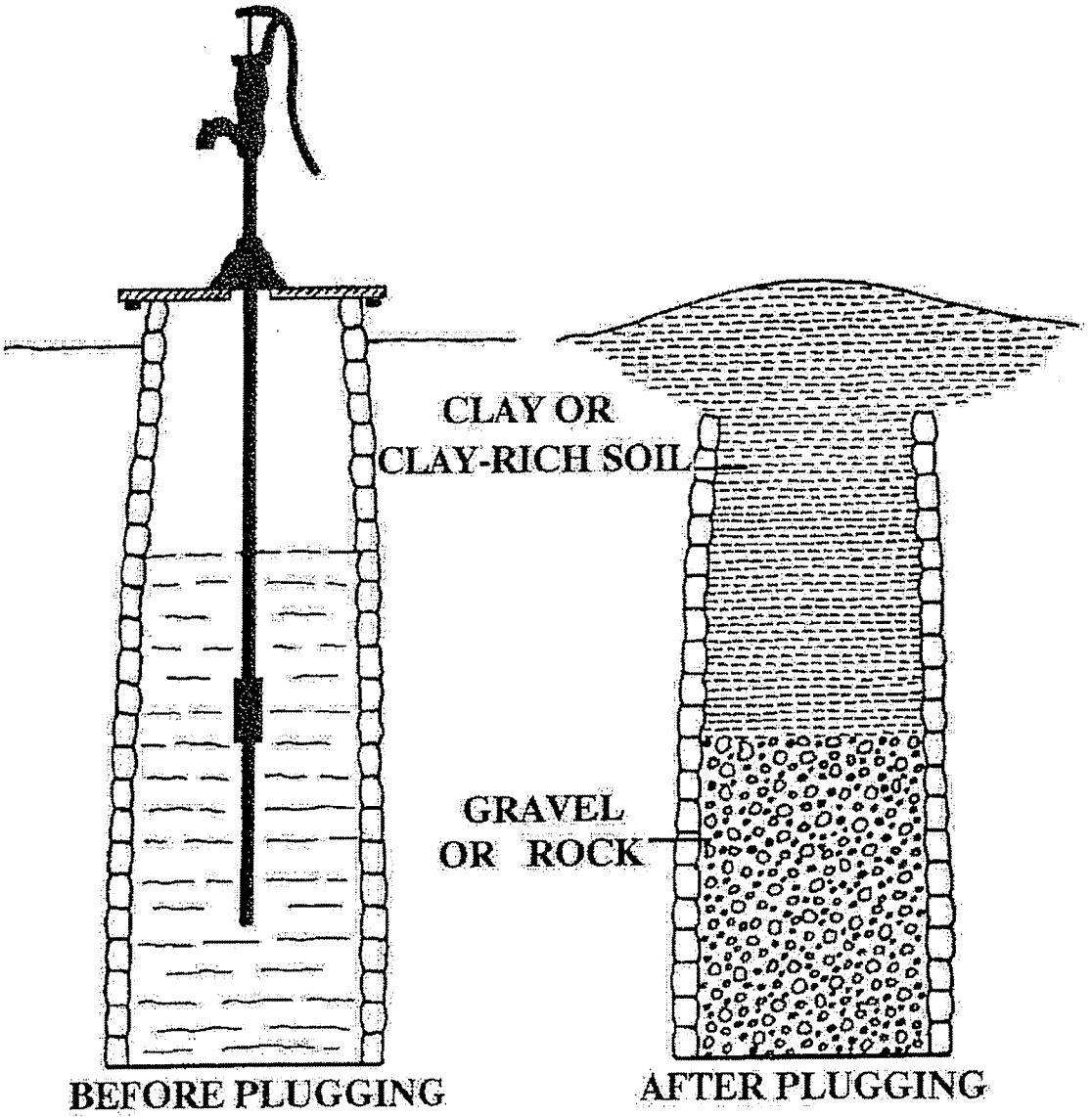

Figure 9 - Plugging diagram for dug wells.

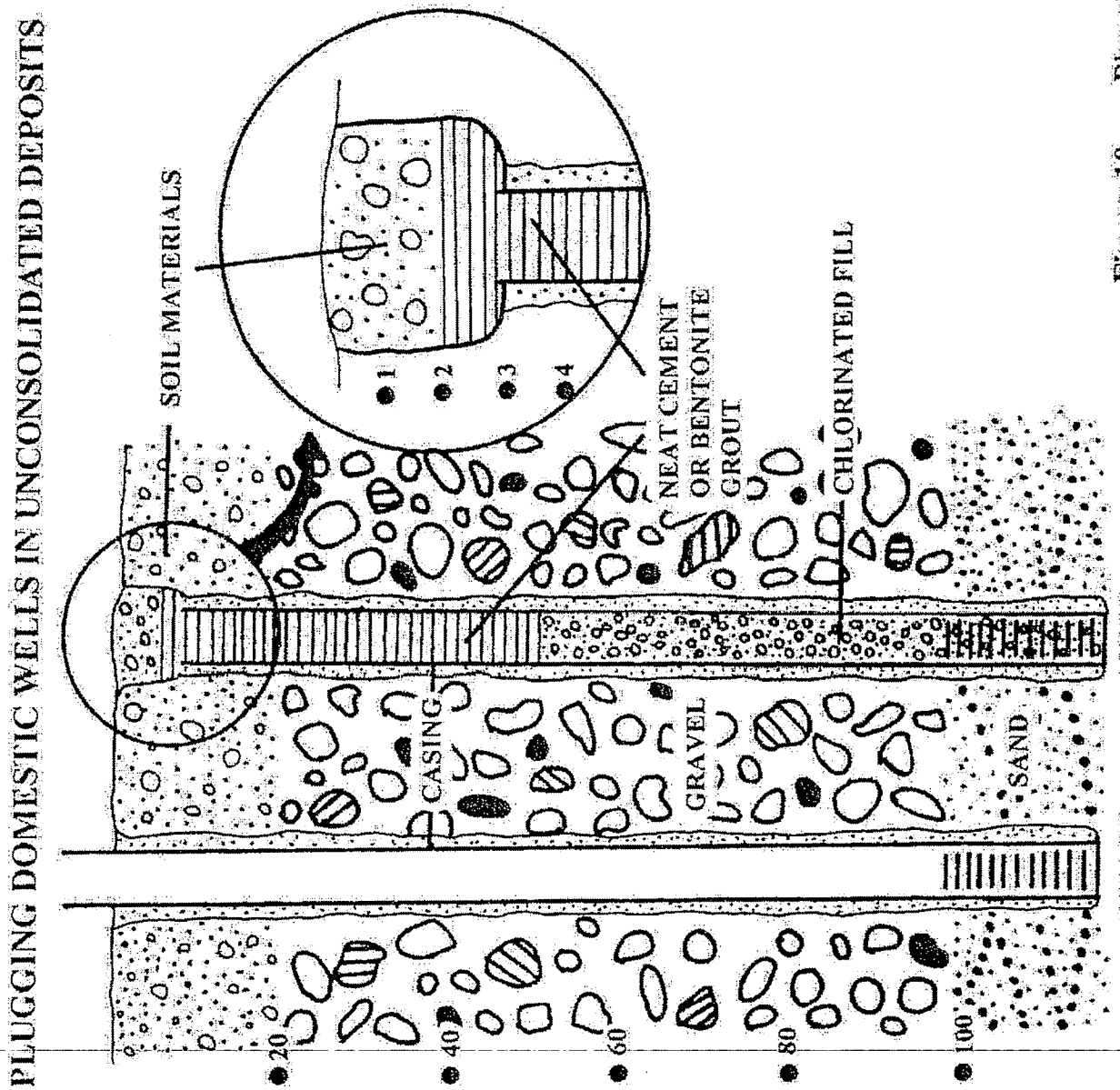

Figure 10 - Plugging diagram for domestic wells in unconsolidated deposits.

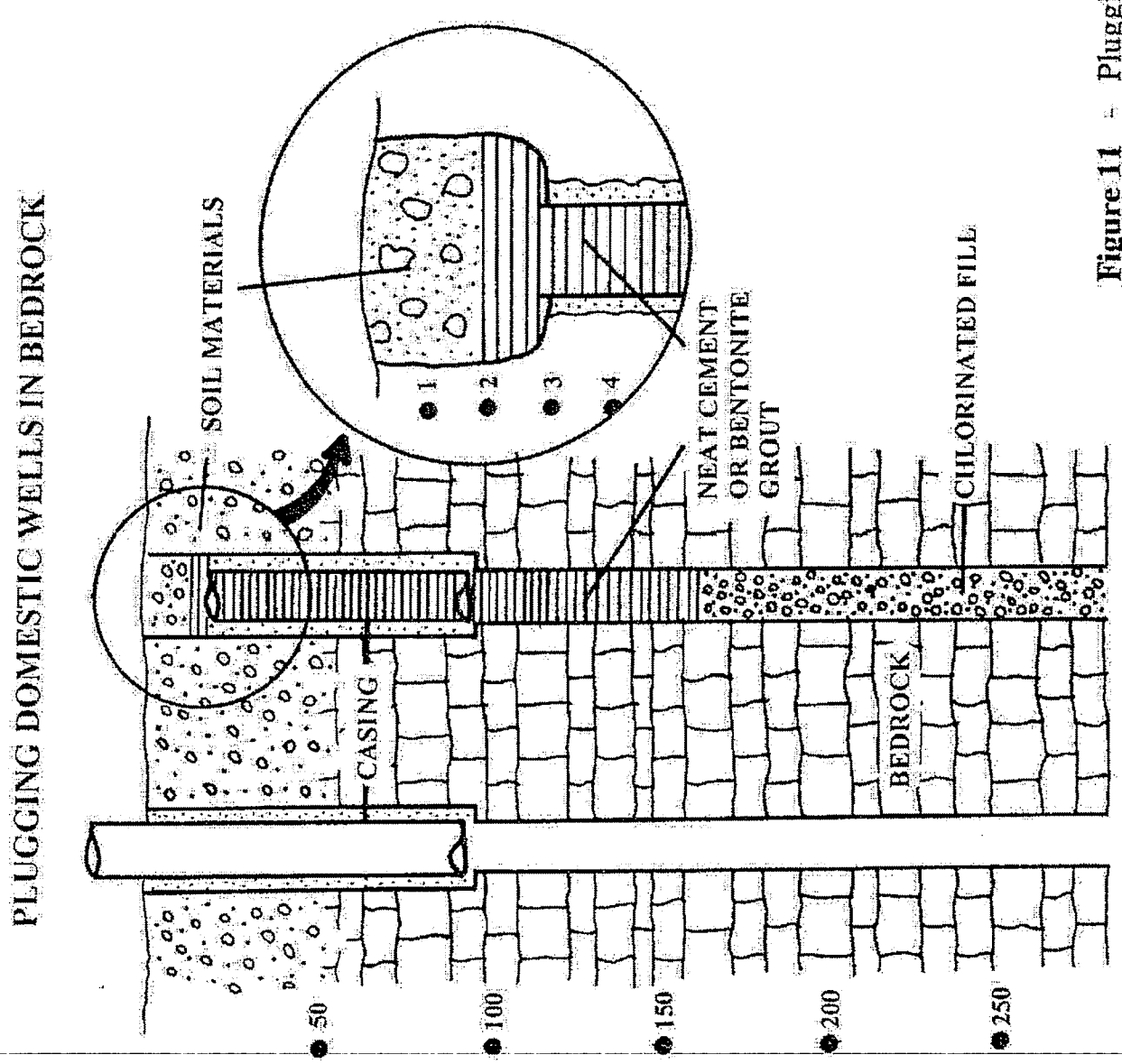

Figure 11 - Plugging diagram for domestic wells in bedrock.