PLUGGING ABANDONED WELLS

DeLynn R. Hay
Extension Specialist, Water Resources and Irrigation
University of Nebraska-Lincoln

The problem of abandoned wells has been ignored for many years. With increasing concern about protecting the quality of our ground water supplies, the thousands of abandoned wells throughout Nebraska can be ignored no longer. It is critical that the quality of our ground water be protected for our current uses and for future generations.

Our ground water is normally protected by a natural filter of soil, sand and gravel. Abandoned wells are holes in that filter that can allow contaminants such as sediment, bacteria, and chemicals to flow directly into our ground water supply. Runoff that might enter an abandoned well can contain pesticides, fertilizers, livestock waste and other contaminants. After these contaminants enter the ground water supply they can move with the natural ground water flow and may show up in public or private wells used to provide drinking water.

Abandoned wells are also a safety hazard to humans and animals. A child can easily fall into large diameter dug wells and irrigation wells. Abandoned wells are an accident waiting to happen; but thousands of abandoned wells remain untouched. With new efforts by many agencies and increasing interest by individuals, the abandoned wells in Nebraska can be plugged to protect water quality and prevent the possible loss of human life.

The Nebraska Water Well Standards and Contractors' Licensing Act requires that abandoned wells be plugged. The Department of Health has developed regulations to guide the plugging of abandoned wells. The Department has defined an abandoned well as "any well the use of which has been accomplished or permanently discontinued. Removal of any necessary operating equipment or a well which is in such a state of disrepair that continual use for the purpose for which it was constructed is impractical shall constitute evidence of abandonment."

Well plugging may appear to be a simple process -- just dump something into the open well until it's full. That might take care of the safety hazard; people and animals could no longer fall into the well. However, unless you use the right plugging materials and methods you will end up with a poorly sealed well; one that will continue to allow contaminants to enter the ground water. To do the job right it is essential that you use the correct plugging materials and install them properly.

Presented at Central Plains Irrigation Short Course and Equipment Exposition, Kearney, NE, February 7-8, 1994.

The regulations developed by the Department of Health outline the procedures and materials that are to be used for plugging abandoned wells. Property owners can plug wells on their property. However, anyone hired to plug a well must be a licensed water well contractor or pump installer.

PLUGGING PROCEDURES

Before beginning the plugging operation you need to gather some information on the construction of the well and the geological setting in which the well is located. If the well is drilled through a confining layer that separates two different aquifers, some special procedures must be used. Information on the geology of the area may be difficult to determine, but possible sources include the original well drillers log, the well registration filed with the Department of Water Resources for some wells, well drillers familiar with the area, or the University of Nebraska Conservation and Survey Division.

Remove all pumps, piping and any other obstructions from the well. This is necessary to allow the proper placing of the plugging materials in the well.

Measure the total depth and the diameter of the well in order to accurately estimate the amount of plugging materials needed to fill the well. Table 1 gives the information necessary to estimate the materials needed. You should also measure the depth to the standing water in the well cavity.

Materials

Two different types of material are used in well plugging. Sealing materials provide watertight barriers to prevent seepage of contaminants into the well and ground water. Fill materials, sand and gravel, are lower cost granular materials used to fill the portion of well cavity where a sealant is not required.

The sealant materials are often called grouts. The Water Well Standards and Contractors' Licensing Act regulations define grout as neat cement, a mixture of cement and water; or sand cement, a mixture of cement, sand and water; or concrete, a mixture of cement, sand and coarse aggregate with water; or bentonite; or other material approved by the Department of Health that will provide a permanent, impervious watertight seal.

Concrete and bentonite are the most common sealing materials used for well plugging. Bentonite is a special type of clay that swells when wet to provide an impervious seal. Powdered bentonite is mixed with water to produce a clay slurry that can be pumped. Any sealant materials that are in a slurry form and are placed below the water level must be injected below the water level through a pipe to prevent dilution of the sealant before it sets up.

Bentonite is also available in pellet and granular forms. When wetted, the pellets or granules swell to about eight times their original size to form a watertight plug. Bentonite in this form is especially easy to use, it can be poured directly into the top of the well.

Disinfection

Before placing any material into the well to be plugged, place chlorine in the well to disinfect the standing water. This will also disinfect the fill material placed in the water bearing zone. The chlorine can be a liquid or in a granular or pelleted form. Enough chlorine should be used to create a concentration of at least 200 ppm in the standing water. Table 1 gives the amount of chlorine to use. Sand and gravel fill material can also be disinfected using a chlorine solution.

Filling the Well Cavity

The filling procedures apply to the entire well cavity from the bottom of the well to three feet below the land surface. The well cavity is filled with clean sand or gravel, or one of the grout sealant materials. For small diameter shallow wells a sealant may be an easy, relatively inexpensive way to completely fill the well cavity. For larger diameter and deeper wells it will be more economical to use sand and gravel as the fill material and use a sealant at the required locations.

One of the most critical steps in well plugging is placing the fill and sealant materials. Special equipment is required to place slurried materials in order to prevent dilution and separation. Granular bentonite, sand and gravel can be placed directly into the top of the well. However, you must take care to avoid bridging of granular materials within the well cavity. Fine sand will be more susceptible to bridging than gravel. Bridging will create a partially plugged well that may eventually collapse. The result is a continued safety hazard and potential for ground water pollution.

To avoid bridging, dump bentonite granules, sand and gravel plugging materials into the well slowly. You can determine how many feet of well casing will be filled with a given quantity of material using Table 1. (It will take approximately 70-72 pounds of bentonite to fill one cubic foot.) Then, frequently measure the depth to the top of the fill material as the well is filled. This will show if the plug is rising faster than expected, indicating a bridge has formed. If a bridge does form, be sure to break it up before adding more plugging material.

The Department of Health regulations require that wells formerly producing from confined aquifers be filled with concrete or cement grout at the impervious layers separating the water bearing zones. These plugs must be at least five feet in depth and are to extend to the wall of the original drilled hole. This will require special water well construction equipment.

Although not required by the current regulations it is suggested for unconfined aquifers that a sealant be placed at the top of the water bearing zone and at the top of the well prior to backfilling and capping. Ideally, these layers should be at least five feet in depth. The top seal prevents contaminants from entering the top of the casing. The seal at the water table keeps contaminants that might enter the casing because the original casing was not watertight or has deteriorated due to corrosion or other failure from reaching the ground water.

Capping and Backfilling

There are two options for capping and backfilling. The alternatives are:

Option I. Remove the top three feet of the well casing and cap the top of the remaining casing with a concrete slab at least four inches thick or by fastening a 1/4 inch metal plate to the casing. The remainder of the hole is then filled with sand or gravel, concrete, cement grout or native top soil mounded for settlement. The most common backfill material will be soil since it will not create a surface obstruction.

Option II. The casing is left in place and the top three feet filled with concrete or cement grout. A permanent watertight cover must be installed on the top of the casing.

Gravel Packed Wells. When a well has been gravel packed to the land surface, the top three feet of casing and gravel pack material must be removed. This would apply to most irrigation wells except those that have constructed according to the current well construction standards. After removal of the casing and gravel pack, a cover or cap must be placed on the remaining well casing and extend at least one foot in every direction beyond the original drilled hole. The cap, which will normally be concrete, must extend at least 2 inches below the top of the remaining well casing and be installed to prevent the entrance of any materials in the well casing or well cavity. The remaining hole is then backfilled with sand or gravel, concrete, cement grout or native top soil that is mounded to allow for settlement.

DOCUMENTATION AND REPORTING

The Department of Health's regulations require that a record be maintained of the materials used, the quantity of materials used, where the materials are placed, and the mix specifications of grouts used. Registered wells that are abandoned must be reported to the Director of the Department of Water Resources within sixty days following the abandonment.

SUMMARY

The primary steps for properly plugging an abandoned well are:

1. Determine well construction and geologic setting.
2. Remove any obstructions from the well.

3. Disinfect the water in the well.
4. Place fill material in the water bearing zone.
5. Place sealing material just above the water level.
6. Place fill material in the non water bearing zone.
7. Place a top seal from 3 to 8 feet below the land surface.

Option I		Option II
8. Remove the top three feet of casing.	or	8. Fill the top three feet of casing with concrete or cement grout.
9. Cap the top of the casing.		9. Install permanent, watertight cover on top of casing.
10. Backfill to the land surface.		

Proper plugging of abandoned wells costs some time and money. But, it is time and money well spent, the benefits include protecting the quality of our ground water supply and possibly saving a child's life. Plugging an abandoned well will benefit you and your neighbor now, but will also be appreciated by future generations.

The Department of Health is considering possible regulation changes that would allow the use of native soil material as a fill material in large diameter dug wells. Changes may also be made in the alternatives for the surface seal of the abandoned well.

For more information, contact the Nebraska Department of Health, county health department, Natural Resources District, University of Nebraska Cooperative Extension, Soil Conservation Service, or a licensed water well contractor or pump installation contractor.

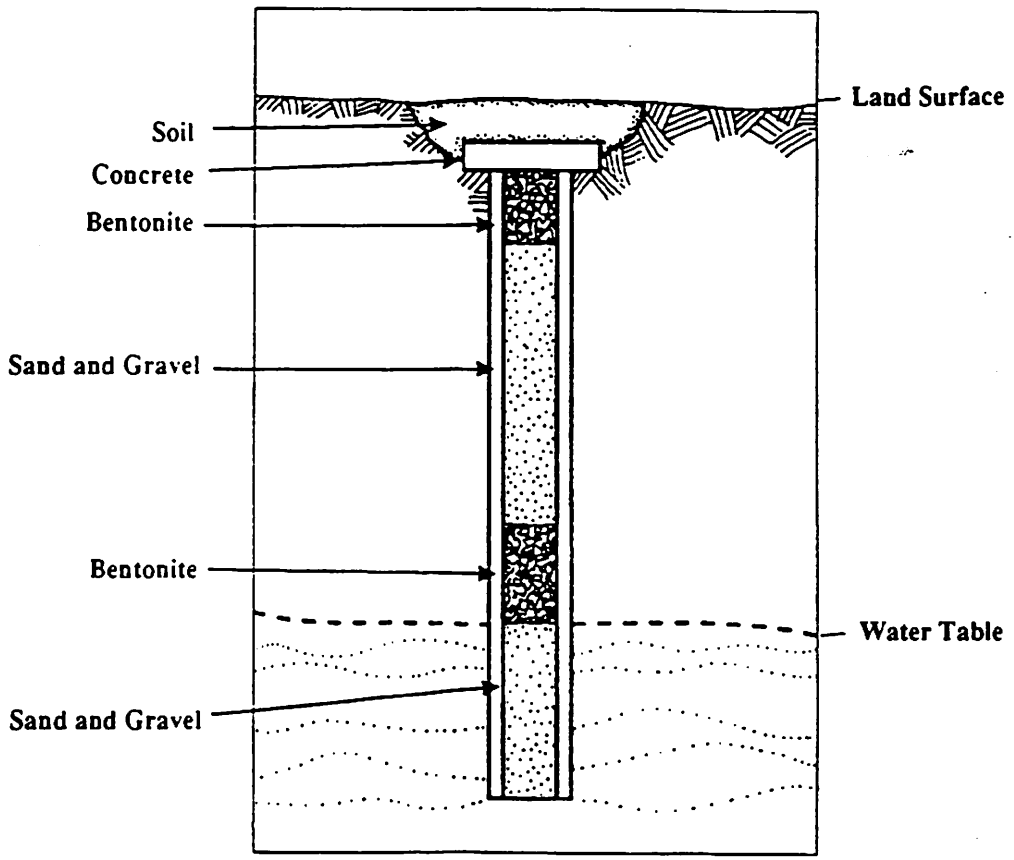
REFERENCE

State of Nebraska, Title 178 - Department of Health and Environmental Control Council, Chapter 12 - Regulations Governing Water Well Construction, Pump Installation and Water Well Abandonment Standards. August 23, 1988.

Table 1. Well Casing Volume and Disinfectant Needed

Diameter of opening	Volume: gallons per foot of depth	Volume: cubic feet per foot of depth	Liquid Chlorine: Fluid Ounces per foot of depth* 5.25%	Liquid Chlorine: Fluid Ounces per foot of depth* 10%	Dry Chlorine: Dry Ounces per foot of depth* 65%	Dry Chlorine: Dry Ounces per foot of depth* 70%
3 inches	0.37	.05	.18	.09	.02	.01
4 inches	0.65	.09	.32	.17	.03	.03
5 inches	1.02	.14	.50	.26	.04	.04
6 inches	1.47	.20	.72	.38	.06	.06
8 inches	2.61	.35	1.28	.67	.11	.10
10 inches	4.08	.55	2.00	1.04	.17	.16
12 inches	5.88	.79	2.88	1.50	.24	.22
14 inches	8.00	1.07	3.91	2.05	.33	.31
16 inches	10.44	1.40	5.11	2.67	.43	.40
18 inches	13.22	1.77	6.47	3.38	.54	.50
2.0 feet	23.50	3.14	11.50	6.02	.97	.90
2.5 feet	36.72	4.91	17.97	9.40	1.51	1.40
3 feet	52.88	7.07	25.88	13.54	2.17	2.02
4 feet	94.00	12.57	46.01	24.06	3.86	3.59
5 feet	146.9	19.64	71.90	37.60	6.03	5.60
6 feet	211.5	28.27	103.50	54.15	8.69	8.07
7 feet	287.9	38.48	140.90	73.70	11.82	10.98
8 feet	376.0	50.27	184.10	96.26	15.44	14.34
9 feet	475.9	63.62	232.90	121.80	19.55	18.15
10 feet	587.5	78.54	287.60	150.40	24.13	22.41

* Will give approximately a 200 mg/L concentration of chlorine


Land Surface
Soil
Concrete
Bentonite
Sand and Gravel
Bentonite
Water Table
Sand and Gravel