Abandoned Well Sealing Demonstration Project

Final Report

Submitted to:

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November, 2002

This project was completed with the support and cooperation of the South Dakota Department of Environment and Natural Resources and the United States Environmental Protection Agency, Region VIII, Grant Number C9008631-92.

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C. Sealing Shallow Abandoned Wells pamphlet
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INTRODUCTION

To tap South Dakota groundwater resources, wells are dug, bored and drilled into the ground. The wells are used for public water supplies, rural domestic use, irrigation, water level observation and other functions. When these wells are no longer used and/or maintained, they can provide a conduit allowing direct flow of contaminated surface water, or other pollutants, into ground water. This is of particular concern for abandoned wells which are improperly constructed, wells located in low areas were large quantities of surface water may congregate and/or wells located close to, or down-gradient from, contamination sources. The potential impacts on public health are more immediate if abandoned wells are located close to operating public or private wells used for drinking water supply.

The number of abandoned shallow wells in South Dakota, although unknown, has generally been accepted to be very large. A 1990 East Dakota Water Development District (EDWDD) telephone survey identified 33 abandoned wells in an eighty square mile area, or one abandoned well every 2 and ½ square miles (0.4 wells per square mile). The number of abandoned wells in both Iowa and North Dakota has been estimated to be over 100,000. State officials in Minnesota estimate there are between 700,000 and 1,200,000 such wells.

Of particular concern are abandoned wells in shallow aquifers. These wells are believed to pose a significant threats to water quality in these aquifers, which are the primary source of both public and private drinking water in South Dakota, because they are a direct conduit to the water table. Abandoned wells that penetrate deeper, buried aquifers may also represent a potential problem. However, many of these aquifers are under artesian conditions and contamination by gravity flow is of little concern.

This project was completed to estimate the number of abandoned wells in South Dakota by the use of representative field surveys; provide educational opportunities and resources to the general public; provide opportunities for the sealing of abandoned wells in selected areas to promote the practice; and determine if a publicly-funded, state-wide assistance program for the sealing of unused wells was necessary. The ultimate purpose was to reduce the contamination potential of shallow ground water resources in South Dakota by encouraging landowners to properly seal abandoned wells. The project activities took place in five counties, three in the eastern part of the state (Codington, Deuel and Hamlin) and two in the south-central portion (Mellette and Todd).

PART 1 - ABANDONED WELLS IN SOUTH DAKOTA

Number of Abandoned Wells

Task 1 of the Abandoned Well Sealing Demonstration Project PIP was designed to estimate the number of shallow abandoned wells in South Dakota. The estimation was to be based on surveys/inventories of selected areas and then extrapolation to the remainder of the state.

Each of the five conservation districts selected representative areas within their counties for an inventory of abandoned wells. After selection of these areas, available information on past and present wells was collected from various sources, including the records of the Department of Environment and Natural Resources (DENR) - Water Rights Program, the South Dakota Geological Survey and the United States Geological Survey.

Landowners in the target areas were contacted and asked about the existence of active and abandoned wells. Field checks were conducted for most areas, especially where conflicts existed between various data sources. An Abandoned Well Survey Inventory Form (Attachment A, AWS-DP-101) was completed for each surveyed well.

A summary of the inventory is presented below (Table 1). Information about the extent of the shallow aquifer in each county inventory area is included, along with a determination of the average number of abandoned wells per square mile of shallow aquifer.

Table 1. Results of Abandoned Well Inventories

County	Inventory Area (Square Miles)	Aquifer Area (Square Miles)	Number of Abandoned Wells	AW Density (Number per square mile of aquifer)
Codington	51	29	15	0.52
Deuel	119	119	95	0.80
Hamlin	22	22	19	0.86
Mellette	26	15	9	0.60
Todd	11	11	3	0.27

The two west river inventories indicate an average of 0.46 abandoned wells per square mile of shallow aquifer in this region. However, multiple, adjacent abandoned wells encountered at some locations in Mellette County resulted in what was considered an artificially high occurrence. In some parts of this area, the aquifer yield is relatively low, and multiple wells are needed to provide even modest water supplies. For the purpose of extrapolation, a density of 0.40 abandoned wells per square mile of shallow aquifer was used.

In the eastern half of the state, the inventories indicate an average of 0.76 abandoned wells per square mile of shallow aquifer. However, because of the wide variation observed in the two smaller sample areas, a density of 0.80 abandoned wells per square mile was used. This matches the larger sampling pool from Deuel County, and probably better represents regional trends.

In order to extrapolate the potential number of abandoned wells in the state, it was necessary to determine the area underlain by shallow aquifers. This information was derived from information gathered by the South Dakota Geological Survey through various regional and county study investigations. The principle references utilized were Hedges and others (1982) and Allen, Iles and Petres (1985). These summary reports, prepared under contract with the U.S. Army Corps of Engineers, were part of a state-wide evaluation of groundwater resources. They represent the best available information for much of the state even today. Subsequent reports on individual counties in the eastern part of the state were utilized to better define conditions in those areas that did not have detailed information at the time of the Corps studies.

Shallow aquifers have been defined as those surficial deposits of sand and gravel, or other comparably permeable material, that occur at the land surface in the state and have the potential to yield water for human usage. East of the Missouri River, the aquifers are primarily glacial outwash deposits or alluvial sediments deposited along Late Pleistocene and/or Recent stream and drainage ways. Shallow aquifers cover a total of 3,874 square miles in this part of the state **(Table 2)**. West of the Missouri River, alluvial deposits occur along major drainage ways, but the bulk of the aquifers identified are Late Cretaceous to Tertiary strata in the northwest and south central regions. These units are poorly- to moderately-consolidated coarse sedimentary deposits. These units are quite extensive, and cover considerable areas. Shallow aquifers west of the Missouri River cover a total of 19,505 square miles **(Table 3)**. **Tables 4 & 5** present the estimations of the number of abandoned wells in each area, based on the average abandoned well densities determined earlier.

In order to evaluate the results of these individual surveys and the applicability of the results to the entire state, certain basic assumptions were then considered. First, climatic conditions within the state change markedly from east to west. In addition, the underlying geology and soils changes dramatically at the Missouri River, which effectively marks the transition from the glaciated eastern area from the unglaciated western part of the State. As a result of these two factors, past and present settlement patterns on either side of the Missouri River are quite different and the State can be divided into two areas, separated by the Missouri River.

More general estimates of the potential number of abandoned wells in the State can be determined from broader resources. Information gathered by the Cooperative Extension Service would suggest that in general, a maximum density of four (4) farms per section (square mile) may have existed east of the Missouri River. West of the river, no more than one (1) farm or ranch may have existed per section of land. Both of these estimates are likely to be too high for the entire State, but may be applicable for areas where water resources were readily attainable, that is in areas underlain by shallow aquifers. Using County Area information presented on Tables 2 & 3, estimates of the expected maximum number of wells are given in Table 6.

The difference between the total estimated number of potential wells (Table 6) and the number of projected abandoned wells (tables 4 & 5) would presumably represent the number of still active wells in the area.

Table 6. Potential Number of Wells based on the Number of Farms per Section

Region / Area	Estimated Number of Farm Wells
Eastern South Dakota - Total Area	35,014 sq mi x 4 wells per sq mi = 140,056 wells
Eastern South Dakota - Shallow Aquifer Areas Only	3,874 sq mi x 4 wells per sq mi = 15,496 wells
Western South Dakota - Total Area	41,522 sq mi x 1 well per sq mi = 41,522 wells
Western South Dakota - Shallow Aquifer Areas Only	19,505 sq mi x 1 well per sq mi = 19,505 wells

When comparing the results of the project survey with the projected more general estimates, a significantly lesser number of abandoned wells have been identified in this project. Given that the general estimate assumptions are reasonable, some explanation for the differences is necessary. The differences could be the result of several factors.

First, the general estimated number, based on a uniform number of wells (farms) per square mile of aquifer, should be expected to overestimate the number of sites. Clearly, not every opportunity to establish a farm would have been taken over the course of the development of the state. In areas in close proximity to population centers, four farms per section might under estimate the potential. However, most of South Dakota is sparsely populated, and a lower number of farms per square mile is more likely.

Another potential factor may involve the location of farm buildings on a parcel of land. By definition, shallow aquifers in the State tend to be associated with generally low-lying topography. Such ground, particularly along rivers and streams, would be prone to periodic flooding. Given the opportunity, land owners will tend to establish building sites on generally higher ground. Wells for such sites would therefore not be established in lowlands, but on upland areas, often away from the actual aquifer. In most instances, large-diameter bored or dug wells established in non-aquifer material would still provide adequate water for a modest farm.

Another potential issue is in regards to the projections (either general or survey driven) for the area west of the Missouri River. The definition of shallow aquifer adopted for this project has resulted in several western counties being defined as being almost entirely underlain by such resources. See the shallow aquifer area for Bennett, Corson and Harding Counties on Table 3 for examples. Even a causal observation of these areas makes it clear that there are not now, nor have there ever been, anything approaching farm densities of one per mile. The same reasoning could be applied to the current project estimates for many of the western counties.

In the end, however, the number of abandoned wells over shallow aquifers as estimated based on project surveys, is considered to be reasonable, at least for the east river areas. Actual west river abandoned well number is probably an over estimate.

Criteria for Evaluation of Risk

Task 2 of the Abandoned Well Sealing Demonstration Project PIP called for the development of a priority rating system for abandoned wells. The premise was that not every well represents a significant risk to local water resources. Abandoned wells representing a higher risk to water resources should be identified and targeted for corrective measures.

EDWDD formulated a priority system (Attachment B, AWS-DP-102) in cooperation with representatives from the Brookings, Deuel, Hamlin, Mellette and Todd conservation districts (CDs), the South Dakota Department of Environment and Natural Resources (DENR), the South Dakota Geological Survey (SDGS), the South Dakota Cooperative Extension Service (CES) and the United States Environmental Protection Agency (USEPA) Region VIII. The CDs and landowners completed form AWS-DP-102 for each well receiving project cost-share assistance for sealing.

The priority system considers many factors for evaluating the environmental and health hazard(s) posed by a particular well. Point values are assigned to each factor, with greater points assigned when the risk is greater (Attachment B, AWS-DP-102). For example, the diameter of the abandoned well is considered, with higher points assigned to large diameter wells. A total score is tallied on completion of the form. Higher scores indicate a greater overall risk.

Factors considered in the evaluation of wells fell into four general areas. The first looks at the distance from the well to potential sources of contamination, and included consideration of future development in the area and transportation routes. The physical characteristics of the well (size, construction and condition) are also evaluated. In most instances, this category produced the most points, reflecting the generally poor physical condition of the wells. The third category looked at the distance from the unused well to active public or private wells. Finally, the general topography and drainage factors are considered.

At the time the priority system was developed, a score of 40 or more on the worksheet was used to define a "priority" well. At the time, project sponsors and participants believed that relatively few wells would meet this criteria. The subsequent results of the evaluations suggest that this belief was not supported. In the western counties, the average priority system score on sealed wells was 56.9. East river wells had generally lower ratings, averaging 42.6.

Number of Potentially Dangerous Abandoned Wells

Based on the results of the evaluations of the wells that were sealed through project cost-share assistance (see below), it appears that most abandoned wells located over shallow aquifers will meet the "priority" rating. As a consequence, it is probably necessary to either reconsider what constitutes a priority well (raise the number) or treat all such wells as targets, and not worry about doing a rating before addressing the problem.

In reviewing the ratings of each sealed well, it was evident that most of the points awarded were based on well construction and/or current physical condition. A review of the weight given to these factors would be appropriate if future activities are planned using a similar rating scheme to determine which wells in a given area would be targeted for action.

PART 2 - PUBLIC INFORMATION

Task 3 of the Abandoned Well Sealing Demonstration Project PIP called for the implementation of an Information and Education (I&E) program. I&E activities were to focus on informing landowners in the study area as to the importance of proper well abandonment and to explain the various methods and procedures to seal an abandoned well.

No such information was available for South Dakota at the time of project initiation. Educational materials from similar well sealing programs from other states in the region (Minnesota, Iowa and Kansas) were reviewed. After reviewing the available materials, and examining the relevant state requirements, three educational publications were prepared, published and distributed in cooperation with the South Dakota State Cooperative Extension Service (CES) and the South Dakota Department of Environment and Natural Resources Water Rights Program (DENR-WR). The first two documents address Sub-Task 3A in the PIP dealing with information for the general public. The final document falls under Sub-Task 3B, which targeted the actual sealing process and provided the necessary detail to successfully abandon a well in accordance to South Dakota law.

Sealing Shallow Abandoned Wells pamphlet (Attachment C) - This document was designed for distribution within the five-county study area. It explained the general purpose of the study, reviewed the need for sealing of abandoned wells in critical areas, discussed costs and requirements and provided local contacts. This pamphlet, along with ExEx 1017 described below, were distributed at all public meetings where abandoned wells were discussed.

Plugging Abandoned Wells, CES Extension Extra (ExEx) Number 1017 (Attachment D) - This document was prepared with the intention to distribute it state-wide. It focuses primarily on the process of abandoning a well, and includes several illustrations. The publication has been distributed through the CES offices.

Plugging Abandoned Water Wells, CES Fact Sheet (FS) Number 891 - (Attachment E) - This document is a combination of the two discussed above, but it provides a more in-depth explanation of the need for abandoned well sealing activities, as well as the procedures required to deal with both shallow and deep abandoned wells. This has been distributed through the CES offices throughout the state.

Finally, as per Sub-Task 3C, a series of public meeting and demonstrations of the sealing of abandoned wells were held. In Codington, Deuel and Hamlin Counties, abandoned well sealing field demonstration days were held in late June 1994. On Monday June 27, a well was sealed on the Dick Wurster farm in Deuel County; a well on the Loren Bjorklund farm in Hamlin County was sealed on June 28; and three wells in Codington County were closed on June 29. In addition, a well on the William Dempsey farm in northeastern Brookings County was sealed on July 14, 1994. The State Conservation Commission witnessed this event, along with local landowners. Copies of notices of these meetings are included as Attachment G.

Russ Derickson, with CES, also conducted a series of well plugging demonstrations in several counties in the area. Two wells were plugged in Hanson County on June 27, 1994; a shallow well in the Big Sioux aquifer near Renner in Minnehaha County was plugged on July 6; and on July 7 two wells near Bruce in Brookings County were sealed.

In Todd and Mellette Counties, public education was centered on public meetings such as local farm shows and water festivals. Booths were set up at Ranchers Workshops and the Mellette and Todd County fairs. Sixty-four farmstead visits with the Farm-A-Syst program were conducted, and included a section on abandoned wells (South Dakota State University Extension Special Series 33 - Factsheet 1).

Part 3 - Demonstration of Abandoned Well Sealing

Project Task 4 called for the establishment of demonstration projects to promote the proper abandonment of otherwise unused wells, as well as to gauge the level of public interest in such an activity. The program called for the project to provide seventy-five percent (75%) of the cost of the sealing of the well, up to a maximum of $300 per well. Well-sealing activities were coordinated by the Deuel County Conservation District in Codington, Deuel and Hamlin Counties, and by the Mellette Conservation District for Mellette and Todd Counties.

Landowners contacted through the original survey were made aware of opportunities for cost-share assistance at the time of the survey. Other property owners within the counties were made aware of the availability of the assistance through regular contact with District staff. In most cases, a minimum assessment score of 40 was required to qualify for cost-share assistance. However, some lower scoring wells in Deuel County were included to expend available funds. A breakdown of the wells sealed in each county and the associated costs are presented in Attachment H. A total of 87 abandoned wells were sealed as a result of this project.

Project participants were generally satisfied with the results, and most applicants had multiple wells sealed. The limit on absolute cost-share ($300 per well) did not appear to be an issue, as several cooperators willingly covered additional cost.

Once the project cost-share was expended, however, public interest in the sealing of abandoned wells dropped. The Deuel County Conservation District is occasionally approached regarding the program, but the absence of cost-share typically eliminates the interest, even with the modest actual costs of the operation.

A similar program to seal abandoned wells has been in place in Miner County for several years. The Miner County Conservation District has secured cost-share funding from several sources to assist land owners in the closure of such wells. As in the current project, participation appears to be strongly tied to the presence of cost-share assistance.

Part 4 - Recommendations for a State-Wide Program for Abandoned Well Sealing

Task 5 called for the development of recommendations for a state-wide, and state-funded, program to deal with abandoned wells in shallow aquifer areas. The primary justification for the implementation of a state-funded program was to protect the state's critical water resources, that is, the shallow aquifers. In addition, based on general estimates, the number of critical wells was thought to be quite large. Finally, it was presumed that the cost of well-sealing would be prohibitive for the individual property owner.

As a result of this project, no such state-wide program to help fund the sealing of abandoned wells is deemed necessary. That is not to say that individual projects to address specific, local problems are inappropriate. The recommendation is based on the following considerations:

Lack of clear impact on water quality – although not strictly part of the project, an informal survey of both local and state records failed to identify any actual or anecdotal instances where an abandoned well was responsible for the impairment or loss of a public water supply well. In some cases, degraded water quality was sited as the reason for the abandonment of the well, but the impact was strictly limited to the well site.

Costs of proper sealing – As noted above, the average cost of sealing an abandoned well in the shallow aquifer was $370.45, with the highest individual cost not exceeding $640. This is not believed to be an unreasonable burden for an individual property owner.

Number of abandoned wells – As discussed earlier, the actual number (based on survey projections) of abandoned wells over shallow aquifers is far below what had previously been projected. When combined with the lack of demonstrable impairment from such wells, the actual risk posed to the public at large is quite low.

Physical risk exceeds water quality concerns – As noted in the risk assessments completed for those wells that received project cost-share assistance, the physical condition of the abandoned wells appears to represent a far greater risk. In many instances, the abandoned wells were located in little traveled portions of current or former building sites. The wells themselves were often not marked or otherwise identified. If covered at all, the covers were poorly constructed and frequently failing. Water quality is perceived to be the big concern, but the reality is that the abandoned wells most often pose a much greater physical danger to people and livestock traversing the property.

State law requires sealing of unused wells – Finally, existing state law, Administrative Rules of South Dakota 74:02:04:67 through 74:02:04:71, requires that unused wells be sealed to comply with established standards. Compliance with these laws does not represent a significant problem for individual property owners. The cost of enforcement would likely be less than the cost of managing a state-wide assistance program.

If a state-wide program for dealing with abandoned wells were to be developed, it should be one of educating well and/or land owners on the potential physical safety and liability issues such wells represent. The well owner is the person for whom the abandoned wells represent the greatest risk, not the state.

Summary and Conclusions

The project implementation plan called for completion of six tasks - estimate the number of abandoned wells in South Dakota using surveys and inventories in selected project areas; formulate a priority ranking system to identify abandoned wells having the greatest contamination potential; implement and information and education program; provide technical and cost-share assistance to landowners for the sealing of priority abandoned wells; recommend a technically and financially feasible state-wide program for sealing abandoned wells; and prepare reports on the project. Each task was completed within the general parameters and time-frame established, with the following exceptions:

Task 2 - the ranking system developed for the project included a priority threshold score (40) for identifying potentially dangerous wells. Once the ranking system was used to evaluate the risk posed by abandoned wells in the project, it was noted that the priority threshold score was less than the average assessment score;

Task 4 - project technical and cost-share assistance was initially intended to be provided to only those landowners with priority wells. As noted above, the priority threshold was actually below the average assessment score. As a result, candidate wells to be sealed with project assistance were rarely rejected based on the scores; and

Task 6 - preparation and submission of the final project report was delayed as the result of change in project management staff.

Project outcomes were targeted at three fundamental issues - 1) estimating the number of abandoned wells (AWs) in shallow aquifers in the state, 2) determining the likely costs of properly sealing such wells and 3) formulating a state-wide policy for dealing with AWs. The project findings on these issues are as follows:

Number of abandoned wells and location. For eastern South Dakota, project survey information suggests that there are approximately 3,100 abandoned wells located within the area underlain by shallow aquifers. Survey results for western South Dakota suggest a greater number (7,082) in this area, but this estimate is probably too high. A total of approximately 9,000 is probably a good, conservative statewide estimate. It should be reiterated that this is number of abandoned wells in the shallow aquifer only. It does not include unused wells in deeper aquifers, or those in typically non-aquifer materials.

Costs of well sealing. A total of 87 wells were sealed during the course of the project, at an average total cost of $370. The wells were sealed in accordance with State standards with materials and expertise readily available through local well-drillers. The cost of sealing the well is modest by any consideration, and a bargain when weighed against the potential liability and physical safety risk posed by the unused wells.

Need for a state-wide program. The bottom line in regards to a state-funded sealing program is that governmental assistance is probably not warranted, at least in the context of a priority. The relatively low cost of well sealing and the absence of a demonstrable adverse impact of the wells on ground water resources indicates that limited governmental resources would be better allocated elsewhere. Many other potential threats exist that pose a greater risk to water quality and which are beyond the potential finances of the landowner. Public education of the potential threat to physical safety the wells pose may be in order.

In summary, the results of this investigation indicate that while abandoned wells exist in South Dakota in the areas underlain by shallow aquifers, these wells represent a limited water quality risk. The cost of properly sealing these abandoned wells is quite modest and there does not appear to be good justification for implementing a state-wide cost-share well sealing program to address the matter.

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Table 2. Estimates of Areas Underlain by Shallow Aquifers in eastern South Dakota

County(s)	County Area (sq mi)	Shallow Aquifer Area (sq mi)	Information Source
Aurora-Jerauld	1239	63	Hedges and others, 1982
Beadle	1261	115	Hedges and others, 1982
Bon Homme	580	20	Hedges and others, 1982
Brookings-Kingsbury	1620	364	Hamilton, 1989
Brown	1677	390	Hedges and others, 1982
Brule	829	29	Flint, 1955
Buffalo	494	90	Flint. 1955
Campbell	763	300	Hedges and others, 1982
Charles Mix-Douglas	1566	60	Hedges and others, 1982
Clark	976	91	Hedges and others, 1982
Clay	403	122	Hedges and others, 1982
Codington-Grant	1375	180	Hansen, 1990
Davison-Hanson	863	48	Hedges and others, 1982
Day	1060	91	Hedges and others, 1982
Deuel-Hamlin	1156	227	Kume, 1985
Edmunds-Faulk-McPherson	3301	370	Hedges and others, 1982
Hand-Hyde	2305	96	Hedges and others, 1982
Hughes	762	36	Hedges and others, 1982
Hutchinson-Turner	1425	116	Lindgren and Hansen, 1990
Lake-Moody	1094	146	Hansen, 1986
Lincoln-Union	1030	265	Niehus, 1994
Marshall	875	50	Hedges and others, 1982
McCook	577	25	Hedges and others, 1982
Miner	571	10	Hedges and others, 1982
Minnehaha	815	155	Lindgren and Niehus, 1992
Potter	887	66	Hedges and others, 1982
Roberts	1111	35	Tomhave, in preperation
Sanborn	571	76	Hedges and others, 1982
Spink	1506	59	Hamilton and Howells, 1996
Sully	1061	59	Hedges and others, 1982
Walworth	737	50	Hedges and others, 1982
Yankton	524	70	Hedges and others, 1982
Total Area	**35,014**	**3,874**	

Table 3. Estimates of Areas Underlain by Shallow Aquifers in western South Dakota

County(s)	County Area (sq mi)	Shallow Aquifer Area (sq mi)	Information Source
Bennett	1187	1181	Allen, Iles and Petres, 1985
Butte	2251	739	Allen, Iles and Petres, 1985
Corson	2525	2113	Allen, Iles and Petres, 1985
Custer	1552	200	Allen, Iles and Petres, 1985
Dewey	2411	724	Allen, Iles and Petres, 1985
Fall River	1748	80	Allen, Iles and Petres, 1985
Gregory	1023	377	Allen, Iles and Petres, 1985
Haakon	1815	372	Allen, Iles and Petres, 1985
Harding	2683	2564	Allen, Iles and Petres, 1985
Jackson	1870	759	Allen, Iles and Petres, 1985
Jones	973	60	Allen, Iles and Petres, 1985
Lawrence	800	80	Allen, Iles and Petres, 1985
Lyman	1685	50	Allen, Iles and Petres, 1985
Meade	3466	2070	Allen, Iles and Petres, 1985
Mellette	1306	518	Allen, Iles and Petres, 1985
Pennington	2776	736	Allen, Iles and Petres, 1985
Perkins	2866	2860	Allen, Iles and Petres, 1985
Shannon	2100	1099	Allen, Iles and Petres, 1985
Stanley	1495	50	Allen, Iles and Petres, 1985
Todd	1388	1154	Allen, Iles and Petres, 1985
Tripp	1620	478	Allen, Iles and Petres, 1985
Ziebach	1982	1241	Allen, Iles and Petres, 1985
Total Area	**41,522**	**19,505**	

Table 4. Estimates of the Number of Abandoned Wells in Shallow Aquifers in Counties in eastern South Dakota

County(s)	Shallow Aquifer Area (sq mi)	Number of Abandoned Wells	
Aurora-Jerauld	63	50	
Beadle	115	92	
Bon Homme	20	16	
Brookings-Kingsbury	364	291	
Brown	390	312	
Brule	29	23	
Buffalo	90	72	
Campbell	300	240	
Charles Mix-Douglas	60	48	
Clark	91	73	
Clay	122	98	
Codington-Grant	180	144	
Davison-Hanson	48	38	
Day	91	73	
Deuel-Hamlin	227	182	
Edmunds-Faulk-McPherson	370	296	
Hand-Hyde	96	77	
Hughes	36	29	
Hutchinson-Turner	116	93	
Lake-Moody	146	117	
Lincoln-Union	265	212	
Marshall	50	40	
McCook	25	20	
Miner	10	8	
Minnehaha	155	124	
Potter	66	53	
Roberts	35	28	
Sanborn	76	61	
Spink	59	47	
Sully	59	47	
Walworth	50	40	
Yankton	70	56	
Total Area	**3,874**	**3,099**	**Total Abandoned Wells**

Table 5. Estimates of the Number of Abandoned Wells in Shallow Aquifers in Counties in western South Dakota

County	Shallow Aquifer Area (sq mi)	Number of Abandoned Wells	
Bennett	1181	472	
Butte	739	296	
Corson	2113	845	
Custer	200	80	
Dewey	724	290	
Fall River	80	32	
Gregory	377	151	
Haakon	372	149	
Harding	2564	1026	
Jackson	759	304	
Jones	60	24	
Lawrence	80	32	
Lyman	50	20	
Meade	2070	828	
Mellette	518	207	
Pennington	736	294	
Perkins	2860	1144	
Shannon	1099	440	
Stanley	50	20	
Todd	1154	462	
Tripp	478	191	
Ziebach	1241	496	
Total Area	**19,505**	**7,082**	**Total Abandoned Wells**

ATTACHMENT A

Abandoned Well Survey Inventory Form (AWS-DP-101)

SHALLOW ABANDONED WELL SEALING DEMONSTRATION PROJECT
ABANDONED WELL (AW) SURVEY/INVENTORY FORM - AWS-DP-101

Owner ____________________ Lessee/Operator ____________________

Address ____________________ Address ____________________

____________________ ____________________

Telephone ____________________ Telephone ____________________

WELL LOCATION: (Attach ASCS photo defining the exact well location)

_____ 1/4 _____ 1/4 Section _______ Township __________ Range ________

Township Name ____________________ County ____________________

WELL CONSTRUCTION: (Attach well log if available)

Casing Material: (concrete, wood, clay-tile, steel, plastic) ______________

Construction Method: (dug, drilled, bored, driven/sand-point) ______________

Date Drilled: __________ Well Driller: ____________________

Well Depth: ________ Ft. Casing Diameter: ____________________ inches

Well Screen: From __________ ft. to __________ ft. below top of casing

WELLHEAD DESCRIPTION: In building? Describe: ____________________

Pit, mound, or buried? Describe: ____________________

Fence, debris or other obstructions?: ____________________

Windmill? _________ Pump jack? _______ Pullrod inside casing? ____________

Connected to pipes or power? Describe: ____________________

WELL CONDITION: Describe: ____________________

____

General: Measured water level: ______________ feet below top of casing

Potable water source nearby? _____ Distance to the AW ____________ ft.

Reason for abandonment: ____________________ Date: ____________

Uses before abandonment: ____________________

Is this a priority well? ________ Interest in sealing assistance? __________

Person filling out form: ____________________ Date: ____________

Comments: ____________________

____

ATTACHMENT B

Priority Worksheet (AWS-DP-102)

SHALLOW ABANDONED WELL SEALING DEMONSTRATION PROJECT
PRIORITY WORKSHEET - AWS-DP-102

To identify for cost-sharing shallow (unconfined) abandoned well (AW) having the greatest potential to contaminate groundwater.

Landowner/Lessee Name ______________________________

Address ______________________________

Abandoned Well Location _____ 1/4, _____ 1/4, Section _____ T _____ R _____

Section A. The abandoned well's (AW) potential to contaminate aquifer because of proximity to sources of contamination.

_____ Located close to the following sources
Note: Score ten (10) points when the AW is within 50 ft. or 100 ft. directly down gradient from the contamination source. Score five (5) points when the AW is within 100 ft. or 200 ft. directly down gradient from the contamination source. A maximum of 40 points can be scored for this sub-section.

petroleum tank _____ septic tank/drain field _____ buried sewer _____

wastewater lagoon _____ livestock feeding/confinement area _____

manure storage area _____ livestock waste lagoon _____ dairy _____

fertilizer/chemical storage area _____ poultry building _____

fertilizer/chemical handling area _____ graveyard _____

5W20/5X28* Class V injection well _____ buried gas line _____

Other (specify) ______________________________

(* - A 5W20 Class V well involves disposal of wastes other than normal human domestic wastes by a business using a septic tank. A 5X28 Class V well involves disposal of wastes through a floor drain and septic tank by a business that services internal combustion engines.)

		POINTS
_____	Located where intensive land use development is planned within two (2) years that will expose the AW to new contamination	10
_____	Located along a major transportation path for hazardous materials where major spills could occur	
	Within 100 ft. and hydraulically down-gradient from a Federal or state highway right-of-way	15
	Within the right-of-way of an interstate or intrastate railroad	15

TOTAL POINTS - Section A _____

Section B. Factors based on well diameter, construction and condition. For larger diameter wells, there is more likelihood debris and other contaminants will be dumped in the well and/or other surface and groundwater will enter at the top of the well or along the well casing.

			Points
_____	AW diameter	- greater than 36"	15
		- 24" to 36"	10
		- 12" to 24"	5
_____	AW construction	- no surface grouting	5
		- porous casing material or open joints	5
_____	AW condition	- casing visibly deteriorated	5
		- open space outside the casing	5
		- top of well uncovered	5

TOTAL POINTS - Section B _____

Section C. The abandoned well's potential to adversely impact a operating drinking water well because of their proximity to each other.

		Points
_____	Proximity to a public water supply (PWS) well	
	within 100 ft.	30
	100 ft. to 300 ft.	25
	300+ ft. but within a delineated WHPA	20
_____	Proximity to a private domestic well	
	within 100 ft.	20
	100 ft. to 300 ft.	15
_____	Proximity to a drinking water supply with no feasible alternative source making replacement more costly	5

TOTAL POINTS - Section C _____

Section D. Location in topographic low areas where large volumes of potentially contaminated surface water can congregate and move through the abandoned well into the aquifer.

		Points
_____	Located within the mapped 100 year frequency flood plain of a named stream or river	20
_____	Located in local draw or drainage way	15
_____	Located in a wetland or any sizable surface depressional area	10

TOTAL POINTS - Section D _____

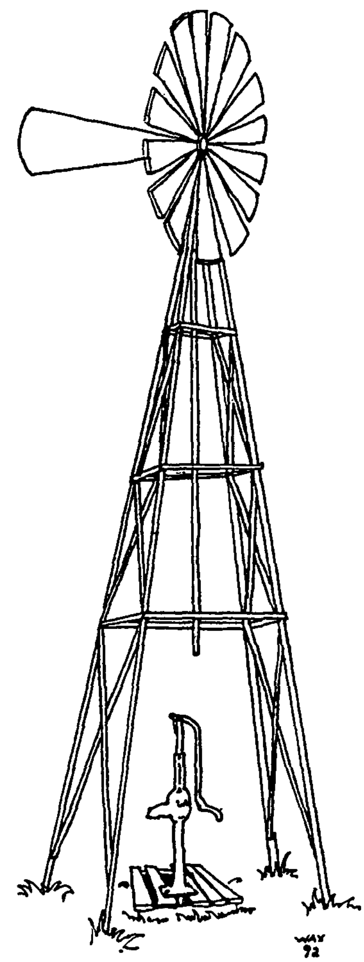
TOTAL POINTS - Sections A, B, C and D _____

PRIORITY WELL - If the total points are 40 or greater, the abandoned well is classified as a priority well and may be eligible for sealing cost-share.

ATTACHMENT C

Sealing Shallow Abandoned Wells Pamphlet

Sealing Shallow Abandoned Wells



East Dakota Water Development District

January 1993

SEALING SHALLOW ABANDONED WATER WELLS

What are abandoned wells?

Abandoned water wells are wells that are no longer in use or that are in such a state of disrepair that it is impractical or infeasible to fix them. They include wells developed for rural domestic use, public water supply, irrigation, observing water levels and monitoring water quality.

Why are abandoned wells a problem?

The soil layer that overlies shallow aquifers filters out some contaminants as water moves downward from the land surface toward the aquifer. Wells pass through this soil layer to provide a direct pathway between the aquifer and the land surface. New wells installed according to state standards are properly located and constructed to minimize the opportunity for contaminated surface water to enter the well.

Older wells may not be properly constructed and many abandoned wells are not maintained. Thus, abandoned wells can act as direct pathways allowing contaminated water to enter shallow aquifers. Abandoned wells located close to wells being used for drinking purposes can affect the health of users. Possible adverse health effects from drinking contaminated water include methemoglobinemia ("Blue Baby" syndrome) from high nitrates, and diseases like hepatitis, cholera, and diarrhea from bacterial contamination. Abandoned well contamination of an aquifer, particularly a segment used by others for drinking water, could possibly represent a landowner liability.

Furthermore, many unsealed, abandoned wells are not marked or covered. Large diameter wells can pose a serious safety threat to children and small animals; small diameter wells can result in broken limbs. This physical threat to human and animal safety could also represent a potential landowner liability.

How should abandoned wells be sealed or plugged?

South Dakota Well Construction Standards specify procedures for sealing abandoned wells in unconfined aquifers. An unconfined aquifer is a shallow aquifer in which the groundwater surface is at atmospheric pressure. Procedures for sealing unconfined wells are contained in Section 74:02:04:69. These rules are administered by the Division of Water Rights of the State Department of Environment and Natural Resources.

Under these procedures abandoned wells are filled with clean sand or gravel to the top of the aquifer (the water table). Above that, they can be filled with bentonite or cement grout. Clay can be used for the upper part of the well if the first two feet above the aquifer are filled with dry bentonite, bentonite grout or cement grout. The top three feet of casing may be removed and the hole backfilled with native soil material. A tremie pipe should be used to fill the well from the bottom up, to prevent bridging of sealing materials or dilution of liquid grouts. If the abandoned well is less than 16 inches in diameter or more than 50 feet deep, a tremie pipe is required under state rules.

Who can seal abandoned wells?

Although state law does not require sealing by a licensed well driller, they have the needed expertise and equipment. Landowners may seal their own wells if they use proper equipment, materials and procedures.

How can abandoned wells be identified and located?

The most obvious evidence of an abandoned well is a windmill, an old hand pump, a pipe sticking out of the ground or an abandoned farmstead. Large diameter dug wells often appear as a ring of concrete, tile, bricks or rocks several feet in diameter. A small shed may represent a pump house for an abondoned well.

Farmsteads served by a rural water system often have abandoned wells. Farmsteads with an operating well may have one or more abandoned wells. Old farmstead sites can often be identified using old aerial photographs or county farm directories.

What determines the cost of well sealing?

The cost of sealing an abandoned well is dependent on well accessibility, diameter and depth. The cost increases if debris, a pumping mechanism, or interconnected piping need to be removed. Well sealing costs can be reduced if a number of wells in an area are identified and sealed at the same time. A source of potable water at the site may also reduce the cost if grout needs to be mixed at the site.

Shallow, small diameter wells can often be sealed for $200 or less by a well driller. Landowners should be able to purchase needed materials for sealing most wells for $50 or less. The cost for sealing deeper, larger diameter wells will be proportionately larger.

The following chart provides a simple method for estimating the volume of materials needed to seal wells of different diameter and depth:

Well Hole Diameter	Volume per foot of well depth	
(inches)	(gal./ft.)	(cu. ft./ft.)
2	.16	.02
3	.37	.05
4	.65	.09
6	1.5	.20
8	2.6	.35
10	4.1	.55
12	5.9	.79
16	10.4	1.4
20	16.3	2.2
24	23.5	3.1
36	52.9	7.1
48	94.0	12.6

Should some abandoned wells have a higher priority for sealing?

It is recognized that the number of unsealed abandoned wells is large. Resources, particularly cost-share assistance, need to be focused on sealing abandoned wells that have the greatest potential to contaminate groundwater and that threaten public health and safety.

A worksheet has been developed for identifying shallow wells that should have priority for sealing. Under this system, abandoned wells receive priority based on four major factors:

Factors For Determining Priority of Abandoned Wells for Cost-Share Assistance:

1. proximity to various sources of contamination;
2. well construction and condition;
3. proximity to other drinking water wells;
4. location in topographic lows such as draws, floodplains, depressions and wetlands.

Is technical and financial assistance available for well sealing?

The Codington, Deuel, Hamlin, Mellette and Todd County Conservation Districts and the East Dakota Water Development District of Brookings, South Dakota initiated a two year shallow abandoned well sealing demonstration project in September 1992. The conservation districts will provide technical assistance and cost-share to landowners for sealing priority abandoned wells.

The five Conservation Districts will be conducting detailed surveys in selected areas to identify all shallow abandoned wells and those wells that would have priority for sealing. This data will be used to estimate the number of shallow abandoned wells and priority shallow abandoned wells statewide. Efforts are being made to make abandoned well sealing an approved ASCS cost-share practice throughout South Dakota.

For further information, contact one of the following offices:

Codington Conservation District
Watertown, SD
Phone: 882-1992

Deuel Conservation District
Clear Lake, SD
Phone: 874-2202

Hamlin Conservation District
Hayti, SD
Phone: 783-3611

Mellette Conservation District
White River, SD
Phone: 259-3252

Todd Conservation District
Mission, SD
Phone: 856-4440

East Dakota Water Development District
Brookings, SD
Phone: 692-5185

State Division of Water Rights
Pierre, SD
Phone: 773-3352

SDSU Cooperative Extension Service
Brookings, SD
Phone: 688-5669 or 688-5677

ATTACHMENT D

Plugging Abandoned Wells, CES Extension Extra Number 1017

COOPERATIVE EXTENSION SERVICE SDSU

Extension Extra

ExEx 1017
January 1993
Water Quality

SOUTH DAKOTA STATE UNIVERSITY / U.S. DEPARTMENT OF AGRICULTURE

Plugging Abandoned Wells

by Russell Derickson, Extension water and natural resources specialist

Why seal abandoned wells?

Abandoned wells pose a threat to the safety of animals and humans, especially small children. Unsealed abandoned wells may act like drains for runoff, allowing contaminated water to flow directly into an aquifer. Sealing abandoned wells by filling them with clay or cement prevents accidents and preserves the drinking water resource.

When must a well be plugged?

A well must be sealed when its original purpose and use has been permanently discontinued or when its condition is so poor that it cannot be repaired.

Who can plug wells?

Private landowners are permitted to plug their own wells provided they follow procedures established by the state. It is recommended that landowners hire a well driller to plug complex wells like flowing or non-flowing wells in confined (artesian) aquifers or wells penetrating multiple aquifers.

Temporary abandonment of wells

A properly constructed well may be temporarily abandoned by sealing the well with a water tight cap.

Plugging wells in unconfined aquifers (water table wells)

1. Fill the well from the bottom to the top of the aquifer (or water table) with clean sand or gravel. (Figure 1).
2. Fill the well to within three feet of surface with clay, bentonite grout, or cement grout.

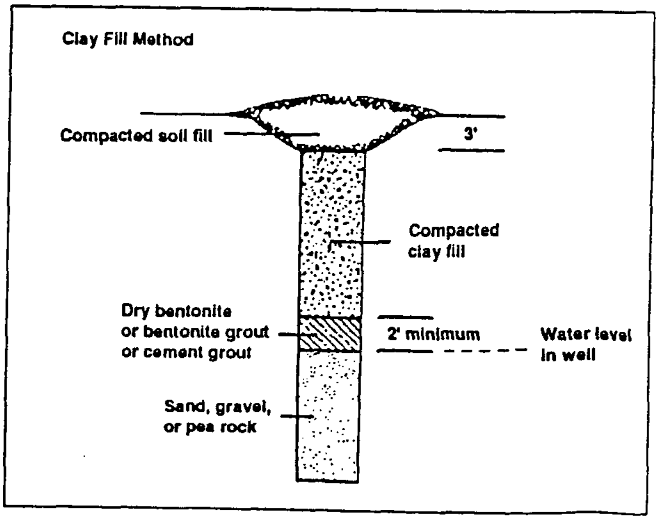
   Note: If clay is used as backfill, place a two-foot layer of dry bentonite, bentonite grout, or cement grout above the aquifer and below the clay fill.
3. Remove the top three feet of well casing and fill remaining hole with compacted soil.

For small diameter wells, like sand point wells, it is easier to use cement grout to plug the complete well.

Using a tremie pipe

If the well is more than 50 feet deep or less than 16 inches in diameter, a tremie pipe must be used. A tremie pipe keeps the sealing materials from becoming bridged inside the well casing and prevents dissolution of liquid grouts. The tremie pipe (or line) must remain submerged and must be raised as the well is filled (Figure 2).

Figure 1. Plugging wells in unconfined aquifers.



Plugging wells in confined aquifers or multiple aquifers

This applies to artesian wells or wells that encounter more than one aquifer [Figure 3].

1. Fill the well from the bottom to within 3 feet of the surface with cement grout and tremie line.
2. Remove the top 3 feet of well casing and fill remaining hole with compacted soil.

Alternative method (if well has low artesian pressure):

1. Fill the well from the bottom to within 8 feet of the surface with bentonite grout and tremie line.
2. Fill the next 5 feet with cement grout.
3. Remove the top 3 feet of well casing and fill remaining hole with compacted soil.

Well-plugging terms

Abandoned well – Well or test hole whose original purpose and use has been permanently discontinued or a well that is in such a state of disrepair that repairing it is not cost effective.

Artesian pressure – Natural pressure that causes water in a well penetrating an aquifer to rise above the top of the aquifer. Flowing wells occur when the pressure is sufficient to force the water above the land surface.

Bentonite – Highly plastic, colloidal clay composed largely of the mineral montmorillonite that swells upon wetting.

Bentonite grout – Bentonite and water mixed at a ratio of 1.5 to 2 pound of granulate bentonite per gallon of water. Bentonite used for grout must be an approved commercially manufactured material designed for plugging or sealing wells.

Clay – Fine-grained, naturally occurring inorganic material with a very low permeability that doesn't easily transmit water.

Cement grout – Mixture of high-sulfate-resistant portland cement and water mixed to a ratio of 1 bag of cement to 6 gallons of water.

Tremie pipe – Small-diameter pipe placed inside the well casing and used to carry material to the bottom of the well. Tremie pipes prevent bridging of materials and the diluting of liquid grouts.

References

South Dakota Codified Law, Chapter 46-6 (Water Rights); Chapter 74-02-04 (Well Construction Standards).

Figure 2. Pumping grout with a tremie pipe.

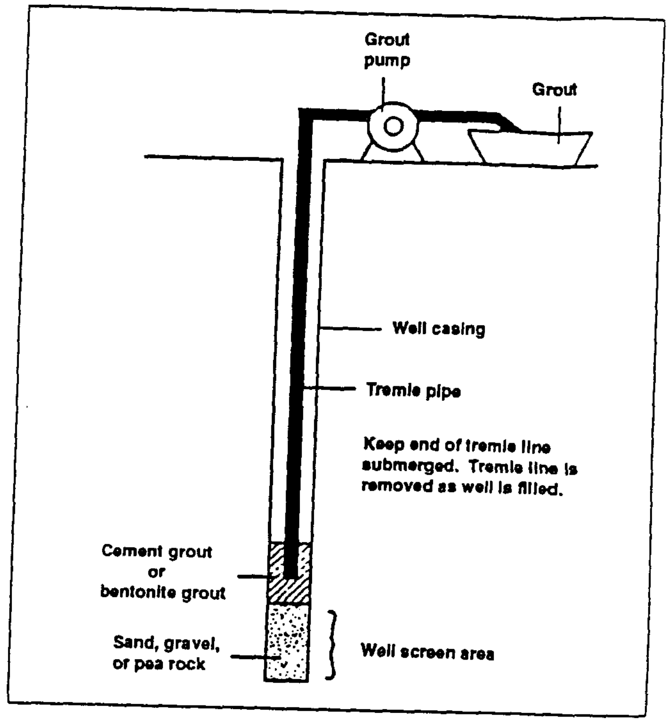
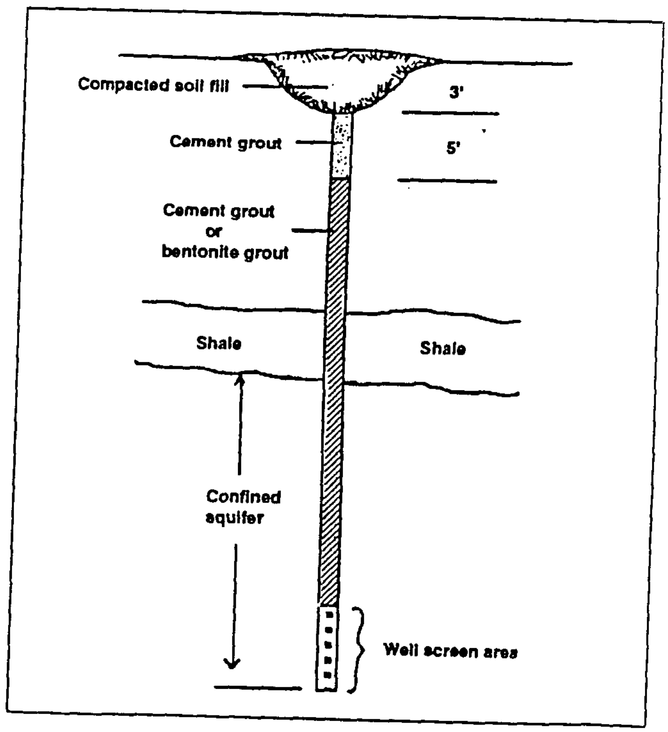


Figure 3. Plugging wells in confined aquifers.



COOPERATIVE EXTENSION SERVICE SDSU

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150 copies printed by CES at a cost of 5.5 cents each. February 1993.

ATTACHMENT E

Plugging Abandoned Water Wells, CES Fact Sheet Number 891

FS 891

Plugging Abandoned Water Wells

by Russell Derickson, SDSU Extension associate;Ken Bulher, natural resource engineer, S.D. Department of Environment and Natural Resources/Division of Water Rights; and Jerry Siegel, manager, East Dakota Water Development District

What are abandoned wells?

When wells are removed from service, they seldom are used again and are considered abandoned wells. Wells are abandoned for many reasons; the well may not produce a desirable or adequate supply of water, or the well has no pumping equipment. After a time, many wells fall into a state of disrepair or nonuse that precludes operation for the original purpose. In time, these wells are forgotten.

Eventually, all traces of old wells disappear, especially after property transfers or the wells are covered over by farming or construction activities. Abandoned wells leave an unnecessary risk of contamination to the drinking water supplies in South Dakota.

Abandoned wells exist throughout South Dakota, tap every principle aquifer, and vary considerably in design, diameter, and depth. The reduction in the number of farms, rural electrification, and general modernization of farms has caused many wells to become obsolete or abandoned. Creation of rural water systems also has caused large numbers of farm wells to become inactive in the past 20 years.

There is no accurate count of abandoned wells in South Dakota. Estimates of abandoned well numbers can be made from farm statistics. In 1910, South Dakota had approximately 78,000 farms. Farm numbers reached a maximum in 1932 with 84,300 farms. Farm numbers have declined steadily to about 36,000 today. In the 60 years since 1932, South Dakota has lost 48,300 farms and each one of these farms had at least one well that now might be an abandoned well.

Another estimate of the number of abandoned wells in South Dakota is one abandoned well per square mile west of the Missouri River and one abandoned well per quarter section east of the Missouri River.

Problems caused by abandoned wells

Abandoned wells and improperly plugged wells may allow contamination of aquifers by:

- Letting surface runoff into wells.
- Permitting cross-contamination of different aquifers encountered by the well bore.
- Reducing artesian pressure head by wasting water.

The soil layer that overlies aquifers filters out some contaminants as water moves downward from the land surface toward aquifers. To utilize underground water, holes called wells were deliberately drilled through soil layers. Unsealed, abandoned wells directly connect the land surface and groundwater. Polluted surface runoff can then make easy contact with groundwater and become concentrated at one point. Once groundwater is polluted, it is difficult and expensive to clean up.

Contamination introduced into aquifers by abandoned wells that are close to wells currently being used can affect the health of users. Possible adverse health effects from drinking contaminated water include methemoglobinemia (blue baby syndrome) from a high nitrate level and water-borne diseases like hepatitis, cholera, and diarrhea caused by bacterial contamination.

Abandoned wells can reduce the head pressure of artesian aquifers and allow the waste of water. As pressurized water discharges either to the land surface or to less pressurized aquifers, pressure head in artesian aquifers is reduced. Reduction in pressure head will eventually lower the water level in nearby wells and cause flowing wells to stop flowing.

Abandoned wells also may be a physical safety threat. Many unsealed, abandoned wells are not marked or covered. They can pose a hazard to people and animals that might fall into the well. These occurrences are rare, but they can be prevented.

Cooperative Extension Service / South Dakota State University / U.S. Department of Agriculture

Identifying and locating abandoned wells

Abandoned wells exist in many locations and can be one of many types of well construction. The most obvious evidence of an abandoned well is a windmill, an old hand pump, a pipe sticking out of the ground, or an abandoned farmstead.

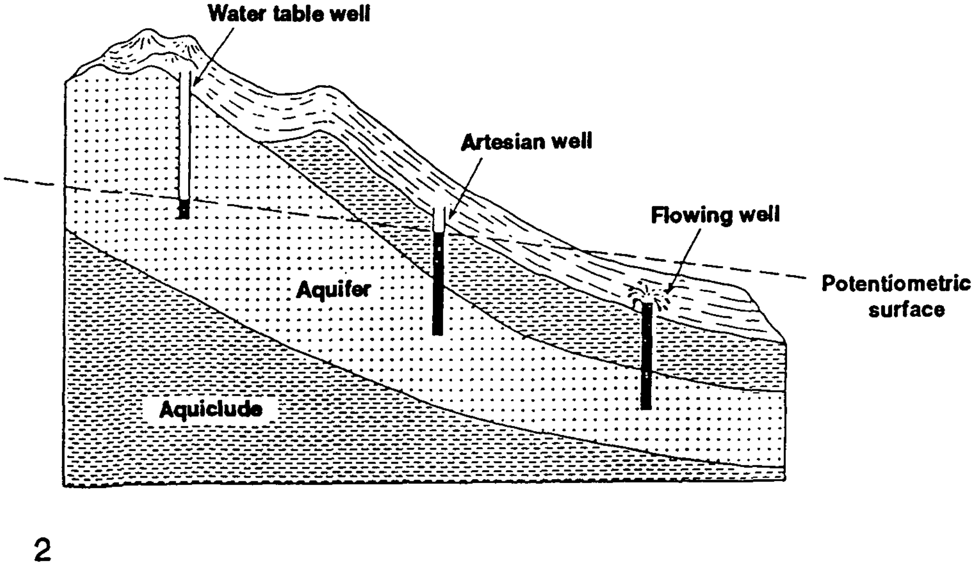
Large dug wells often appear as a ring of concrete, tile, wood, bricks, or rocks several feet in diameter. A small depression may indicate that an old well was buried. A wet area could indicate that a flowing well was not plugged properly. A small shed may represent a pump house for an abandoned well. Many wells were drilled next to outbuildings and in the basements of homes.

Farmsteads served by rural water most likely contain abandoned wells. Even farmsteads with active wells often contain an abandoned well. Abandoned farmstead locations can be identified using old aerial photographs or farm directories.

Other information sources for locating abandoned wells include:

- Previous landowners or longtime neighborhood residents.
- Well drillers and well development reports filed with the Department of Environment and Natural Resources (DENR).
- Old photos of the property showing locations of buildings.
- County and city building permits.
- Old fire insurance plan drawings may contain locations of wells.

Figure 1. Artesian and flowing wells in confined aquifer.



Laws concerning abandoned wells and owner responsibilities

S.D. codified law 46-6-27 states that when a well is abandoned it must be plugged/sealed. Requirements in South Dakota for plugging abandoned wells are contained in S.D. Well Construction Standards [ARSD 74:02:04]. These rules are administered by the DENR. Specific requirements for plugging wells in unconfined aquifers are contained in Section 74:02:04:69 and for wells in confined (artesian) aquifers are in 74:02:02:67.

Landowners are responsible for all wells located on their property including the cost of plugging abandoned wells. It is up to landowners to make sure that abandoned wells are plugged.

Landowners also are responsible for groundwater contamination or personal injuries caused by unsealed, abandoned wells. Improperly plugged wells are a continuing liability.

The well-plugging process

Plugging abandoned wells involves removing the pumping equipment, determining the well volume, determining the plugging method, and placing plugging material. There are different procedures for the different types of wells drilled into different types of aquifers. State well-plugging regulations are separated by aquifer types: confined aquifers (including wells penetrating multiple aquifers) and unconfined aquifers.

Site geology and well construction determine the plugging method. If well construction is unknown, the most effective method of preventing groundwater contamination is to completely fill the well with plugging materials.

Use of the wrong plugging method or improper plugging materials can lead to gradual settling or sudden collapse and renewed risk of groundwater contamination. Once a well is improperly plugged it is very difficult and expensive to correct the mistake. It is recommended that abandoned well owners consult a well driller if the well in question is in a confined aquifer, penetrates more than one aquifer, or is deeper than 200 ft.

The initial step in plugging a well is to remove any pumping equipment and piping that restricts access to the well casing. Volume of the well is then determined by measurement of the well diameter and depth to water and total depth of the well. Refer to Table 1 to determine the volume of material needed to fill the well casing.

Cross check the well diameter, depth and construction information with the drillers log of when the well was constructed. A copy of the drill logs can be obtained from the DENR's Division of Water Rights, Joe Foss Bldg., 523 East Capitol, Pierre, SD, 57501 (605 773-3352). A well log contains basic information on original well depth, diameter, and thickness of geological materials the well penetrated. Well drillers have been required to file well drill logs with the DENR since 1955.

The type of aquifer (ie. confined or unconfined) and which plugging method to use may be determined from the well drill log. If a well log is not available or there are major discrepancies from the well log, seek assistance.

Dig around the outside of the well casing to see if grout was used to seal the casing. If there is no grout, or there is only a gravel pack outside of the casing, then the area around the casing must be plugged to prevent contaminants from moving down the outside of the well casing. Remove 3 feet of casing and excavate as much of the gravel pack as possible and fill the void with well plugging material. If the casing cannot be removed, then place as much well plugging material around the casing as possible.

If the well casing terminates in a well pit, remove the well pit , if possible, after the well is plugged. At a minimum, knock in or remove one side of the well pit to prevent collection of water in the pit. Fill the well pit with native soil and cover with a layer of top soil.

Simply dumping well plugging material into a well is not effective, except for shallow, large diameter wells. Dumping plugging materials into small diameter wells may cause materials to bridge part-way down. When this happens, the well will be only partially filled. Well-plugging materials should be placed from the bottom of the well to the top with a tremie pipe.

A tremie pipe (Figure 2) is a tube temporarily inserted into the well casing to the depth where materials are to be placed/used. A tremie pipe allows for proper placement of plugging materials and prevents plugging materials from bridging, reduces void spaces, and prevents liquid grouts from being diluted by water in the well. Tremie lines should reach to within 1 or 2 feet of the desired depth and have the end cut in a diagonal.

Tremie pipes generally are attached to a funnel or pump. When placing plugging materials into a well, the tremie

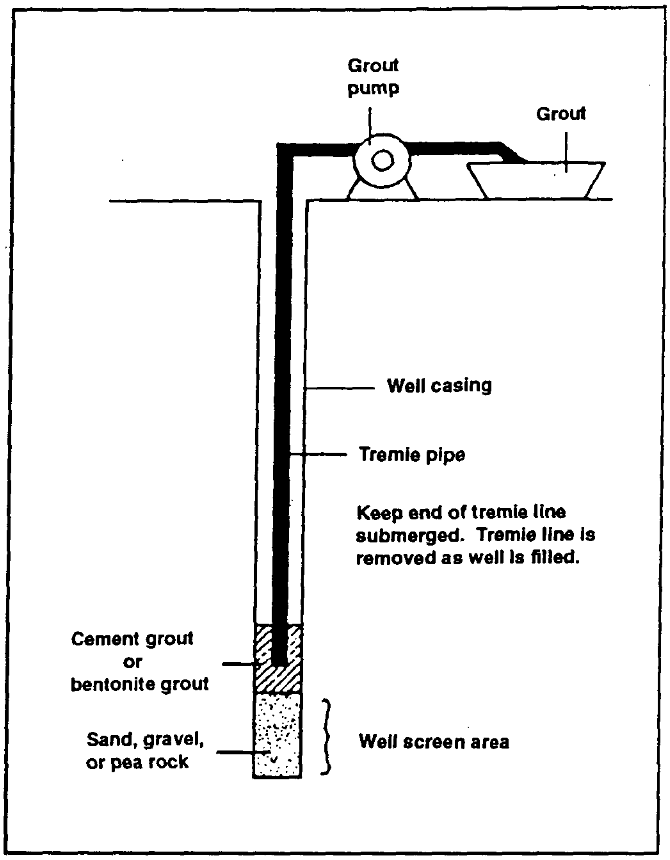


Figure 2. Pumping grout with a tremie pipe.

line should stay submerged in the plugging material and be retrieved slowly as the well casing fills. Under state regulation ARSD 74:02:04:69, if an abandoned well is less than 16 inches in diameter or more than 50 feet deep, a tremie pipe must be used for placing plugging materials.

Well plugging differences in geological environments

The amount of plugging materials needed also depends on the types of geological materials in which the well was drilled. Materials that have large void space or cracks and fissures will take more plugging materials to fill. Unfractured bedrock and glacial till have little or no void spaces while sand, gravel, and limestone have large void spaces. Any combination of geological materials may exist above the aquifer that was developed as a water supply when the well was drilled.

It may be difficult to estimate the amount of plugging material needed in fractured rock or other porous aquifer media. When plugging wells in porous media, make sure there is more than a sufficient amount of well plugging material available.

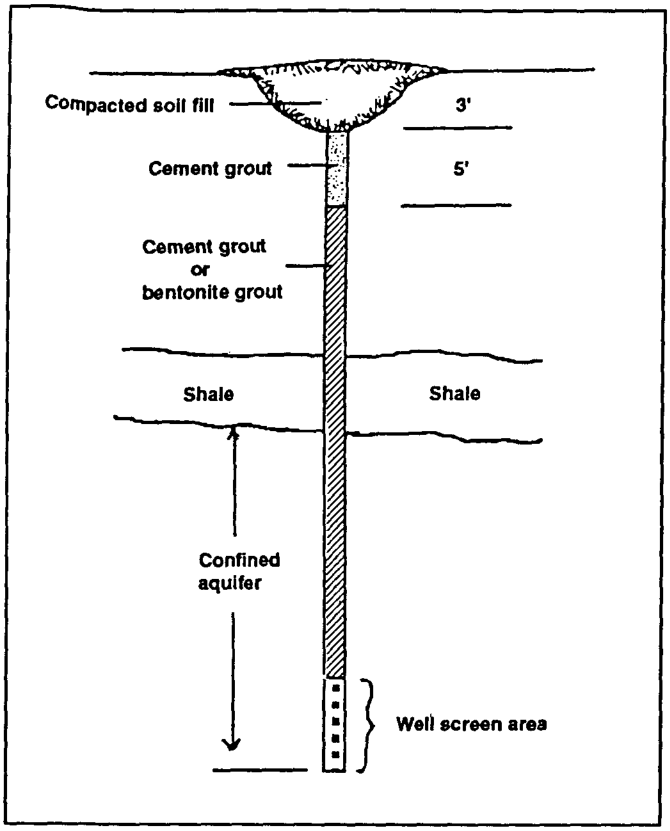


Figure 3. Plugging wells in confined aquifers.

Bentonite grout is a mixture of high solids, sodium bentonite material (sodium montmorillonite clay), and water. Bentonite used as a grout must be commercially manufactured and specifically formulated as a plugging material and approved by the DENR.

Dry bentonite used in the clay fill method can be purchased in powdered, granular, pelleted, and chipped formulations. Powdered and granulars are used for grout mixtures and the other formulations are used for dry layer applications. Chipped bentonite is mined and screened and graded by size. Bentonite pellets are easier to use but cost more due to the cost of processing.

Native clays used in well plugging should have a medium or loamy texture (excluding sandy loam) using the USDA textural classification system or be classified as silty clays (CL-ML or lean clay CL) using the Unified Soil Classification System. Native clays should be slowly added to the well in 6- to 12-inch layers and tamped in order to decrease the permeability of the clay.

Clay subsoils are low in organic matter and other contaminants. Avoid using native soils that have been subjected to ag-chemical applications (fertilizers and pesticides, because residues may still be present).

Well plugging materials

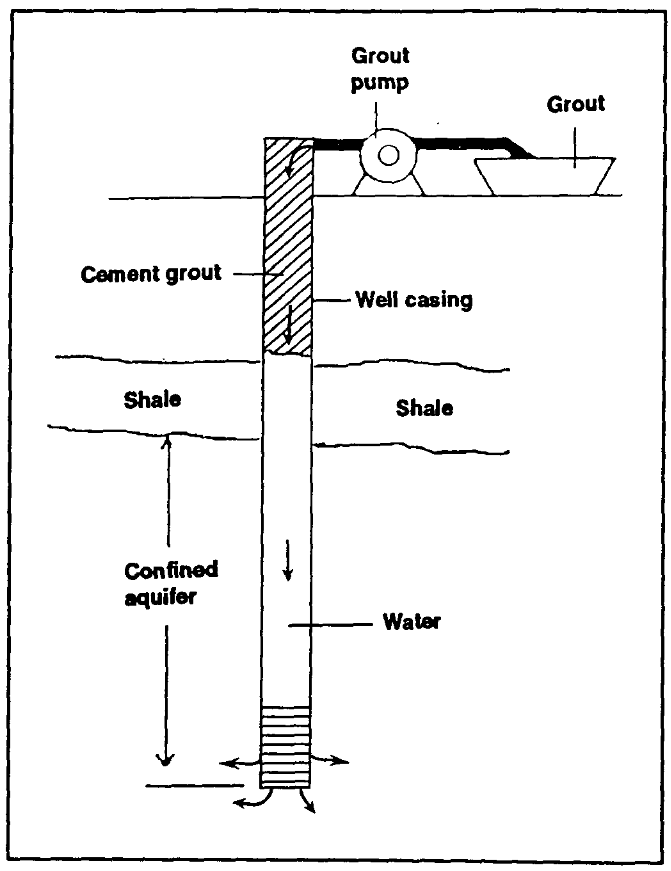
In general well plugging materials should form a permanent, impermeable plug that will not shrink or crack and will prevent the flow of water.

The most common material used for plugging wells is grout. Grout is a slurry which forms a permanent, impervious seal. Grout is preferred because it will flow into odd shapes and holes to completely plug a well. Plugging wells with grout is always the most effective option for any abandoned well no matter how large or deep.

Two types of grout are allowed for plugging wells in South Dakota, cement grout and bentonite grout.

Cement grout is a mixture of one 94 lb. bag of high-sulfate resistant portland cement and no more than 6 gallons of water. It has a consistency of thick cream and yields about 1.28 cubic feet of cement grout per bag of cement. Sand or other aggregate is not used in cement grout because they will separate out of the slurry and weaken the seal.

Figure 4. Top down fill method.



Sand and gravel is used as a coarse fill material for unconfined aquifer wells inside the well casing below the water table.

Chlorine bleach is used to sanitize the abandoned well water before the well plugging materials are added. HTH tablets (commonly used to chlorinate for swimming pools) also may be used for this purpose. Chlorination of well water eliminates coliform bacteria and other bacteria. The water inside abandoned wells is sanitized to prevent contamination from being introduced by plugging materials.

Confined aquifers, flowing wells, and multiple aquifer wells

In confined aquifers (artesian), the water level in the well rises above the top of the aquifer. The height of the rise is a measure of the head pressure (Figure 1). If head pressure is high enough, water will flow at the land surface. In unconfined aquifers, the water level does not rise above the top of the aquifer.

Wells completed into **confined aquifers** or where more than one aquifer is penetrated must be plugged with grout (Figure 3) from the bottom of the well to three feet below ground surface. The top three feet of casing is removed and backfilled with native material. Two types of grout are allowed: cement grout and bentonite grout.

If bentonite grout is used, a minimum of five feet of cement grout must be placed on top of the bentonite grout.

Wells penetrating **multiple aquifers** generally are`small diameter and can be thousands of feet deep. These wells will enter and exit shallow aquifers and penetrate rock formations like shale or sandstone. These wells are plugged the same as described above.

Flowing wells present a unique problem because of the continuous upward movement of water. In most cases, the owner should consider obtaining the services of a licensed well driller. Plugging flowing wells requires the placement of grout through a tremie line fast enough to stop the water flow. Sometimes mechanical plugs must be inserted into the well to prevent the water flow from pushing out the grout.

In certain situations, tremie pipes cannot be inserted into a well. Then cement grout must be forced into the well by making a tight connection at the top of the casing and pumping enough grout to completely fill the casing (Figure 4).

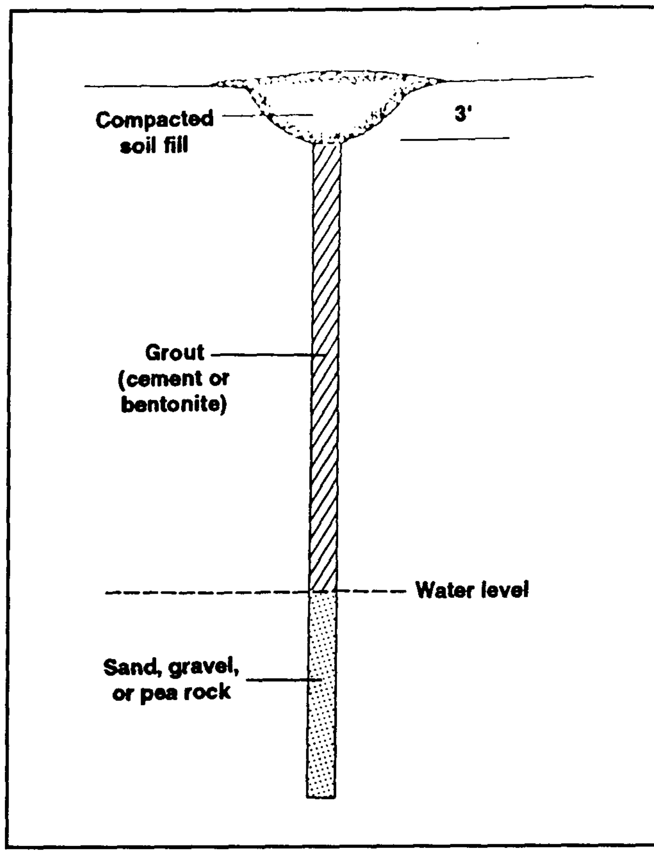


Figure 5. Sealing well in unconfined aquifer with grout.

Unconfined aquifers

Unconfined aquifers or water table aquifers have no confining layers that prevents the uppermost groundwater surface from equalizing with atmospheric pressure. The water levels of unconfined aquifers are within the aquifer (Figure 1).

Wells completed into unconfined aquifers are sanitized with chlorine and then filled with sand or gravel to the top of the aquifer. The remainder of the well is filled with bentonite grout or cement grout.

When grout is not practical because or large volume or expense, clay fill (Figure 6) can be used above unconfined aquifers. If clay is used, a minimum of 2 linear feet of dry bentonite, bentonite grout, or cement grout must be placed at the top of the aquifer. The casing may be removed at a depth of three feet and the hole filled with compacted soil to form a slight crown.

A tremie pipe must be used when plugging wells smaller than 16 inches in diameter and greater than 50 feet in depth. Pour plugging materials slowly to prevent their bridging inside the tremie pipe. Shorten the tremie pipe as the well fills. For small diameter wells, it is more

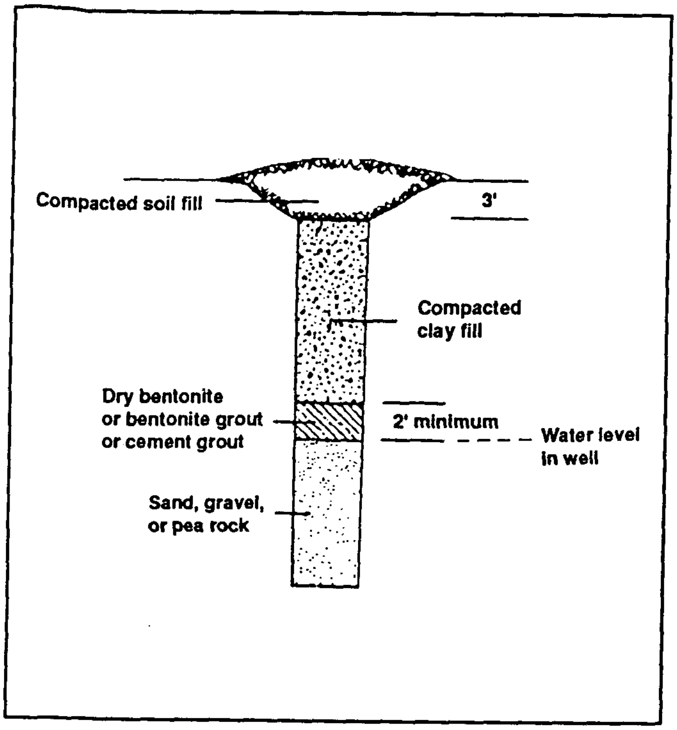
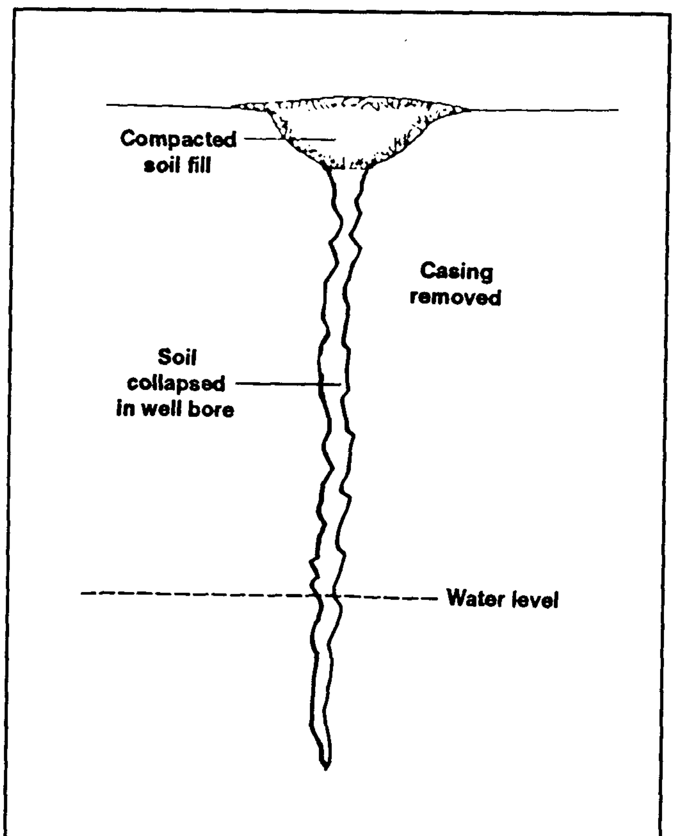


Figure 6. Plugging wells in unconfined aquifers with the clay fill method.

Figure 7. Sealing sand point wells.



effective and less time consuming to use grout to fill the entire well. Figures 5 and 6 show the cross sections of properly plugged wells in an unconfined aquifer.

When plugging **large diameter wells**, it is probably more cost effective to use native clay because of the large volume that must be filled. The clay fill method uses a clean, native clay as the plugging material. To plug a well using clay, first measure the depth to water and to the bottom of the well. Pour one gallon of 5 1/4 percent chlorine bleach (or 2 lbs of HTH tablets) into the well and then fill the well to the top of the water table with sand or gravel. Next add a minimum of two linear feet of dry bentonite, bentonite grout, or cement grout. Fill the remainder of the hole with clay.

If native material is used, make sure it is free of ag chemical residues or other contaminates. Pour plugging materials slowly down the well to prevent bridging. Pack the clay in layers to eliminate air spaces and future settling. Cut off the casing at three feet and fill with top soil to form a slight crown to allow for future settling. Figure 6 shows a cross section of a properly plugged drilled, dug, or bored well. If a drilled well extends below a dug well, the drilled well must be plugged first.

Sand point wells generally were driven in by hand. They have small diameters, shallow depth, and are placed in course-textured materials. These wells are best plugged by extracting the complete casing and allowing the well hole to collapse (Figure 7). Add a small amount of soil to allow for settling in the future. If the casing cannot be pulled, pump bentonite grout or cement grout into the well through a tremie pipe. Cut off the casing at three feet and back fill with compacted soil leaving a slight crown.

Well plugging records

If owners plug their own wells they are not required to report the plugging to the DENR. However, keep a record of any plugged well for future reference.
A typical well plugging report should include:

- Name and address of well owner.
- Legal land description of the well.
- Casing diameter, depth.
- Type of well.
- Description of well condition.
- Description of plugging method.
- Completion date.

Well drillers are required to send a copy of well plugging reports to the DENR and to the well owner. Owners who plug their own wells are advised to file a well plugging report with the DENR because land

Table 1. Volume vs. depth

Hole diameter (inches)	Volume per foot of depth gal/ft	cu.ft/ft	Cement grout lin. Feet per bag cement	bags of cement per foot of depth
2	.16	.02	58.7	.017
3	.37	.05	26.0	.038
4	.65	.09	14.7	.07
5	1.0	.14	9.4	.11
6	1.5	.2	6.5	.15
7	2.0	.27	4.8	.21
8	2.6	.35	3.7	.273
10	4.1	.55	2.35	.43
12	5.9	.79	1.6	.61
16	10.5	1.4	.92	1.1
20	16.4	2.2	.59	1.7
24	24.6	3.1	.23	2.45
36	53.0	7.1	.14	5.5
48	94.2	12.6	.07	9.82

Table 2. Cost of well plugging materials.

Material	Cost	Cost per cu. ft.
sand/gravel	$1.50 per yard	$0.05
pea rock	$4.00 per yard	$0.14
chlorine bleach (5 1/4 %)	$1.00 per gallon	-
HTH tablets	$1.50 per lb	-
dry bentonite		
granular	$6.70 per 50 lb bag	$10.50
chips	$7.25 per bag	$10.42
bentonite grout	$6.70 per 50 lb bag	$ 4.00
cement grout	$6.50 per 94 lb bag	$ 5.08

transactions in the future may require a disclosure statement detailing current and abandoned wells and other farm pollution concerns.

Who may plug an abandoned well?

Private landowners are permitted to plug their own wells provided they follow procedures established by the state. Although state law does not require plugging by a licensed well driller, they have the proper equipment and experience.

Well plugging must be done correctly the first time. It is important that the proper equipment, materials, and procedures are used. If a well has been plugged incorrectly, it is nearly impossible to re-do the job properly. If you plan to plug a well yourself, make sure you are thoroughly familiar with the proper plugging procedure for your well, estimate the amount of plugging materials needed, and obtain the correct plugging materials. If in doubt, seek assistance.

Cost of well plugging

The cost of plugging an abandoned well depends on several factors including the well's accessibility, diameter, and depth; whether debris, a pumping mechanism, or interconnected piping need to be removed; and whether there is potable water at the site to use during the plugging process.

Shallow, small diameter wells often can be plugged for $200 or less by a well driller. Landowners often can purchase needed plugging materials for $50 or less. The cost for plugging deeper, large diameter wells will be proportionally larger. Table 3 contains a worksheet to estimate the cost of plugging materials.

The cost of plugging a well can be reduced if a group of wells in an area are identified and plugged at the same time by one well contractor. Well depth and diameter determine the amount of plugging materials required (See Table 1). Table 2 lists cost for common well plugging materials.

Additional assistance

Contact your county Extension agent, local well driller, water development district, or DENR's Division of Water Rights, (605) 773-3352.

References

South Dakota Codified Law, Chapter 46-6, (Water Rights).

South Dakota Codified Law, Chapter 74-02-04, (Well Construction Standards).

Table 3. Well plugging worksheet.

a. diameter of well	convert in. to ft (inches/12)	___ ft
b. total depth of well		___ ft
c. depth to water		___ ft
d. ft of water in well	line b - line c	___ ft
e. ft of dry casing	line b - line d	___ ft
f. well casing area	line a^2 * 3.14 / 4	___ (sq.ft.)
Cement grout		
g. volume of cement grout	line f * line b	___ (cu.ft)
h. volume of top soil	line f * 3 / 27	___ (cu.yds
Clay fill Method (only used in unconfined aquifers)		
i. volume of sand or gravel	line f * line d / 27	___ (cu.yds)
j. vol of dry bentonite (if used)	line f * 2	___ (cu.ft.)
k. vol clay, cement or bent. grout	line f * (line e-3)	___ (cu.ft.)
l. volume of top soil	line f * 3 / 27	___ (cu.yds)
Bentonite grout (cannot be used for top-down fill method)		
m. volume of bentonite grout	line f * (line b - 8)	___
n. volume of cement grout	line f * 5	___ (cu ft)
o. volume of top soil	line f * 3 / 27	___ (cu.yds)
Material cost		
p. sand or gravel	line i * $/cu.yds.	$___
q. dry bentonite	line j * $/cu.ft.	$___
r. clay	line k * $/cu.ft.	$___
s. cement grout	line g, k or n * $/cu ft	$___
t. bentonite grout	line m or k * $/cu ft	$___
u. top soil	line h,l or o * $/cu.yds.	$___
v. Total material cost		$___

Additional expenses may be incurred from the following sources:

- labor charge
- equipment rental
- transportation charge (getting materials to site)
- rental or set up fees

COOPERATIVE EXTENSION SERVICE SDSU

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500 copies printed by the Agricultural Engineering Dept. at a cost of 45¢ each. FS891 February 1994

ATTACHMENT F

Record of Abandoned Wells Sealed with Project Cost-Share (AWS-DP-103)

SHALLOW ABANDONED WELL SEALING DEMONSTRATION PROJECT
RECORD OF ABANDONED WELLS SEALED WITH PROJECT COST-SHARE - AWS-DP-103

NOTE: Attach a copy of completed forms AWS-DP-101/-102 and send to:
DENR, Division of Water Rights, Joe Foss Building, Pierre, SD 57501

Landowner/Lessee ______________________________

Address ______________________________

Abandoned Well Location _____ 1/4, _____ 1/4, Section _____ T _____ R _____

Description of plugging procedure/materials ______________________________

____

____

Sealing completed by: ______________________________ Date: __________

* Total of eligible costs $ __________

Project cost provided (75%) $ __________

Landowner cost-share (25%) $ __________

(* - Eligible work includes removal of debris at the site, removing the pumping mechanism, unhooking water lines/connections and properly sealing the well. Eligible costs include labor, materials and equipment used. Costs must be itemized including the hourly labor charge. All billings must be signed.)

Note: The landowner/lessee must provide and document 25% cost-share of the eligible sealing items. Maximum project cost-share per sealed well is $300.

I, (landowner/lessee or licensed well driller) ______________________________
certify that the above noted abandoned well was sealed in accordance with approved State well construction standards and that the sealing costs are correct to the best of my knowledge. I agree to provide any additional information requested by the Conservation District noted below.

Signature ______________________________ Date __________

Conservation District official witnessing the landowners signature and the well sealing:

______________________________ ______________________________
Typed or printed name Signature

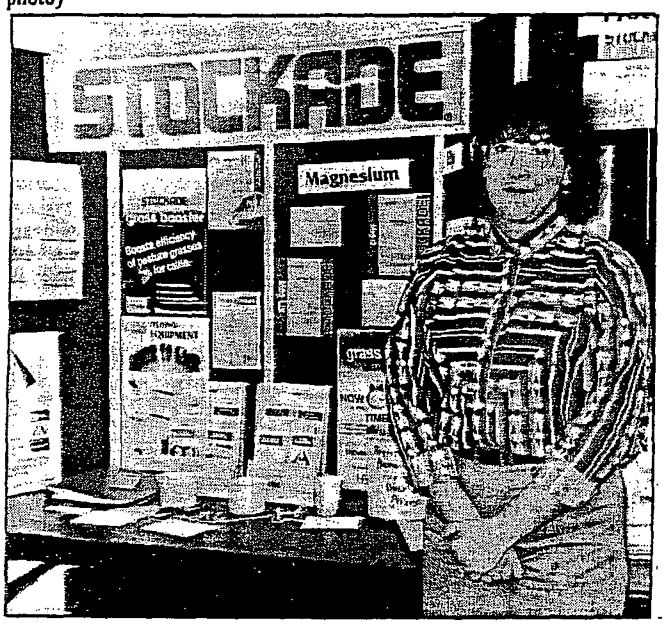
Conservation District ______________________________

ATTACHMENT G

Public Meeting and Demonstration Notices

Ranchers Workshop held at WR

Sena Lauritsen, with a project on Abandoned Well Sealing. (Karen Week photo)



Joyce Glynn and Roger Glynn, Stockade products. (Karen Week photo)

Dan Valburg and Jon Knochenmus, Ralco Mix (Karen Week photo)

WHITE RIVER — The 1995 Ranchers Workshop was held at the Mellette County Courthouse basement on January 18. Eighty-four individuals signed the registration sheet. All who attended agreed that it was a very educational day. Topics for the workshop followed the theme, "Cutting Cow Costs". Derrill Glynn, Mellette County Conservation District Board Chairman welcomed everyone to the workshop.

Wayne VanderVorste and Clarence Nollette opened the program with a report on the Bootstraps Program. Clarence gave a moving talk about what the program has done for him and his family.

Dean Dave Bryant of SDSU gave an update on the Ag and Bio Sciences Dept.

Dr. Jim Males, SDSU Animal & Range Sc. Head talked about Animal Rights and Welfare. As he stated, all ranchers must promote animal welfare in order to be successful, but we must also learn to deal with those who call themselves animal activists.

Ed Twidell, SDSU, gave an informative talk about the best hay and how we can produce it.

Rick Buoy, Cowboy Poet from Ainsworth, NE, provided a wonderful 30 minutes of entertainment with his program, "Through a Twisted Mind". Rick, who ranches with his wife and family, helped us laugh at ourselves as we saw ourselves in his poetry.

Dave Steffen and Jeff Adrian gave an informative report on the Plant and Animal Nutrient Analysis Project. This program provides area ranches with an extremely interesting look at the actual nutrients that their cattle utilize from the range.

Calvin Gunter, from Integrated Beef Technologies, Englewood, CO, talked to the group about Value Based Management and Strategic alliances. This thought-provoking talk created a lot of interest and many questions were asked of this speaker. Ranchers definitely want to hear more from Mr. Gunter.

Doug Zalesky, SDSU Extension Beef Specialist, talked to the crowd about marketing strategy alternatives. In this time of financial stress on the ranch, Doug gave us several ideas to help us increase our profit margin. Mr. Zalesky has been to this area many times and has helped individuals and groups with marketing.

Mellette County News – January 25, 1995

1994 PROGRAM

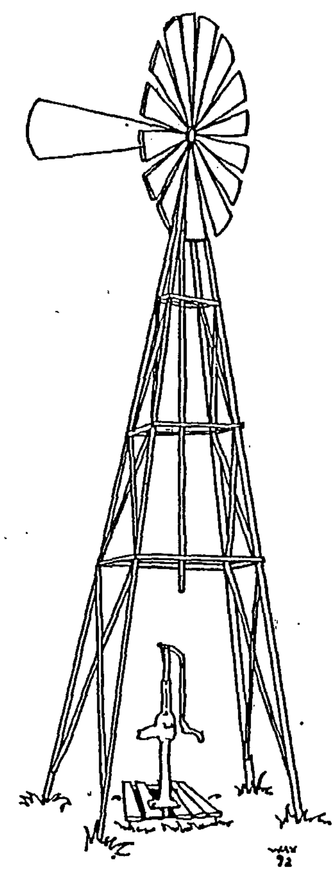
1994 was the first year for the abandoned well sealing program. A total of 83 wells were sealed, mostly in Deuel Co. and also in Hamlin, Codington and Brookings Counties. Another 85 wells are signed up for 1995 sealing.

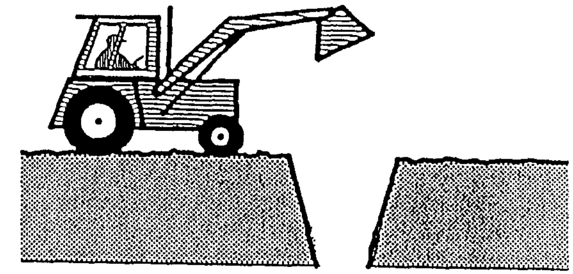
Don Megard of Astoria was contracted by Deuel Conservation District to provide equipment and operator to perform the sealing. LeRoy Stohr of Clear Lake was hired by the District to take care of the technical portion of the sealing.

Average cost of sealing a well is $350, with a range of $300 - $400 depending on width, depth and amount of materials needed.

ASCS has a cost-share program available at the rate of 75% c/s. On a $350 well, c/s would be $263, leaving a net cost to landowner of $87.

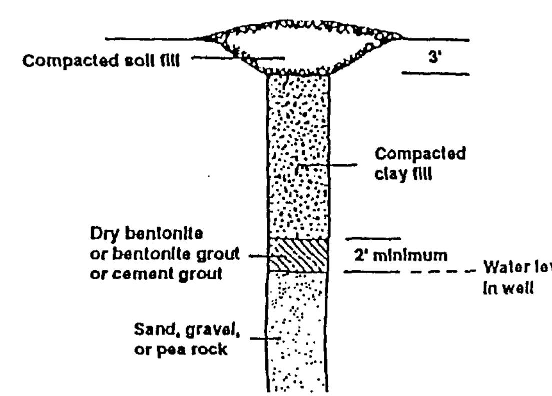
Sealing Shallow Abandoned Wells





METHOD USED

1. Pump water out of well
2. Pour bleach into well to disinfect
3. Deposit layer of sand & gravel up to aquifer level
4. Pour 2' layer of bentonite into well
5. Deposit layer of clay into well within 3' of top
6. Remove casing
7. Tamp black top soil on top of hole
8. Level off finished site

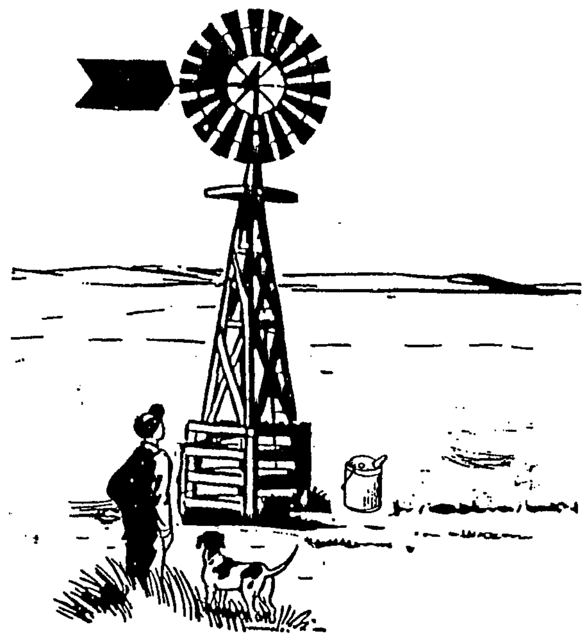


SAFETY AND
POLLUTION
CONCERNS

why seal abandoned wells?

Abandoned wells can act as direct pathways allowing contaminated water to enter shallow aquifers.

Furthermore, many abandoned wells are not marked or covered. They can pose a serious threat to children and small animals.



PERSONNEL:

District Supervisors:

- Harley Blumke
- Charles Appelhof
- Darwin Hunt
- Lonnie Budahl
- Doug Toben
- Clarence Roecker (Assistant)

District Employees:

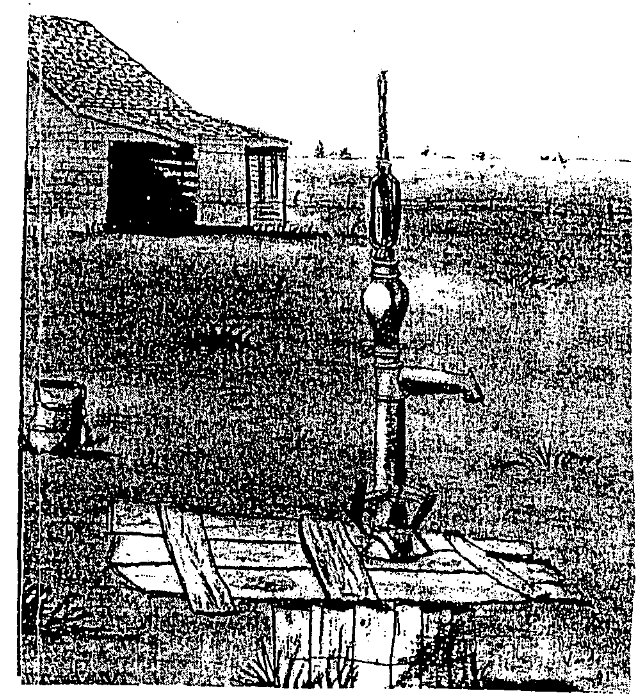
- Elois Redlin
- LeRoy Stohr

Natural Resources Conservation Service:

- Kevin Luoma
- Cheryl Stohr

DEUEL COUNTY
CONSERVATION
DISTRICT

ABANDONED WELL
SEALING
PROGRAM
1995



Well-plugging terms

Abandoned well - Well or test hole whose original purpose and use has been permanently discontinued or a well that is in such a state of disrepair that repairing it is not cost effective.

Artesian pressure - Natural pressure that causes water in a well penetrating an aquifer to rise above the top of the aquifer. Flowing wells occur when the pressure is sufficient to force the water above the land surface.

Bentonite - Highly plastic, colloidal clay composed largely of the mineral montmorillonite that swells upon wetting.

Bentonite grout - Bentonite and water mixed at a ratio of 1.5 to 2 pound of granulate bentonite per gallon of water. Bentonite used for grout must be an approved commercially manufactured material designed for plugging or sealing wells.

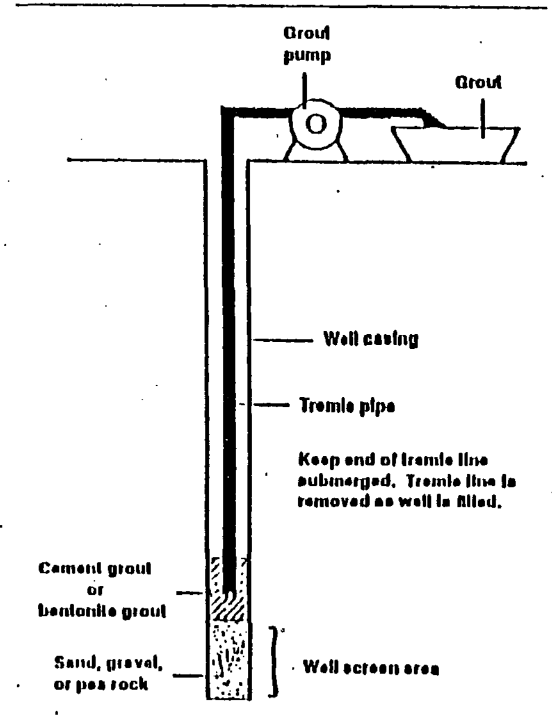
Clay - Fine-grained, naturally occurring inorganic material with a very low permeability that doesn't easily transmit water.

Cement grout - Mixture of high-sulfate-resistant portland cement and water mixed to a ratio of 1 bag of cement to 6 gallons of water.

Tremie pipe - Small-diameter pipe placed inside the well casing and used to carry material to the bottom of the well. Tremie pipes prevent bridging of materials and the diluting of liquid grouts.

References
South Dakota Codified Law, Chapter 46-6 (Water Rights); Chapter 74-02-04 (Well Construction Standards).

Figure 2. Pumping grout with a tremie pipe.



WELL-PLUGGING DEMONSTRATION

Dempsey Farm
(SE 1/4 28-112-48)
8:30 A.M.
Thursday, July 14, 1994

Agency Sponsors

Extension Service

Soil Conservation Service

ASCS

Brookings & Deuel
Conservation Districts

In Cooperation With

East Dakota
Water Development District

Brookings-Deuel
Rural Water System

South Dakota Association of
Rural Water Systems

PLUGGING ABANDONED WELLS

by Russell Derickson,
Extension water & natural resources specialist

Why seal abandoned wells?
Abandoned wells pose a threat to the safety of animals and humans, especially small children. Unsealed abandoned wells may act like drains for runoff, allowing contaminated water to flow directly into an aquifer. Sealing abandoned wells by filling them with clay or cement prevents accidents and preserves the drinking water resource.

When must a well be plugged?
A well must be sealed when its original purpose and use has been permanently discontinued or when its condition is so poor that it cannot be repaired.

Who can plug wells?
Private landowners are permitted to plug their own wells provided they follow procedures established by the state. It is recommended that landowners hire a well driller to plug complex wells like flowing or non-flowing wells in confined (artesian)aquifers or wells penetrating multiple aquifers.

Temporary abandonment of wells
A properly constructed well may be temporarily abandoned by sealing the well with a water tight cap.

Plugging wells in unconfined aquifers (water table wells)
1 - Fill the well from the bottom to the top of the aquifer (or water table) with clean sand or gravel. (Figure 1)
2 - Fill the well to within three feet of surface with clay, bentonite grout, or cement grout.

Note: If clay is used as backfill, place a two-foot layer of dry bentonite, bentonite grout, or cement grout above the aquifer and below the clay fill.

3 - Remove the top three feet of well casing and fill the remaining hole with compacted soil.

For small diameter wells, like sand point wells, it is easier to use cement grout to plug the complete well.

Using a tremie pipe
If the well is more than 50 feet deep or less than 16 inches in diameter, a tremie pipe must be used. A tremie pipe keeps the sealing materials from becoming bridged inside the well casing and prevents dissolution of liquid grouts. The tremie pipe (or line) must remain submerged and must be raised as the well is filled (Figure 2).

Plugging wells in confined aquifers or multiple aquifers
This applies to artesian wells or wells that encounter more than one aquifer (Figure 3.).
1 - Fill the well from the bottom to within 3 feet of the surface with cement grout and tremie line.

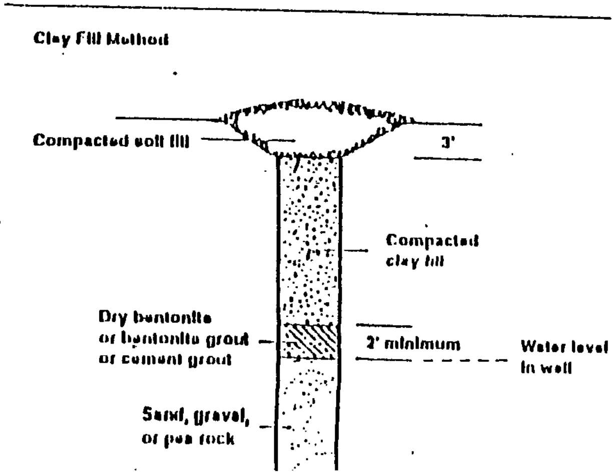
2 - Remove the top 3 feet of well casing and fill remaining hole with compacted soil.

<u>Alternative method</u> (if well has low artesian pressure):
1 - Fill the well from the bottom to within 8 feet of the surface with bentonite grout and tremie line.

2 - Fill the next 5 feet with cement grout.

3 - Remove the top 3 feet of well casing and fill remaining hole with compacted soil.

Figure 1. Plugging wells in unconfined aquifers.



ATTACHMENT H

Abandoned Wells Sealed with Project Assistance

Tri-County Wells
Codington, Deuel and Hamlin Counties

Landowner	Total Cost	Match	Grant $
Moore, Ray (6)	$2,155.60	$538.88	$1,616.72
Sanderson, Bill	$360.50	$90.12	$270.38
Deuel County	$408.40	$102.10	$306.30
Oleson, Martin	$347.50	$86.87	$260.63
Stohr, LeRoy (2)	$803.75	$200.94	$602.81
Wurster, Glenda (5)	$1,743.80	$435.94	$1,307.86
Hofman, Roger (2)	$743.25	$185.81	$557.44
Cafourek & Purdy (3)	$1,112.00	$278.00	$834.00
Hamann, Herb	$364.10	$91.02	$273.08
Boeder, Gerald	$361.91	$90.48	$271.43
Foley, Vince	$358.40	$89.60	$268.80
Foley, Vince	$400.00	$100.00	$300.00
Foley, Vince	$297.00	$74.25	$222.75
Rau, Rodney	$369.00	$92.25	$276.75
West, Harold	$400.00	$100.00	$300.00
Bemis Church	$358.51	$89.63	$268.88
Hofman, Roger	$325.99	$81.50	$244.49
Lutz, Jim	$358.80	$89.70	$269.10
Wiekamp, Wendell	$400.00	$100.00	$300.00
VanLiere, Ray	$400.00	$100.00	$300.00
Olerud, Harlan	$381.60	$95.40	$286.20
Broksieck, Clarence (2)	$764.91	$191.23	$573.68
Krause, Lonnie (2)	$800.00	$200.00	$600.00
Holt, Dale	$374.65	$93.66	$280.99
Bjerke, Loren	$389.60	$97.40	$292.20
Krause, LeWaine	$374.80	$93.70	$281.10
Rau, Rodney (Demonstration Site)	$567.30	$0.00	$567.30
Davis, Stan (Demonstration Site)	$433.50	$0.00	$433.50
Gauger, Myron (Demonstration Site)	$441.50	$0.00	$441.50
Bjorklund, Loren (Demonstration Site)	$461.50	$0.00	$461.50
	$17,057.87	$3,788.48	$13,269.39

Mellette and Todd Counties

Landowner	Total Cost	Match	Grant $
Jons, Richard	$350.08	$87.58	$262.50
Valburg, Dan	$352.00	$88.00	$264.00
Valburg, Dan	$362.50	$90.62	$271.88
Valburg, Dan	$368.25	$92.06	$276.19
Newbold, Levi	$436.00	$136.00	$300.00
Newbold, Levi	$309.25	$77.31	$231.94
Newbold, Levi	$432.50	$132.50	$300.00
Newbold, Levi	$352.00	$88.00	$264.00
Newbold, Levi	$421.00	$121.00	$300.00
Newbold, Levi	$355.00	$88.75	$266.25
Newbold, Levi	$351.50	$87.87	$263.63
Horsely, Les	$500.50	$200.50	$300.00
Horsely, Les	$497.50	$197.50	$300.00
Stanley, Mary	$374.92	$93.73	$281.19
Ryno, Bert	$354.00	$88.50	$265.50
Ryno, Bert	$351.50	$87.87	$263.63
Bruning, Hollis	$351.83	$87.96	$263.87
Bruning, Hollis	$352.08	$88.02	$264.06
Kingsbury, Ken	$353.08	$88.27	$264.81
Kingsbury, Ken	$361.45	$90.36	$271.09
Chamberlain Inc.	$640.50	$340.50	$300.00
Chamberlain Inc.	$458.90	$158.90	$300.00
Chamberlain Inc.	$370.30	$92.57	$277.73
Chamberlain Inc.	$364.40	$91.10	$273.30
Bouman, Ron	$374.50	$93.62	$280.88
Bouman, Ron	$361.00	$90.25	$270.75
Bouman, Ron	$375.00	$93.75	$281.25
Bouman, Ron	$367.75	$91.94	$275.81
Bouman, Ron	$394.50	$98.62	$295.88
Bouman, Ron	$361.50	$90.37	$271.13
Krogman, Dan	$388.00	$97.00	$291.00
Massingale, Beatrice	$362.57	$90.65	$271.92
Massingale, Beatrice	$370.20	$92.55	$277.65
Massingale, Beatrice	$369.18	$92.30	$276.88
Dimond, Ronald	$368.70	$92.18	$276.52
Dimond, Burton	$370.41	$92.61	$277.80
Bruning, Hollis	$372.86	$93.22	$279.64
Bruning, Hollis	$361.41	$90.36	$271.05
Schmidt, Melvin	$287.97	$77.50	$210.47
Schmidt, Melvin	$283.16	$77.50	$205.66
Fronek, Robert	$378.37	$94.60	$283.77
Holmes, Wayne	$289.16	$77.50	$211.66
Holmes, Wayne	$303.78	$77.50	$226.28
Dunn, Barry	$289.82	$77.50	$212.32
Dunn, Barry	$291.15	$77.50	$213.65
Dunn, Barry	$332.89	$83.23	$249.66
	$17,074.92	$4,737.72	$12,337.20

ATTACHMENT I

Project Budget Summary

Abandoned Well Sealing Demonstration Project
Final Budget Summary

Work Item	Original Budget	Project Total	Sources EPA	CWFCP	GRPEP	EDWDD	Landowner
Conservation District Staff Tim	$4,500.00	$7,363.60	$5,104.65			$2,258.95	
Conservation District Travel	$1,200.00	$590.18	$590.18				
EDWDD Staff Time (2)	$6,300.00	$7,909.93	$5,483.39			$2,426.54	
EDWDD Travel	$200.00	$387.29	$387.29				
Well Sealing							
AWS Cost-Share (3)	$40,000.00	$32,228.99	$4,154.29	$8,221.50	$11,327.00		$8,526.20
AWS Demonstration (4)	$1,800.00	$1,903.80	$1,903.80				
Publications (5)	$0.00	$376.40	$376.40				
Indirect Costs (6)	$1,000.00	$1,581.99				1581.99	
Project Totals	$55,000.00	$52,342.18	$18,000.00	$8,221.50	$11,327.00	$6,267.48	$8,526.20

1 - Tasks 1, 3 and 4 (AWS Technical Assistance)
2 - Tasks 2, 3, 5, 6 and administration
3 - Task 4
4 - Task 3c
5 - Task 3b
6 - 20% of EDWDD salary & benefits