



Rural Wellhead Protection Fact Sheet

WELL CONSTRUCTION

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INTRODUCTION

Domestic water wells that are not constructed properly pose a threat to the quality of your drinking water and may even threaten your neighbor's water supply. Well construction must meet applicable specifications. Wyoming does not have a licensing board to certify well drillers; therefore, it is the property owner's responsibility to have their well driller comply with proper design specifications when drilling a new well. While it may be less expensive to construct a well that is not within specifications, the potential cost to correct a groundwater contamination problem caused by improper well construction far outweighs the cost of having a new well designed and constructed properly.

REGULATIONS

Two state agencies have regulations pertaining to construction specifications for water supply wells. The Wyoming State Engineer's Office provides well design requirements in their Regulations and Instructions, Part III, Water Well Minimum Construction Standards. It is the joint responsibility of the owner and the well driller to comply with the requirements presented in the SEO Construction Standards. A copy of the document can be obtained from the State Engineer's Office in Cheyenne ((307) 777-7354).

The Department of Environmental Quality, Water Quality Division (WDEQ/WQD) does not regulate the construction of domestic wells, but Chapter 11, Part G, and Chapter 12, Section 9 of Wyoming Water Quality Rules & Regulations apply to the construction of monitoring wells and public drinking water supply wells, respectively. The WDEQ/WQD can be contacted to obtain a copy of these regulations at (307) 777-7781. The WDEQ/WQD regulations do not govern the construction of domestic wells, but it is highly recommended that the well construction design complies with these regulations to help prevent groundwater contamination.

TYPES OF WELLS

Dug Wells

Wells are constructed by various methods varying from hand dug wells to drilled wells. Dug wells pose the greatest potential for causing groundwater contamination, because they are usually shallow and poorly protected from surface water. If you are in the process of constructing a new well, installing a dug well is strongly discouraged. Many existing wells in Wyoming are dug wells because they are inexpensive to construct. If you have a dug well and you question whether the well is adequately protected from surface water, it is highly recommended that you replace it with a drilled well. Properly constructed dug wells are shown in **Figure 1** and

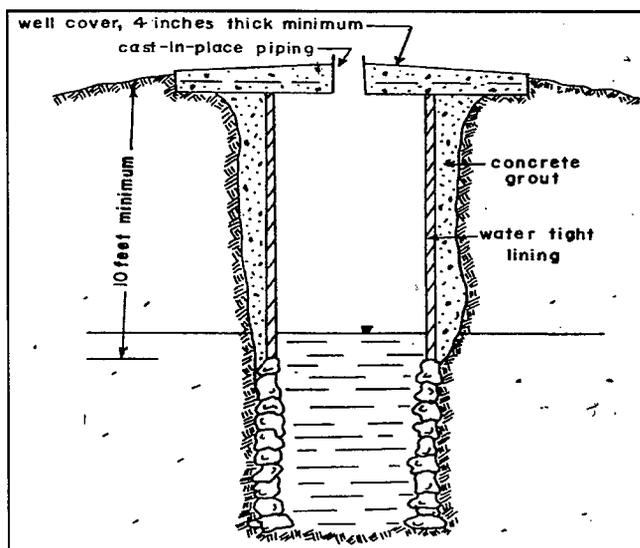


Figure 1. Standard Dug Well Construction

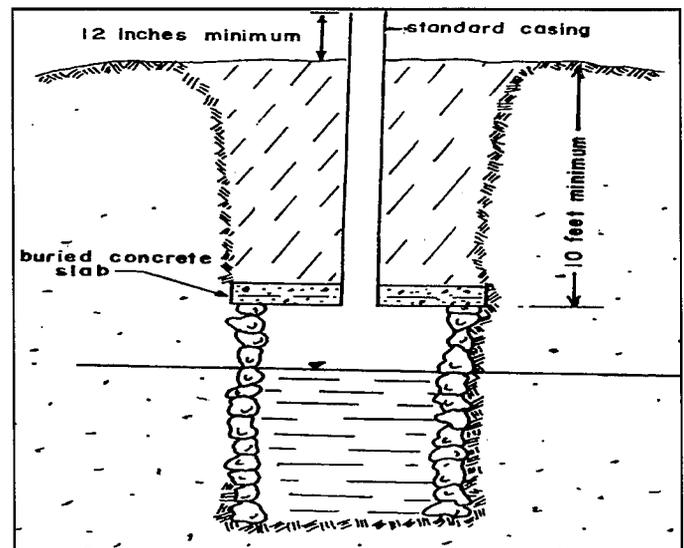


Figure 2. Buried Slab Dug Well Construction

Figure 2. Proper procedures for plugging and abandoning wells are described in the **Well Plugging Fact Sheet**.

Well Points

Well points or sand points are pipes with a point and well screen attached to one end which can be lengthened by assembling additional lengths of pipe. The well point is driven into the ground to the desired depth below the water table. These wells are usually installed in areas of consolidated sands and gravels where groundwater is shallow. Well points need to be protected from surface water contamination by the installation of surface seals.

Drilled Wells

Water wells that are constructed by drilling are much less likely to contaminate your water supply than dug wells or well point; however, shallow drilled wells can be susceptible to contamination. Well design and construction needs to comply with the specifications described below.

CONSTRUCTION STANDARDS

Surface Seals

Wells need to be sealed at the ground surface to reduce the risk of surface water carrying bacteria, pesticides, fertilizers, oil products, or other contaminants to your drinking water supply. If the well casing rises above ground surface, a cement pad is required at the ground surface. The correct completion of the surface seal is shown for (loose) unconsolidated and consolidated (rock) aquifers in **Figure 3**. A cement or bentonite grout seal needs to extend at least 10 ft. deep; greater depths are highly recommended. The cement pad must be sloped away from the well at the surface. A surface casing can be installed as shown for the gravel packed well in **Figure 4**. Well caps are required on any type of water supply well and they should remain locked.

As shown in **Figure 4**, the top of the well casing should extend at least 1 ft. above the ground surface and should not lie within a pit or a low topographic area. A pitless adapter (**Figure 5**) is highly recommended for domestic wellheads. By design, pitless adapters will considerably reduce the potential for surface water entering the well. As shown in **Figure 5**, the pitless adaptor connects to the top of the casing and provides a subsurface connection for the pump discharge or suction lines between the top of the casing and pressure tanks. The lines are installed below the frost line as shown in **Figure 5**. Access for maintenance is still possible by removing the well cap at the wellhead.

Subsurface Seals

In addition to sealing the well at the ground surface,

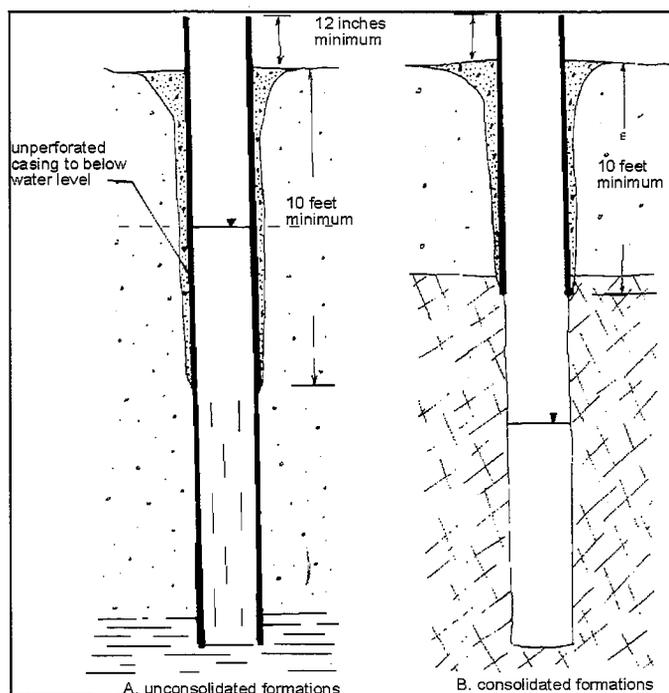


Figure 3. Construction of Wells in Unconsolidated and Consolidated Formations

subsurface seals are needed to seal the annular space between different geologic and/or aquifer units. The annular space is the area between the sides of the drilled boring and the well casing that is placed in the hole. Annular seals should be placed where confining layers are present to prevent mixing of water from different aquifers. Confining layers are geologically impermeable formations where the water will not readily travel (i.e., claystone, shale, other unfractured bedrock formations). The correct completion of the annular space is shown for (loose) unconsolidated and consolidated (rock) aquifers in **Figure 3**.

Sealing of the Annular Space

As shown in **Figure 4**, the boring diameter needs to be a minimum of 6 in. greater in diameter than the casing diameter to provide 3 inches of annular space. It is very important that the annular space be sealed off at the surface and at specific depths in the drilled hole. The main purpose of the annular seal is to prevent the threat of surface water and/or shallow groundwater flowing down alongside of the casing and contaminating the water supply. In addition, the annular seal provides the following protection to the casing: 1) prevents casing corrosion; 2) assures structural integrity of the casing, and 3) stabilizes the upper formation.

It is common for well drillers to install pea size gravel or other porous materials in the annular space from the bottom of the well to near the ground surface. This common practice of well construction, called "gravel packing",

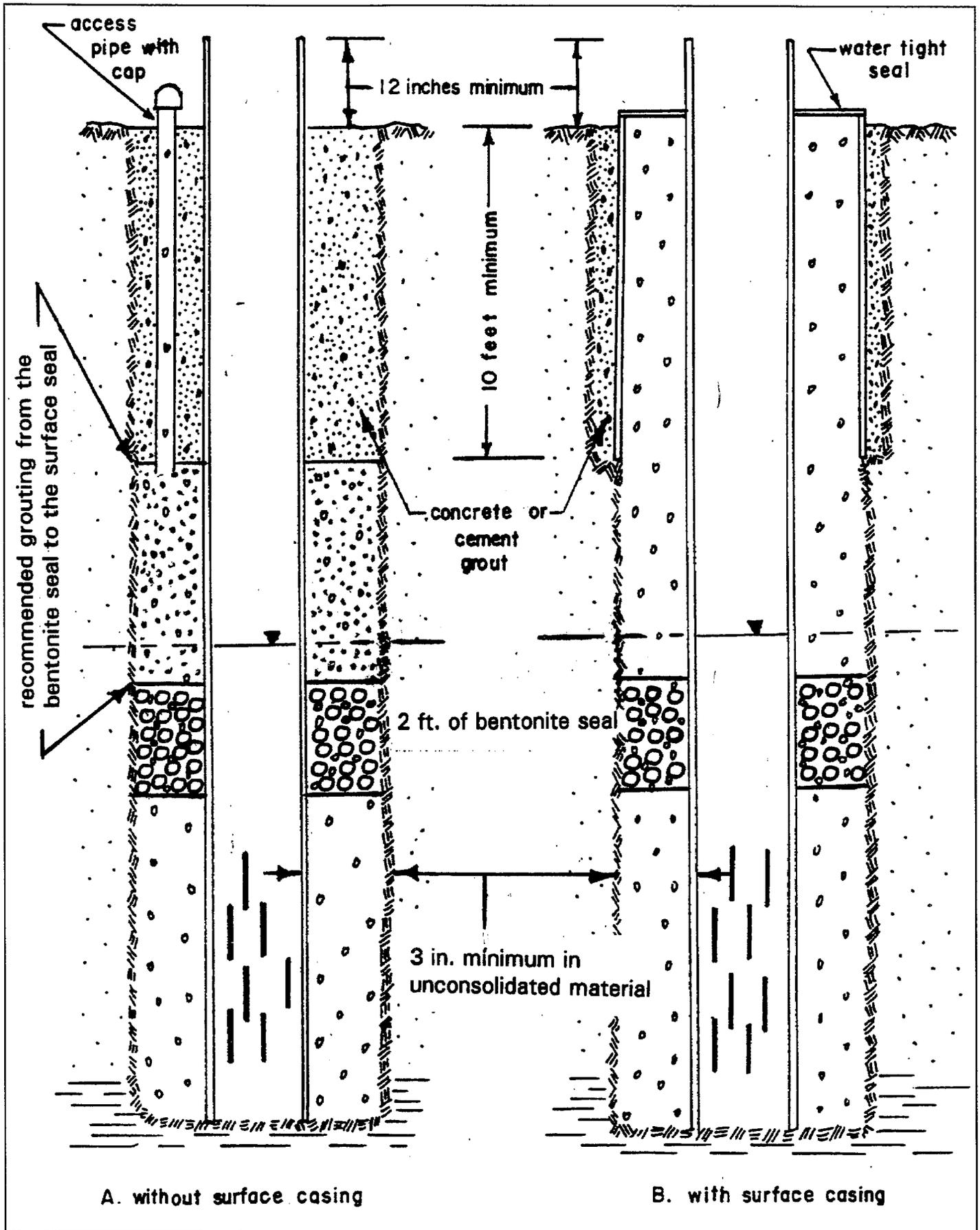


Figure 4. Typical Construction Details of Wells with and without Surface Casing

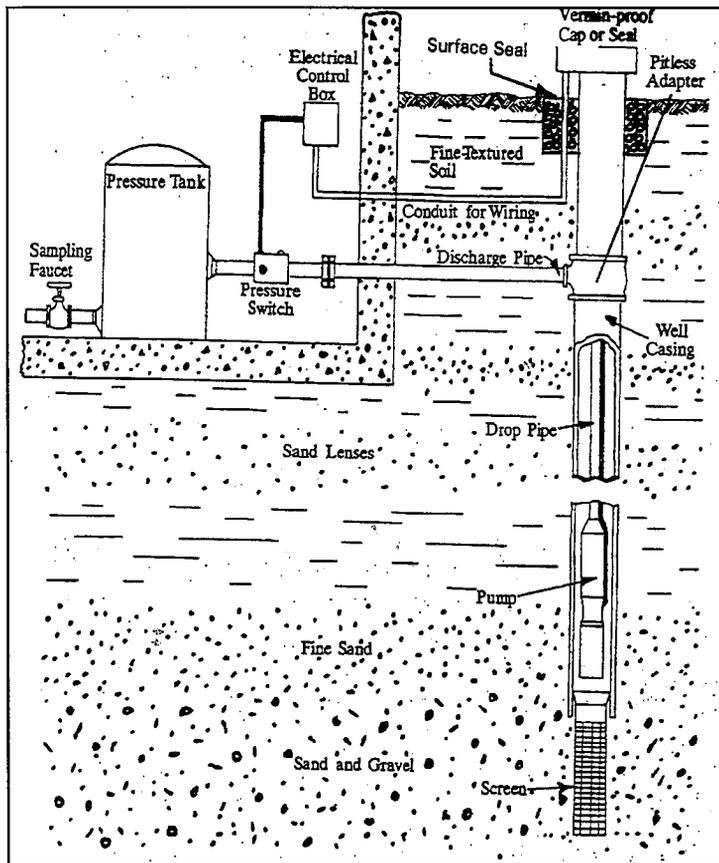


Figure 5. Typical Well Installation with Pitless Adapter

significantly increases the likelihood that contamination from surface water or shallow groundwater will flow down alongside the casing and contaminate your water supply.

To prevent this risk, an impermeable grout material (i.e., neat cement, concrete, sand-cement, bentonite clay) should be placed in the annular space as a sealing material. The sealing material should fill the annular space and the surrounding void spaces which may absorb the sealing material. As shown in **Figure 4**, a 2 ft. bentonite plug or seal is recommended at the top of the gravel or filter pack. The filter pack should extend approximately 1 - 2 ft. above the well screen or casing perforations. It is recommended that an impermeable grout be placed from the depth of the bentonite seal up to the depth of the surface seal. Depending on the depth of the well, it may not be economically feasible to grout the full length of the annular space, but the grout should extend from the bentonite plug up to the shallowest depth possible.

As shown in **Figure 6**, a seal for the annular space is also required in any wells that penetrate more than one aquifer or water bearing formation. As described in WDEQ/WQD Regulations, wells must be screened or perforated to produce from only one unique aquifer or

water bearing formation. All other aquifers (inferior quality water, etc.) must be sealed off. The seal in the annular space should extend at least 10 ft. below and above inferior water bearing formations and into the impermeable zones. **Figure 7** illustrates the annular seal that is required in the impervious zone located above an artisan water bearing formation.

In areas of the state where nitrate contamination has been identified in groundwater in alluvial valleys, such as the North Platte River Valley and Salt River (Star) Valley, the placement and integrity of the annular seal is very important. In general, drilling and screening the well as deep as possible in alluvial aquifers will decrease the likelihood that nitrate contamination will be present in drinking water because nitrate contamination tends to be stratified and lower in concentration at deeper depths in alluvial aquifers. Therefore, domestic water supply wells in alluvial aquifers should be drilled to the deepest depth of the yielding aquifer that is economically feasible. In alluvial valleys the deepest depth is normally the depth to bedrock. Wells should be screened at the bottom of the well, and it is highly recommended that the annular seal extend from the filter pack up to the surface seal.

Well Screens & Casings

Well casings and screens need to comply with the State Engineer's Office and WDEQ/WQD regulations. A

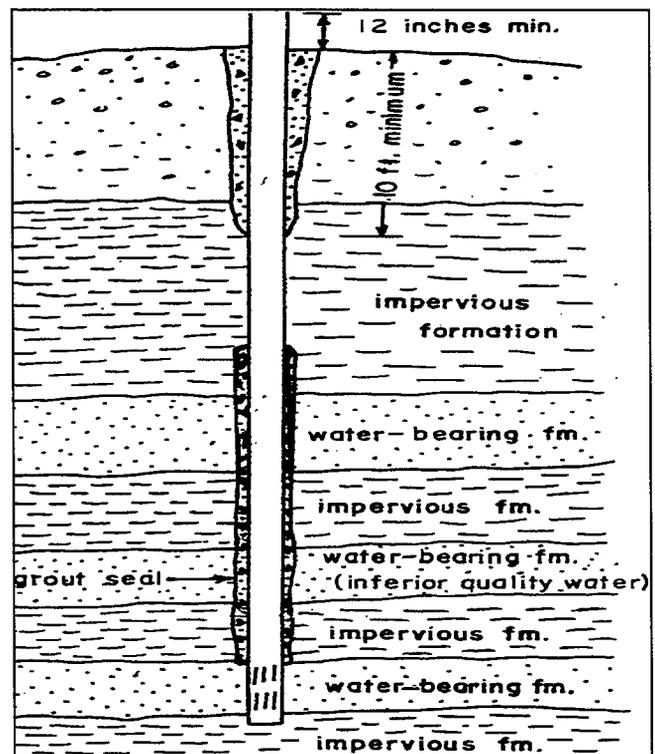


Figure 6. Construction of Well Encountering Multiple Water-Bearing Zones

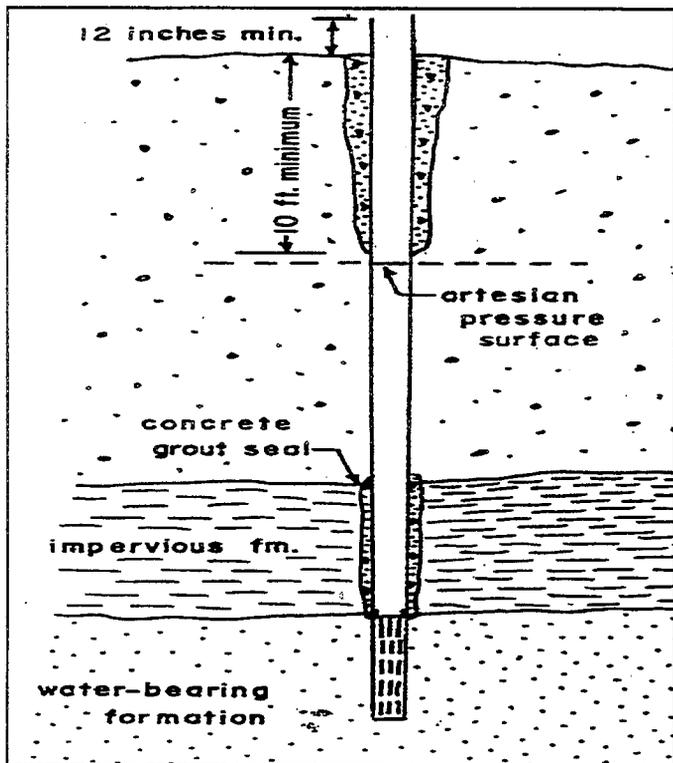


Figure 7. Construction of Well Encountering Artesian Water

polyvinyl chloride (PVC) or metal pipe with saw blade cuts should never be utilized as a well screen; rather, a manufactured well screen or factory slotted pipe should be installed. The size of gravel pack or filter pack materials should be based upon a sieve analysis of the aquifer material, and the size of the openings in the screen should be compatible with the filter pack size. This will allow the filter pack to prevent all but the finest aquifer material from entering the well, filter out suspended solids in the pumped water, and increase well yield.

How to check whether an existing well is properly constructed

The annular seal, surface seal, and casing of an existing well may not be adequate. The top of the casing may be easily checked by visually inspecting for holes or cracks on the outside of the casing above the ground surface and inside the well casing with a light. If the casing moves when it is pushed from the side, the casing may be cracked, and the annular seal and/or surface seal needs to be repaired or replaced. In unconsolidated formations, if you can hear water running in the well when the pump is turned off, the casing may be cracked or may not extend to the water level in the well. In either case, the casing needs to be replaced. If you can not find the completion information for your well, the records may be requested from the Wyoming State Engineer's Office((307) 777-7354). The

Statement of Completion and Description of Well, Form U.W. 6, should include a well driller's borehole log and the as-built completion details. You need to review these completion details to determine whether your well is properly constructed to reduce and prevent the threat of contamination.

Contacts

Wyoming Dept. of Environmental Quality, Water Quality Division, 122 W. 25th St. 4W, Cheyenne, WY 82002, (307)777-7781.

Wyoming State Engineers Office, 122 W. 25th St. Herschler Bldg., 4E, Cheyenne, WY 82002, (307)777-7354.

Geological Survey of Wyoming, P.O. Box 3008, University Station, Laramie, WY 82071-3008, (307)766-2286.

U.S. Geological Survey, Water Resources Division, 2617 E. Lincolnway, Cheyenne, WY 82007, (307)772-2153.

U.S. Environmental Protection Agency, Region VIII, 999 18th St., Suite 500, Denver, CO 80202-2466, 1-800-227-8917.

University of Wyoming Water Resources Center, P.O. Box 3067, University Station, Laramie, WY 82071-3067, (307)766-2143.

RURAL WELLHEAD PROTECTION WORKSHEET

WELL CONSTRUCTION

Assessing the Construction of Your Water Supply Wells

Summarize the wells on your ranch/farmstead by filling the information in the blanks provided. Include all known wells on your property, whether they are active, not being used, or abandoned.

DRINKING WATER WELLS			
Name and Legal Description	Type of Well	Year Constructed	Depth to Water and Total Depth

LIVESTOCK WELLS			
Name and Legal Description	Type of Well	Year Constructed	Depth to Water and Total Depth

IRRIGATION WELLS			
Name and Legal Description	Type of Well	Year Constructed	Depth to Water and Total Depth

Answer the following questions for each well identified on page 1 of this *Worksheet*.

Surface Water Protection

Yes **No** **Don't Know**

- | | | | |
|--|-------|-------|-------|
| 1. Does your well have an adequate surface seal? | _____ | _____ | _____ |
| 2. Does the cement cap slope away from the casing? | _____ | _____ | _____ |
| 3. Does surface water pond near your wellhead after precipitation events or after spilling water (i.e., when filling water tanks, etc.)? | _____ | _____ | _____ |
| a. Does the surface water or spilled water seep down along the well's casing? | _____ | _____ | _____ |
| 4. Can you move your casing by gently pushing it from the side? | _____ | _____ | _____ |

Well Casing

- | | | | |
|---|-------|-------|-------|
| 5. Does your well casing extend approx. 1 ft. above the ground surface? | _____ | _____ | _____ |
| 6. Does your well casing contain any holes or cracks when inspecting the inside with a light and inspecting the outside of the casing above the ground surface? | _____ | _____ | _____ |
| 7. Can you hear water running down inside your well when the pump is turned off? | _____ | _____ | _____ |

Surface Completion Features

- | | | | |
|---|-------|-------|-------|
| 8. Is your well located in a pit or topographic low area? | _____ | _____ | _____ |
| 9. Does your well have a pitless adapter? | _____ | _____ | _____ |
| 10. Does your well have a permanent cap? | _____ | _____ | _____ |

Site Conditions

- | | | | |
|---|-------|-------|-------|
| 11. Is your well artisan (free flowing) at the surface? | _____ | _____ | _____ |
| 12. Do you have a copy of the Wyoming State Engineer's Office U.W. 6 Form, <i>Statement of Completion and Description of Well</i> for each well listed on page 1 of this <i>Worksheet</i> ? | _____ | _____ | _____ |
| 13. Do you have the well driller's borehole log? | _____ | _____ | _____ |

Answer the following questions for each well identified on page 1.

Adequate Well Construction

Yes

No

Don't Know

14. Do you have the Completion Detail of the Well?
(i.e., drawing or description of how the well was built)

If yes, review the completion information to answer the following:

a. What is the total depth of your well?

_____ ft.

b. What is the depth of the well screen or casing perforations?

_____ ft. to _____ ft.

c. What is the length of the surface seal?

_____ ft.

d. What is the length and width of the annular seal?

_____ ft. long _____ in. wide

e. What volume of seal material was placed in your well?

_____)

f. What type of seal material was installed in the annular space of your well? (circle one)

sand or neat cement
concrete
bentonite(clay)
drilling mud or drill cuttings
other _____

g. What type of screen was installed in your well?
(circle one)

_____ manufactured
saw blade cuts in casing
other _____

h. What type(s) of filter pack material was installed in your well? (circle one)

pea size gravel
native formation materials
graded sand (based upon sieve analysis)
other _____

EVALUATION OF WORKSHEET ANSWERS

Type and Age of Wells

It is highly recommended that hand dug drinking water wells be replaced with a properly constructed drilled well, because dug wells are difficult to protect from contaminated surface water. Also, older wells (i.e., 20 - 30 years old or older) that have not been properly maintained may need to be replaced. Any of the old or abandoned wells listed on page 1 of this worksheet that are no longer in use need to be properly plugged and abandoned to prevent potentially contaminated surface water from entering the well. Please refer to the **Plugging Abandoned Wells Fact Sheet** for additional information.

Surface Water Protection

If you answered yes to 3 and 3.a or 4, the groundwater near your wellhead may be threatened by contaminated surface water. At a minimum, a cement cap needs to be installed at the wellhead. Berms may need to be installed around the wellhead to direct surface water runoff away from the well.

Well Casing

If you answered yes to 6 or 7, the well casing may need to be replaced. Drilling a new well may be easier and more economical than attempting to repair an existing well.

Surface Completion Features

If you answered yes to 8 and the wellhead does not have a pitless adapter, your well may be threatened by contaminated surface water. A pitless adaptor may need to be installed, or a watertight roof and a berm should be built to direct rain and runoff away from the wellhead. The well may need to be moved if it's present location is being significantly impacted by potentially contaminated surface water.

Site Conditions

The Wyoming State Engineer's **U.W. 6 Form**, *Statement of Completion and Description of Well* should be reviewed to determine whether your well is adequately constructed. The **U.W. 6 Form** may include the well driller's borehole log. The borehole log should be reviewed to determine the local geologic conditions where the well is located.

Adequate Well Construction

The length of the surface seal (14.c) in your well should extend 10 ft. below the ground surface. The annular seal (14.d) above the filter pack should be at least 3 in. wide and 2 ft. long. If the seals in your well are significantly smaller in size, or were not installed, your well is not

adequately protected from contamination. If drill cuttings or drilling mud (14.f) were used as seal material, the seal is not adequate. A concrete grout or bentonite (clay) is needed for sealing the annular space. If your well screen (14.g) consists of saw blade cuts in the plastic or metal pipe, and the filter pack materials (14.h) were not sized correctly, the well pump and screen may be threatened by damage due to plugging, biofouling, incrustation, or corrosion. The repair of these problems is expensive, and should only be attempted by a qualified well technician. It may be more economical to drill a new well.