Tech Brief

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Preventing Well Contamination

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Summary

Nearly 80 percent of communities rely on groundwater as their primary drinking water source. Wells extract groundwater for use in homes and businesses. In addition, about 42 million Americans use private wells for drinking water. In light of this information, preventing groundwater contamination is of utmost importance, especially since a number of factors can contribute to groundwater contamination. To prevent well contamination, one of the first steps is to construct it properly. This Tech Brief presents tips about how to site a well and includes information about design issues; material selection and location, such as screens and filter pack; appropriate well sealing methods; and the use of pitless adaptors to prevent contamination.

Introduction:
To prevent well contamination, one of the first steps is to construct it properly. This tech brief presents tips on siting a well, its design, choosing proper materials, proper location of screens, filter pack and appropriate method of sealing a well and use of pitless adaptors to prevent contamination.

Site Selection

To prevent groundwater contamination, the first step is to locate the well so that surface water and contaminants cannot flow into it. Site engineers try to install the well uphill from any potential contamination source. This means avoiding potential pollution sources, such as industrial plants, home septic systems, landfills, and underground storage tanks. Hiring a qualified hydrogeologist to investigate potential contaminant sources and likely subsurface conditions makes locating a well easier.

For most private wells, the primary contaminant source is the owner's septic system. The best protection practice is to locate the well above the area where contaminants can enter it, usually about 50 to 100 feet away. In addition, install a surface seal into a fine-grained layer or non-fractured zone above the aquifer.

To prevent water from collecting near the casing, the ground surrounding the well should slope away from the wellhead on all sides. In addition, most states regulate how far a well must be located from potential contamination sources. For instance, most states require that wells be a minimum of 50 feet away from a septic system.

Well Design

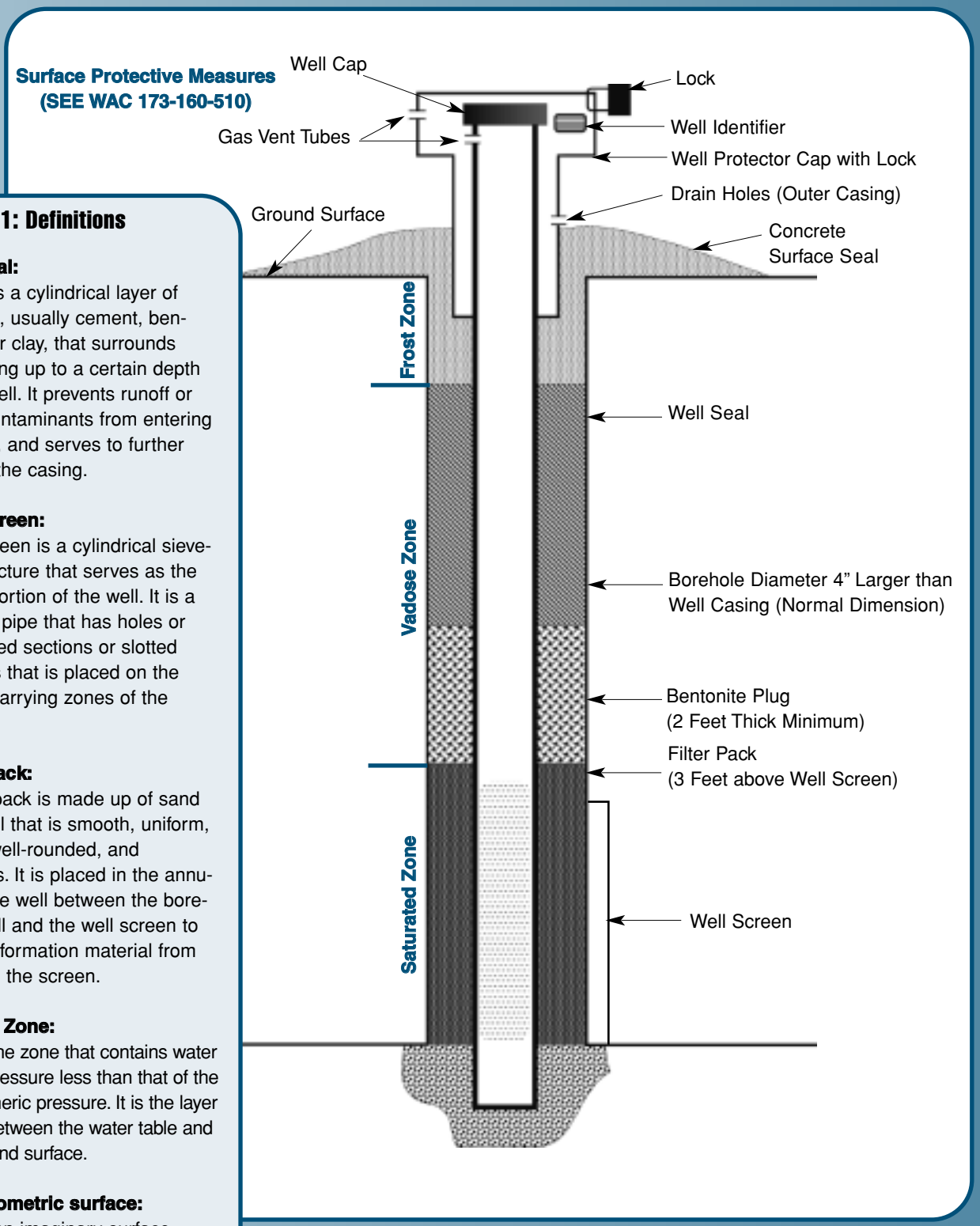
Proper selection of well casings, seals, screens, filter packs, and pump chamber casings are important factors that determine the efficiency of the well and prevent contamination. ***Figure 1*** shows the components of a well that prevent pollutants from entering the well. Most states have well construction standards and permitting processes that must be followed. The American Water Works Association has a standard A100-90 that deals with construction design.

Casing

A casing is a pipe that is usually made of steel or plastic. It lines the borehole dug in the earth and keeps the well from caving in and prevents runoff and other material from getting into the well.

When contactors select casing, they must take into account the forces that are exerted while installing. In addition, the surrounding materials, such as soil and rocks, tend to collapse into the hole. If possible, the driller should use a temporary casing for the borehole. The temporary casing diameter must be at least four inches larger than the permanent casing to provide sufficient space for a good well seal.

Figure 1: General Resource Protection Well–Cross Section



Adapted from *Groundwater and Wells, Second Edition* by Fletcher G. Driscoll, Ph.D.

Figure 1: Definitions

Well seal:
A seal is a cylindrical layer of material, usually cement, bentonite, or clay, that surrounds the casing up to a certain depth in the well. It prevents runoff or other contaminants from entering the well, and serves to further protect the casing.

Well Screen:
Well screen is a cylindrical sieve-like structure that serves as the intake portion of the well. It is a metallic pipe that has holes or perforated sections or slotted sections that is placed on the water- carrying zones of the aquifer.

Filter pack:
A filter pack is made up of sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation material from entering the screen.

Vadose Zone:
This is the zone that contains water under pressure less than that of the atmospheric pressure. It is the layer of soil between the water table and the ground surface.

Potentiometric surface:
This is an imaginary surface representing the total head of groundwater in a confined aquifer that is defined by a level to which water will rise in the well.

The American Society for Testing and Materials, the American Petroleum Institute, and the American Iron and Steel Institute have specifications for casings. Most state standards require steel casing of a specified wall thickness for wells, whether for a community or private individual.

The diameter of the casing must leave enough room to install the submersible pump and still have space for maintenance. The size of the pump depends upon the desired well yield.

Casing depth also helps prevent well contamination. Logs of any other nearby wells and the local geology can help determine how deep the casing should go. The casing should extend at least 12 inches above the ground for sanitary protection. Reducing the casing's diameter requires a minimum of eight feet of casing overlap. A watertight well cap should be placed on top of the casing. The Water Systems Council (WSC) has standards for well caps and other well components.

Well Screen

A well screen is a cylindrical sieve-like structure that serves as the intake portion of the well. It is a metallic pipe that has holes or perforated sections or slotted sections that is placed on the water carrying zones of the aquifer. Proper selection, design, placement, and development of the screened section are very important and determine the well's efficiency and yield.

Since certain sections of the ground are more porous than others and, hence, carry more water, placing the screens in these sections will yield higher flow rates. By looking at the data collected during drilling, a good well driller can locate and place the screen in the proper zones.

To better understand conditions at the site, use borehole geophysical logs to grasp the subsurface conditions. In addition, visual inspection of the cuttings or samples can show if the layers of earth are sandy, coarse, or clayey. And to help determine well yield, use sieve analysis and hydraulic conductivity tests.

Filter Pack

A filter pack is typically made up of sand or gravel that is smooth, uniform, clean, well rounded. It is placed in the area between the borehole wall and the well screen to prevent formation material from entering the screen.

To enhance the permeability of the zone surrounding the screen, place a filter pack around it. A good filter pack keeps sediment out and decreases friction losses around the screen and is especially important if the aquifer consists of uniform fine sand. A filter pack allows for larger openings in the screen and improves well yield. To install a filter pack, start from the bottom of the screen, filling in to at least three feet above the top of the screen. Domestic wells do not require a filter pack.

Well Seals

The most important components that prevent contaminants from entering the well are well seals. A seal is a cylindrical layer of material, usually cement, bentonite, or clay, that surrounds the casing up to a certain well depth. It prevents runoff or other contaminants from entering the well and serves to further protect the casing. The drilled hole must be four inches larger in diameter than the outer diameter of the casing so that the seal can be placed in the space between casing and the hole.

Well construction standards specify the material that well installers must use to seal the well, as well as the depth to which the well is grouted. Typically, public water supply wells are grouted to a depth of 50 feet. A cement slurry is pumped in the ring-shaped space between casing and hole and the well is sealed from the bottom up. Grout is placed using a small diameter pipe called a tremie. A layer of bentonite two feet thick should be placed on top of the filter pack.

Pitless Adaptors

Pitless adapters and pitless units are devices that attach to the well casing below the frost line and provide sanitary connections. They prevent entry of contaminants into the well near the surface. These devices provide access to the well for servicing. The adapter connects the casing with a horizontal line that supplies water through a removable seal joint. This connection allows the drop pipe and pumping equipment in the well to be easily removed for repair or maintenance work without digging the ground around the well.

WSC has performance standards for pitless adapters, pitless units, and watertight well caps. A list of manufacturers that meet those standards can be obtained from the WSC.

Disinfection Procedures

Well installers must disinfect all equipment and tools using a chlorine solution before any drilling operation to prevent bacterial contamination. The well must be disinfected after it's completed. Some types of bacteria, such as *E. coli*, are found in soils and can contaminate the well. By dissolving calcium hypochlorite or sodium hypochlorite, installers can make a chlorinated water solution. The strength of the solution can range from 50–200 milligrams per liter of available chlorine.

Where can I find more information?

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National Ground Water Association, Westerville, OH: NGWA. (*www.ngwa.org*)

Water Systems Council, National Programs Office, Washington, DC: WSC. (*www.wellcarehotline.org*)

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