Good Wells for Safe Water

A reliable supply of safe drinking water is important to everyone. Nearly 800,000 Iowans living in the countryside and in small communities rely on private wells as their primary source of water. Many of these wells do not supply safe water. Construction defects and deterioration are often to blame.

The best defenses against well contamination are good construction, periodic inspection and maintenance, and regular water testing (at least once a year). Construction features that help to ensure sanitation are described here, in detail, to assist in planning new wells or inspecting and repairing existing ones.

Does your well provide safe water?

It is not known exactly how many private wells are being used in Iowa or how many of these deliver safe water. However, we do know that a substantial portion of the water samples voluntarily submitted to the State Hygienic Laboratory by private well owners do not meet recommended standards for safe drinking water. Of nearly 10,000 private water supply samples submitted annually, approximately 40 percent show unsafe bacterial content and 15 to 20 percent exceed the maximum recommended level for nitrate in drinking water.

For further information on water quality and testing, see *Sampling Your Drinking Water*, Iowa State University Extension publication Pm-1335.

Well contamination—Occurrence and prevention

Whether planning a new well or upgrading an existing one that tests unsafe, prevention of well contamination requires some basic understanding of how it occurs. Once the nature of well contamination is understood, the protective measures required are more easily understood.

Soil is nature's protection against groundwater contamination

Most of the well contaminants that commonly cause concern originate above ground, often as the result of human activities. Disease causing bacteria and viruses, pesticides, fuels, and industrial chemicals are examples of pollutants that can contaminate a groundwater supply. Spills and careless storage or use of chemicals, and poor treatment and disposal of waste materials are often to blame.

Soil overlaying the water table provides the primary protection against groundwater pollution. Bacteria, sediment, and other insoluble forms of contamination become trapped within the soil pores. Some chemicals are absorbed or react chemically with various soil constituents, thereby

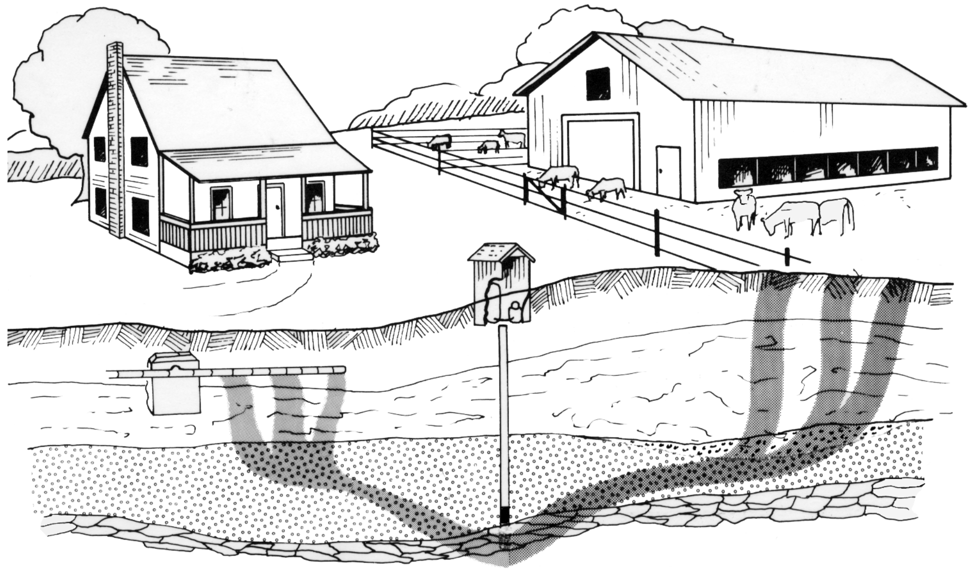

Figure 1. Concentrated sources of pollution can overload the natural filtering capacity of the soil.

Table 1. Minimum recommended separation distance between wells and common sources of groundwater pollution.

Sources of contamination	Minimum lateral distance
Preparation or storage area for spray materials, commercial fertilizers, or chemicals that may result in groundwater pollution	150 feet
Soil absorption field, pit privy, or similar disposal unit	100 feet
Confined livestock feeding facilities; accumulations of manure	100 feet
Septic tank, concrete vault privy, sewer of tightly joined tile, or equivalent materials	50 feet
Cast-iron sewers, independent clear water drains, or cisterns	10 feet
Lagoons and sanitary landfills	1,000 feet
Unused wells that have not been properly plugged	100 feet

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preventing or slowing the migration of these pollutants into the groundwater. In addition, plants and soil microorganisms use some potential pollutants, such as nitrogen, as nutrients for growth, thereby depleting the amount that reaches the groundwater.

Just as any manufactured filtering device can be overloaded, so can the natural filtering capacity of soil. Figure 1 shows how large amounts of potential pollutants concentrated in a small area can cause localized groundwater contamination, depending on the depth and type of soil above the water table.

To help protect water wells against contamination, it is important to use the natural protection that soil provides by maintaining adequate distance between wells and potential sources of contamination. Follow the recommendations in table 1 when locating a new well or when using or storing potential pollutants in the vicinity of an existing well.

Never store or handle fuels or pesticides near a well, see figure 2. Once a chemical enters the groundwater near a well, it can take years for the contamination to dissipate. As a result, a chemically contaminated well usually must be abandoned and a new well constructed in a different location. If water must be used with chemicals, a pipeline should be extended to a work area located a safe distance from the well.

Some areas of the state, particularly in northeastern Iowa, have little or no soil cover. Fractured bedrock lies at or very near the ground surface and surface water enters the water table without adequate soil filtration. Where these conditions exist, extra care must be taken when handling potential pollutants and constructing water wells.

Well design and construction

Well construction begins with drilling an open hole and installing casing to prevent collapse of the bore hole. This provides the desired access to groundwater but also removes the protective soil cover over the groundwater and provides pathways for contaminants to enter the well, as figure 3 shows. Good well design and construction practices incorporate several protective features that block these pathways, thereby reestablishing protection for the groundwater and well, see figures 4 and 5.

These features should be used on every newly constructed well and, to the extent possible, should be applied to reconstruction of existing wells. It may cost a little extra for good construction but a well that is easily contaminated is no bargain!

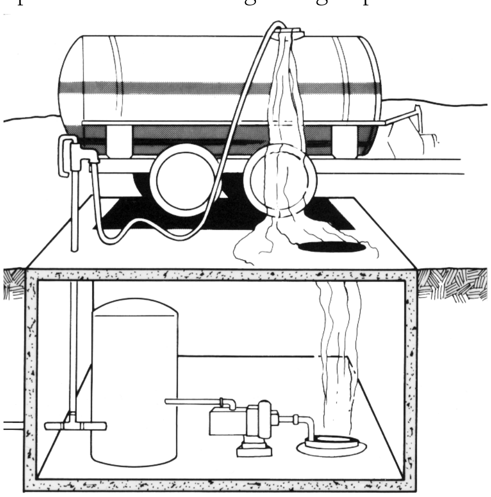

Figure 2. Never store or handle fuel or pesticides near a well.

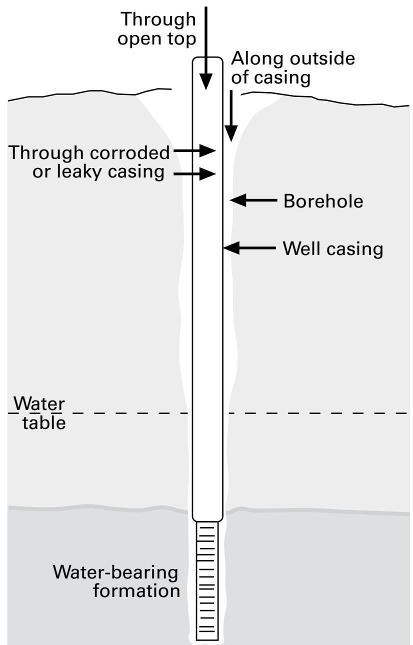

Figure 3. Pathways for contaminants into an unprotected well.

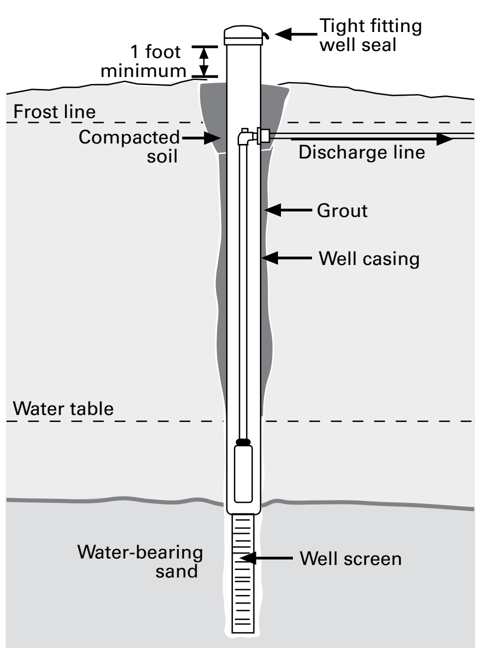

Figure 4. Drilled well tapping waterbearing sand.

General design

Two general types of wells are commonly used for private water supplies in Iowa. Bored wells, commonly constructed using 36-inch-diameter concrete tile casing, are frequently used for domestic and farm supplies in southern Iowa. They are usually less than 100 feet deep and often tap waterbearing sands that yield 5 gallons per minute or less. The large-diameter casing serves as an underground reservoir, storing approximately 50 gallons of water in each lineal foot of casing filled. During peak water-use periods of the day, water is pumped out of storage as needed. Seepage refills the well during periods of low water use.

Drilled wells are commonly constructed with 5- or 6-inch diameter steel or plastic casings. They are used throughout Iowa at depths ranging from 20 feet to more than 3,000 feet. Little water is stored in the small-diameter casing so the pumping rate is limited by the yield capacity of the waterbearing formation. Above-ground storage must be used to meet demands that exceed the well capacity.

Although bored wells have typically been considered more prone to contamination than drilled wells, both types can be adequately protected if the protective features described in the following paragraphs are applied.

Casing

All wells should have at least 20 feet of permanently installed casing This helps to ensure that surface water filters through at least 10 to 20 feet of soil before it enters the well.

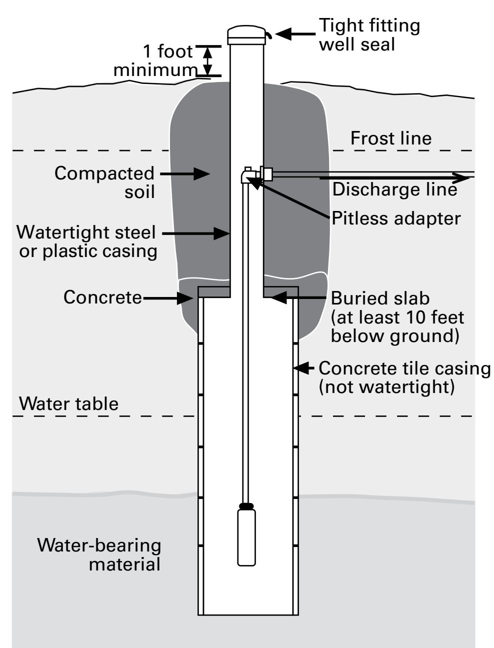

Figure 5. Buried slab design for bored well.

In regions such as northeastern Iowa, where soil cover is thin and upper bedrock layers are heavily fractured, shallow wells are likely to be contaminated. To reduce the risks of contamination, deeper wells are used to draw water from beneath less porous rock layers that are a barrier to downward migration of contaminants (figure 6).

It is essential that casing in at least the upper 10 to 20 feet of soil be watertight. This requires extra precautions when constructing bored wells because concrete tile casing is not watertight. There are several ways to overcome this problem.The recommended method incorporates the buried-slab design shown in figure 5. Concrete tile casing is terminated at least 10 feet below ground and capped with a precast concrete slab. Steel or plastic casing, 6 inches in diameter or. greater, is fitted to the slab and extended above the ground. This not only ensures that the top 10 feet of the well is watertight; it also facilitates use of standard pitless equipment and well caps designed and manufactured for steel or plastic casing.

Top of the well

All wells should extend at least 1 foot above ground or above the highest known water level in areas subject to flooding. Well tops are not generally watertight, so they should not be located below ground in frost pits because this permits direct entry of ponded surface water, chemical spills, or shallow groundwater, see figure 2.

The pump discharge line can be located below frost line without constructing a frost pit by using a pitless adapter, see figure 7. This is a specially designed and gasketed coupling that routes the pump discharge directly through the casing wall. The coupling can be easily disconnected to permit removal and maintenance of pumping equipment and piping.

Existing wells that terminate below ground can have additional casing and a pitless adapter installed to reduce the risks of contaminant entry at the top of the well, see figure 8.

Grout

Space between the outside of the well casing and inside of the bore hole must be sealed to prevent well contamination. A slurry of cement or clay, called grout, is used to seal this space. At least 10 to 20 feet of the upper well casing should be grouted. Casing that extends through fractured rock Iying near the ground surface must be grouted throughout the full depth of the suspected zone of contamination as shown in figure 6. The bore hole diameter should be at least 5 inches greater than the outside diameter of the casing to ensure a good seal of adequate thickness.

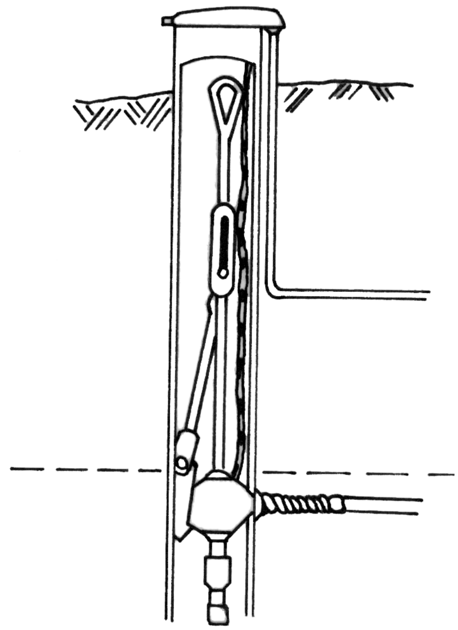

Figure 7. One type of pitless adapter for sanitary discharge of water below the frost line.

Bored wells using the buried-slab design are not grouted since the large diameter bore hole provides adequate room to place thoroughly compacted backfill around the watertight section of casing. Concrete is poured over and around the buried slab before backfilling with compacted soil, as shown in figure 5.

Well seal

A tightly fitting seal or cap should be installed at the top of the casing to prevent dirt, rodents, and other foreign material from entering the well, see figure 9. Commercially manufactured caps or seals designed for drilled wells can be applied to bored wells if the buried slab design is used.

Disinfection and water testing

All new or reconstructed wells must be disinfected and a water sample analyzed for bacteria and nitrate before the water is consumed or used in food preparation. For further information on the disinfection procedure, see Iowa State University Extension publication Pm-899, *Shock-Chlorinating Small Water Systems.*

Abandoned wells

Figure 10 shows how unused, deteriorated wells can lead to contamination of active wells nearby. In addition, abandoned wells are a safety hazard, particularly for children and animals. For these reasons, the Groundwater Protection Act, passed by the Iowa Legislature in 1987, requires all abandoned wells to be properly plugged. For information on well plugging, see Iowa State University Extension publication Pm-1328 *Successfully Plugging Your Abandoned Well.*

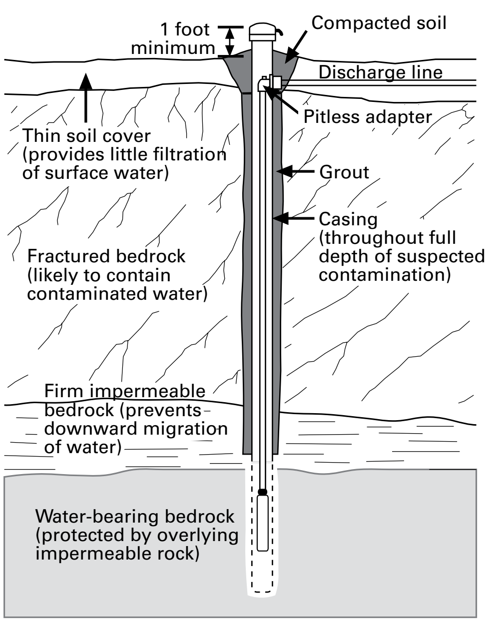

Figure 6. Watertight construction must extend through fractured rock that lies near the ground surface.

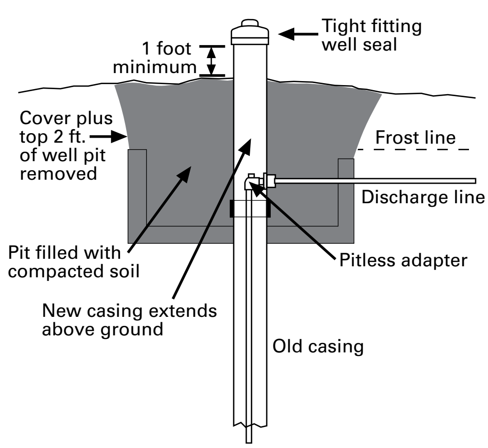

Figure 8. Renovation of well top to eliminate contaminant entry.

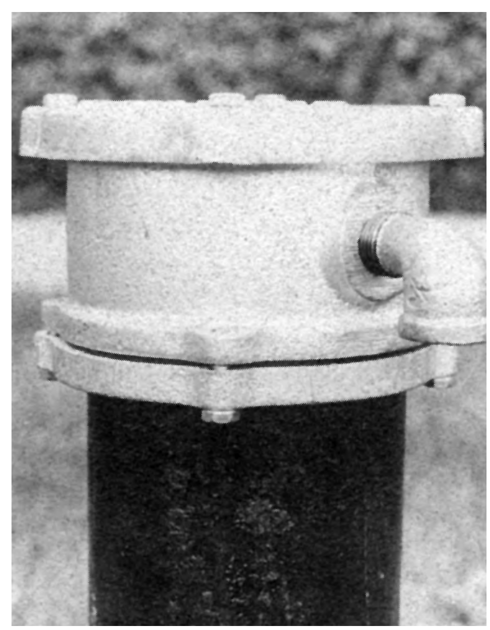

Figure 9. A tightly fitting well seal helps prevent well contamination.

Obtain a contract

To avoid misunderstandings when constructing a new well, be sure to secure a written contract with the well driller. This protects both the contractor and the property owner. Contracts should clearly indicate materials and services that will be supplied and the unit costs of these items. The date of project completion and the payment schedule should also be included.

If special problems are anticipated, such as failure to get adequate water, or a need to go substantially deeper than the estimated depth, a course of action should be agreed upon before construction begins.

Insist that the contractor supply an adequately detailed well log. A log provides a written record of the well construction including depth, geologic formations penetrated; length of casing and subsurface changes in casing diameter; type and length of well screen, if used depth to water; and depth of grouting. This information is extremely valuable if well maintenance and repair become necessary.

Observe state and local regulations

To protect public health, standards for Construction or reconstruction of private wells have been established by public health officials in consultation with members of the well drilling industry. For further information on well construction regulations, contact your county health agency, the Iowa Department of Natural Resources, or the Iowa Department of Public Health.

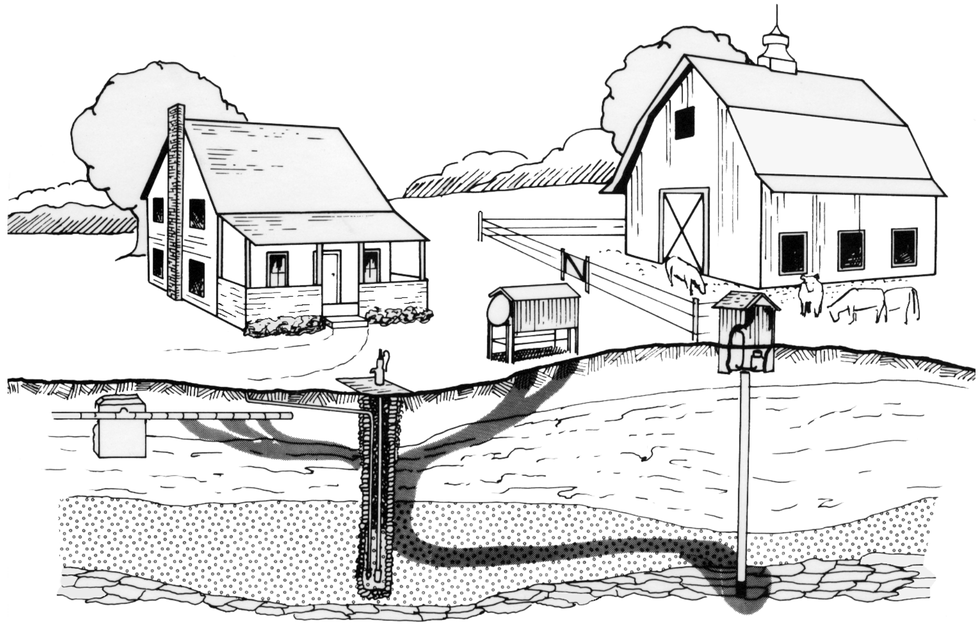

Figure 10. Unless properly plugged, old unused wells will permit groundwater contamination.

Iowa State University Extension publications about water-related subjects include:

Pm-899 *Shock-Chlorinating Small Water Systems*
Pm-1335 *Sampling Your Drinking Water*
Pm-1328 *Successfully Plugging Your Abandoned Well*
Pm-1329 *Coping with Contaminated Wells*
Pm-1334i *Is Your Drinking Water Safe?*

These publications are available at county extension offices in Iowa or from Extension Distribution Center, Printing and Publications Building, Iowa State University, Ames, Iowa 50011; phone 1-515-294-5247.

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