WATER QUALITY

Groundwater and Well Contamination

If you get drinking water from a well, it's your responsibility to make sure that your water supply is safe. Trained staff regulate, monitor and regularly test public water supplies as required. In contrast, testing private water supplies is voluntary and the responsibility of the landowner or user. Some counties and lending institutions require water tests when ownership changes. This reveals some water quality problems, but the best assurance of safe drinking water is good well location, safe construction and regular testing at qualified laboratories (see "Ensuring Safe Drinking Water," MF-952, "Testing to Help Ensure Safety of Drinking Water," MF-951 and "Suggested Water Testing for Private Systems," MF-871).

Groundwater that supplies wells may be contaminated from natural sources or from nearby land use activities. Little can be done to prevent naturally occurring contamination from minerals in soil or rocks. Conversely, the wide variety of potential contaminants resulting from human activities—nitrate, bacteria, and natural or synthetic organic chemicals, including pesticides or volatile organic chemicals (VOCs)—can be managed. You are legally responsible for contamination that you cause or allow. By understanding how contamination occurs, you can take precautions to prevent it.

Many Wells Are Contaminated

A recent study of Kansas farmstead wells found 37 percent contained inorganic chemicals above safe drinking water standards. Nitrate was the most frequently found contaminant, in 28 percent of the wells. Lead, cadmium, and mercury, all heavy metals, were found above present or proposed maximum contaminant levels in 6, 5, and 1 percent of wells, respectively.

The farmstead well study also found manmade organic chemicals—pesticides and VOCs—in 8 and 3 percent of wells, respectively. Of these, 4 percent were at concentrations above health advisory levels for long-term use. Many people are concerned about organic chemicals because most are of recent origin and they are found with increasing frequency in surface and groundwater. Bacteria was not tested in the farmstead well study.

Data collected in 1988-1990 from over 1,500 private wells through Extension water-quality clinics verify that nitrate is a major contaminant along with bacteria. Forty percent of the wells had one or both contaminants.

Based on data from these two sources, nearly one out of two or 50 percent of private wells would be judged unsafe if evaluated by safe drinking water standards used for public systems. The frequency of groundwater contamination with health consequences is of great concern because water from private wells usually is pumped and used without treatment. Additionally, few private well users have regularly tested their water have not discovered contaminants.

Groundwater Movement

Groundwater is found beneath the surface of the ground where voids within the soil and rocks are saturated with water. The source of groundwater is precipitation which soaks into the soil then percolates down through soil and rock until it reaches the saturated zone, the top of which is called the water table. When enough groundwater is available to supply a well, the formation is called an aquifer.

Once in the saturated zone, groundwater usually moves less than a few feet per day through porous sand and gravel deposits, and eventually resurfaces at springs, wetlands, or streams. Water also moves through cracks, joints, and solution channels in rock aquifers. These comparatively large openings permit water to move more rapidly, much farther and more unpredictably than in unconsolidated sands and gravel.

For a safe water supply:

- ❑ Ensure safe well construction
- ■ Protect water sources from contamination
- ❑ Get recommended water tests
- ❑ Select treatment based on tests
- ❑ Save and compare test results

Groundwater flow is generally downslope in response to gravity. Water that percolates at the "top of the hill" eventually resurfaces somewhere downslope (Figure 1). Movement is usually slow, thousands of years or even tens of thousands, for water which enters the soil to resurface. Depending on the land slope, soil, and local geology, groundwater may resurface as near as a few hundred feet or as far as several miles from its point of origin.

When water is pumped from a well, the water table drops, creating a cone of depression that causes groundwater to flow toward the well. Water in a shallow well usually comes from the immediate area, but in a deep well, the water may have traveled a considerable distance underground.

How Water Becomes Contaminated

Water often is called the universal solvent, meaning that it will dissolve some of almost all natural chemicals and most synthetic ones. Water picks up contaminants as it falls through the air as precipitation. As it flows into and through the soil, water dissolves and collects materials from soil, rock, and chemicals from various land-use activities and may leach them through the soil (Figure 1).

Soil acts as a protective blanket to adsorb, filter out, and degrade contaminants, especially biodegradable organics. The type and amount of contaminants which reach groundwater vary depending upon the characteristics of the soil, rock, contaminants, and the speed with which they move through the soil. Large contamination sources such as leaks or spills from buried tanks, pipelines, or impoundments may overload the soils and thus allow the contaminant to percolate rapidly to groundwater.

Contaminants in surface water usually mix throughout the body of water, diluting the contamination. When concentrated contaminants reach groundwater, they form a "slug" or "plume" (Figure 2). This plume slowly moves with the groundwater through the aquifer. Some materials (such as petroleum products), may float at or near the top of the saturated area while materials heavier than water (many chlorinated hydrocarbons such as carbon tetrachloride) settle to the bottom. Others are dissolved and mixed in the water (Figure 2).

Some of the most serious contamination problems result from a direct link to the groundwater via abandoned wells, mine shafts, sinkholes, cesspools, and other places where the protective soil blanket is missing or substantially reduced. Other conditions where the protective soil cover may be short-circuited include soils that shrink and crack. Soils with large openings may allow rapid infiltration and movement of water through the soil. Rapidly permeable sandy, gravelly, or exposed bedrock soils are also conducive to contaminants reaching groundwater. Depth to groundwater is also a factor. Depths of more than 100 feet are less susceptible to contamination than shallower depths.

Because water is an ideal solvent, some products placed on or in the soil will eventually end up in the groundwater. The extent to which human activities threaten groundwater quality depends on the types and amounts of materials used, how they are used, and the risk of spills or accidents. Many soils have a large capacity to adsorb and degrade wastes, especially biodegradable organics. However, repeated application at excessive rates and uncontrolled discharge of chemicals or wastes increase the likelihood of exceeding the soil's assimilative capacity and reaching the groundwater.

Many daily activities around the home or business contribute to groundwater contamination. These include improper disposal of household chemicals, careless or excessive application of chemicals to lawns and gardens, spills or dumping wastes on the ground. Repeated activities such as cleaning equipment in the same area often eventually result in some of the chemicals involved reaching the groundwater. We all contribute to groundwater contamination.

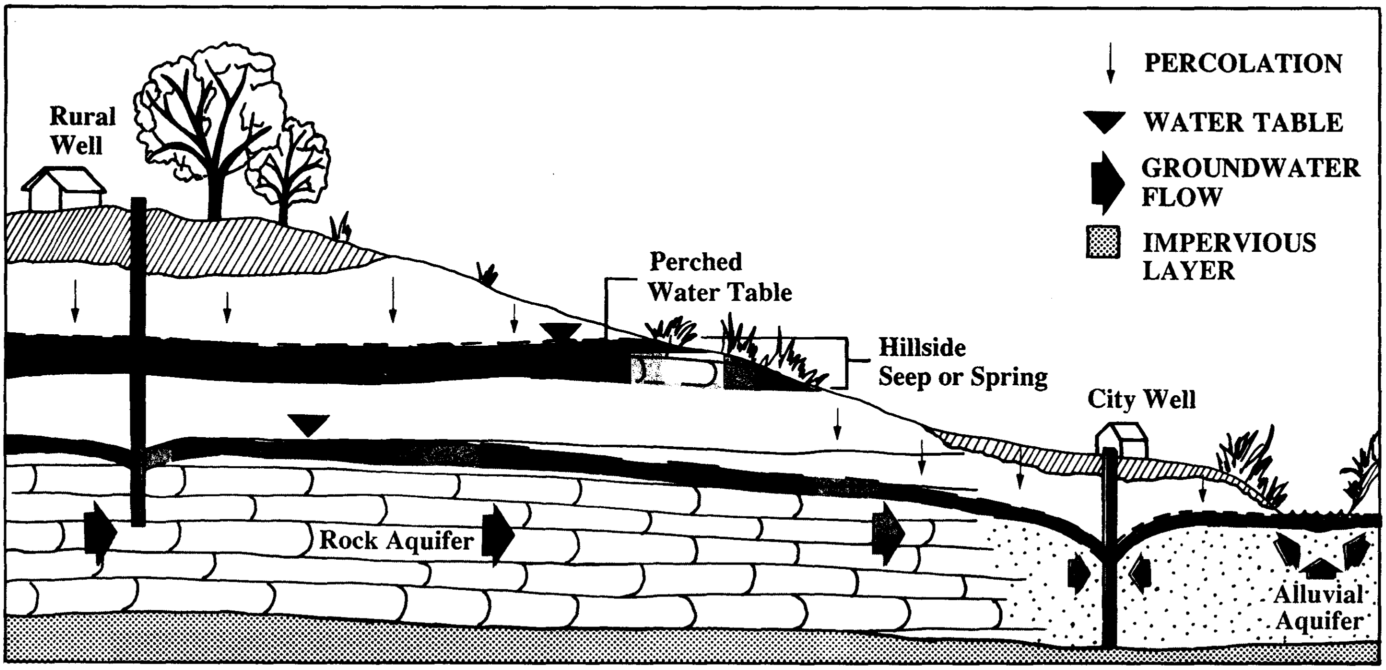
Groundwater contamination can also result from the manufacture, transport, and distribution of chemicals, disposal of wastes on land, and crop and livestock production practices. (For more information about controlling contamination from the farmstead, see "Managing the Farmstead to Minimize Groundwater and Well Contamination," MF-948.) Awareness of the consequences of poor management of these activities is the first step in preventing groundwater contamination.

Land uses or activities close to the well, particularly those upslope, give clues to contaminants that maybe found in a well. Table 1 lists several land uses or activities and related contaminants which may enter the soil and eventually the groundwater. Figure 2 illustrates how land uses can result in groundwater and well contamination.

Groundwater Evaluation and Cleanup

The groundwater protection policy in Kansas prohibits degradation of water quality. Groundwater, like surface water, is evaluated for its intended purpose. All fresh groundwater is or may be used directly as drinking water without treatment for health effects and thus should meet safe drinking water standards. When one or more contaminants exceed the standard or criteria for the intended use, the water is considered polluted.

Once groundwater is polluted, it usually remains in that condition until the water resurfaces or is cleaned up. Processes that degrade or remove contaminants proceed slowly or, in some cases, do not occur naturally in groundwater. Groundwater cleanup is difficult and expensive, so the best practice is to prevent contamination. Once contamination has occurred, the only practical option in many cases is securing a new water source or treatment before use.



'igure 1. Groundwater, recharged by precipitation, moves by gravity to outlet. Dark blue indicates seasonal changes in water level. Perched water may entirely disappear in dry season.

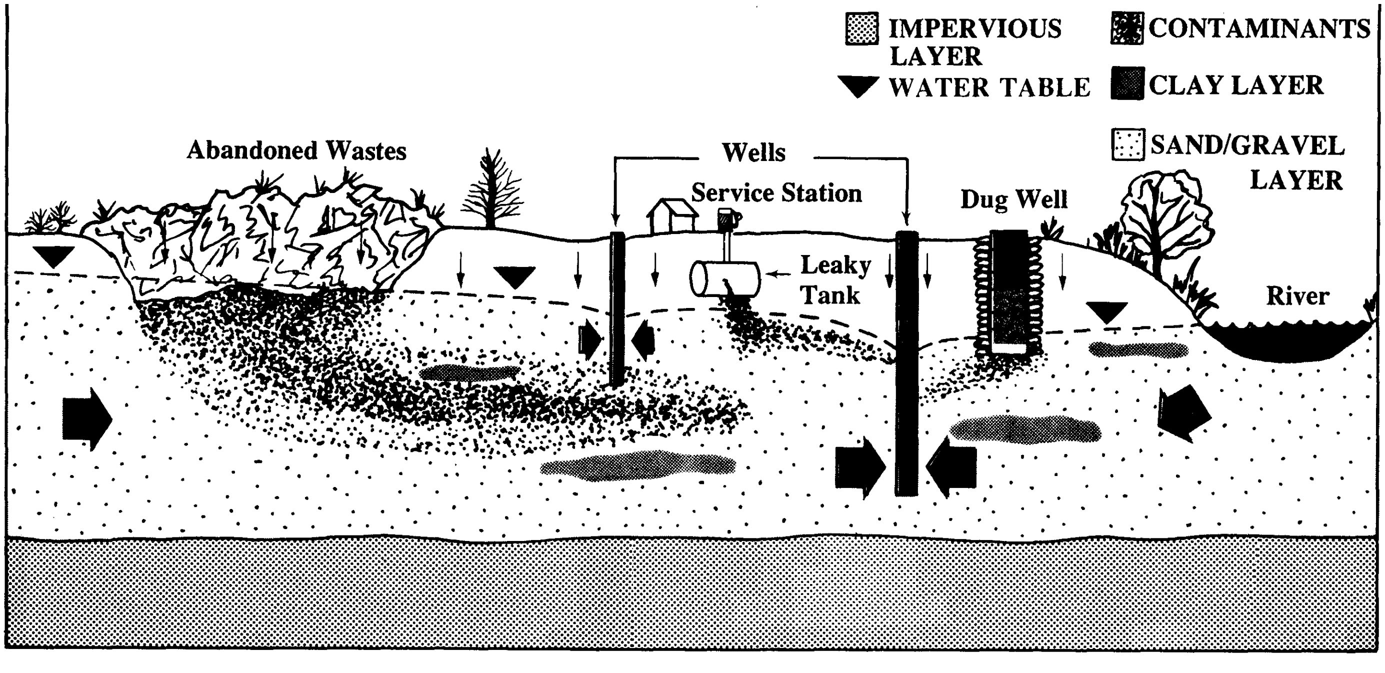


Figure 2. Groundwater contamination occurs from many sources and usually moves in concentrated plumes.

Prevent Groundwater Contamination

Good management is the key to protecting groundwater quality. This is best done by eliminating or at least carefully managing land uses or activities near the well, especially upslope, to prevent potential contamination.

Contamination sources more than 1,000 feet upslope, within 500 feet on level ground, or 250 feet downslope usually have little impact on wells when the aquifer is sand and gravel. Because of unpredictable direction and distance of movement in rock aquifers, it is more difficult to determine a safe distance. It maybe as much as several miles.

Remember, correcting the problem after contamination occurs is difficult and costly. Locate and plug abandoned wells, direct links to the groundwater which bypass the protective soil blanket (See "Plugging Abandoned Wells," MF-935) and encourage others to do the same. For information about safe disposal of household chemicals while protecting the environment, see "Household Product Disposal Guide," MF-965.

Table 1. Contaminant categories from land uses or activities

Land use or activity	Possible cause of contamination	Bacteria	Nitrate	Volatile organics	Hydro- carbon	Pesticide	Metals or minerals	Salts or chloride
Abandoned well	Direct entry from surface leakage between layers	X	X	X	X	X		X
Crop production: (irrigation), agricultural chemicals	Excess application, accidental loss, back siphonage or backflow		X	X		X		X
Farmstead	Leaks, spills, dumping, careless management		X	X	X	X		
Feedlot, confined livestock	Overloaded, careless management, close proximitv, abandoned lots	X	X					X
Garden and lawn chemicals	Repeated use, spill, overuse		X			X	X	
Household products (chemicals)	Spills, dumping, repeated use			X	X	X		
Industry: manufacture and transportation	Leaks, spills, dumping, poor management, disposal failures			X	X	X	X	X
Landfill	Percolation from site, pollutant plume	X	X	X	X	X	X	X
Mining: surface, underground	Abandoned mine drainage, mine spoil						X	X
Oil exploration, production	Leaks, casing failure, poor plugging, spills, dumping disposal				X			X
Waste disposal: lagoon, sludge, septic, etc.	Leaks, spills, overloading, poor management	X	X	X	X	X	X	
Storage tanks: surface or buried	Leaks, spills, fire fighting, abandoned tanks			X	X	X		

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