MISSOURI'S HIDDEN WATERS

MISSOURI DEPARTMENT OF NATURAL RESOURCES

What is Ground Water?

Lakes, rivers, and streams abound throughout Missouri, making the state one of the richest in water resources. Yet this surface water is only a small percentage of Missouri's total water supply. Most of our water is ground water —water that is found from a few feet to hundreds of feet beneath the earth's surface.

Ground water provides approximately one-third of Missourians' water needs. It is used for agriculture, industry, public supplies, and domestic supplies. Ground water is also a major source of drinking water, especially in rural areas. Compared to some other states, many parts of Missouri are fortunate to have plentiful sources of fresh, usable ground water. If we are to have an abundance of fresh ground water for the future, however, we must protect it now.

Ground water is stored beneath the earth's surface in formations of saturated rock, sand, gravel, and soil. Unlike surface water, ground water does not flow in a series of lakes and rivers. Instead, the precipitation that seeps into the ground fills the pores of rock formations similar to the way water fills a sponge.

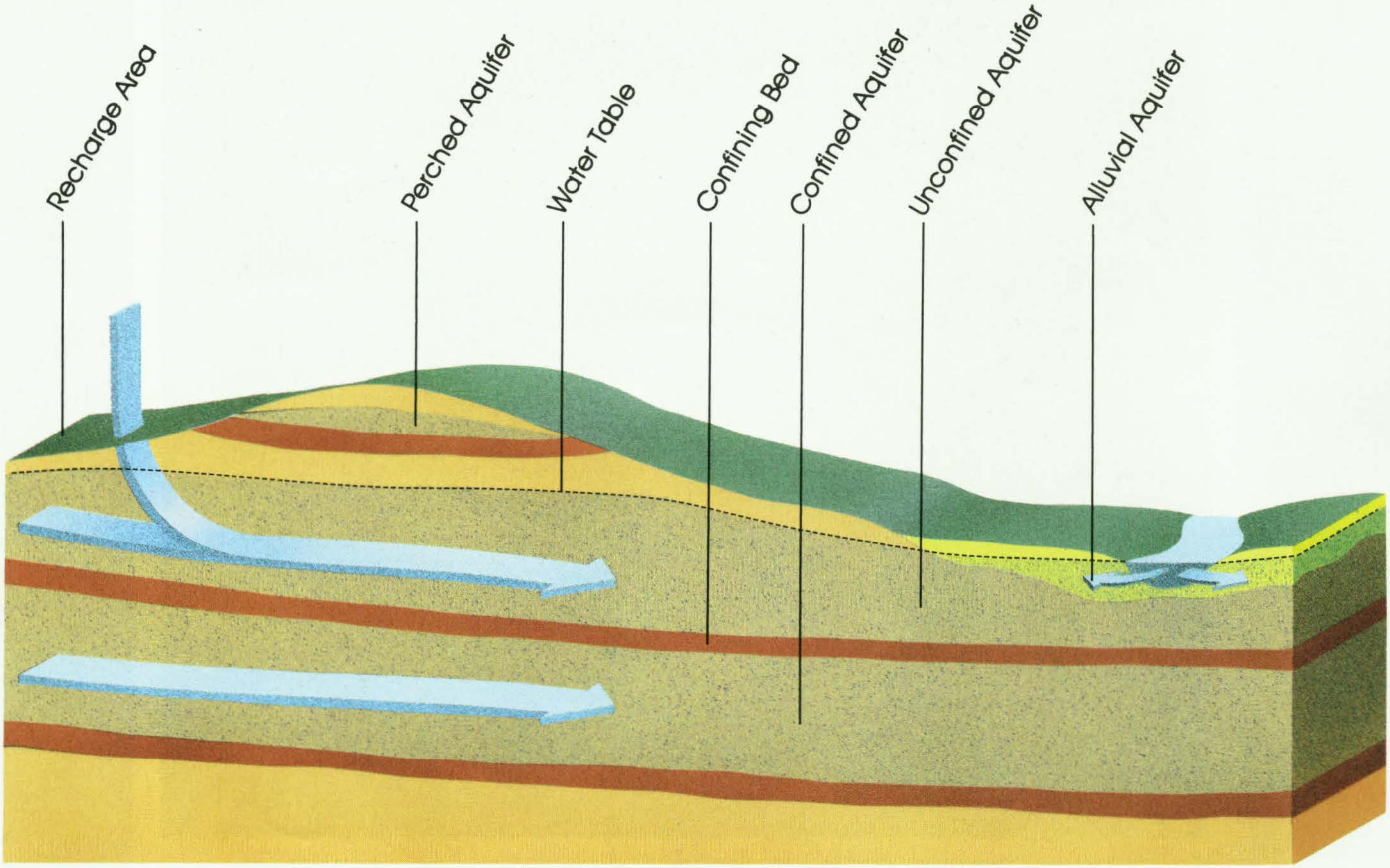
Formations that yield usable amounts of water to springs or wells are called aquifers. Two factors determine the amount of water that aquifers yield: porosity and permeability. Porosity refers to the ability of the material to store water, and permeability is the material's ability to transmit ground water through its pores and cracks. Sandstone, a highly porous material, allows water to seep through easily. Limestone, however, is permeable but not porous — water can flow only through its cracks and fissures.

Two main types of aquifers are "confined" and "unconfined." Impermeable material such as clay and shale form a boundary at the top and bottom of confined aquifers. This impermeable material prevents ground water from easily flowing through its cracks and pores and may protect confined aquifers from contamination.

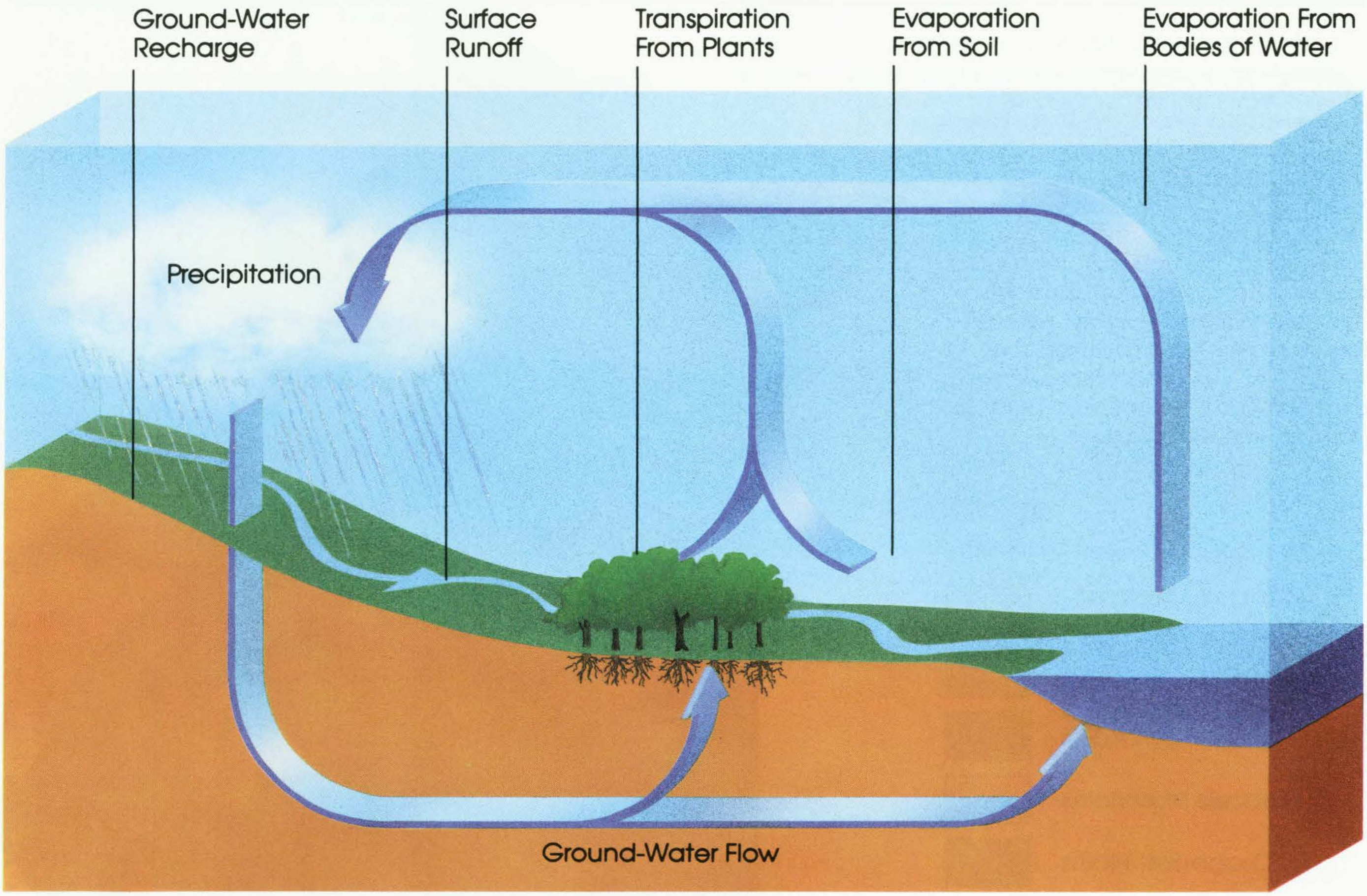
Unlike confined aquifers, unconfined aquifers are not protected by overlying layers of impermeable material and, therefore, are more susceptible to contamination. The top of the unconfined aquifer is called the water table, which is usually located a few feet beneath the surface. The water level in unconfined aquifers varies depending on the amount of usage and precipitation.

Ground water is part of a continuous cycle known as the hydrological cycle. As the earth warms, water evaporates from moist ground, plants, and surface water. The air and water vapor rise into the atmosphere, where the air cools and the water vapor condenses to form clouds. Precipitation in the form of rain,

Types of Aquifers



The Hydrological Cycle: Water is Constantly Recycled By Nature



hail, sleet, or snow falls to the earth. Some of this precipitation evaporates before it reaches the ground; some of it runs off the earth's surface into streams, rivers, and lakes; and some of the precipitation soaks into the ground. Aquifer recharge (replenishment) occurs when water from precipitation percolates through the soil until it reaches the saturated zone of an aquifer. Only water that has reached the saturated zone is referred to as ground water.

Ground Water in Missouri

A major characteristic of ground water is its diversity. In some areas, an abundance of fresh water may be found in large, deep aquifers. In other areas, such as Missouri's northern regions, fresh ground water is available only in small quantities due to the areas' compacted soil and impermeable rock.

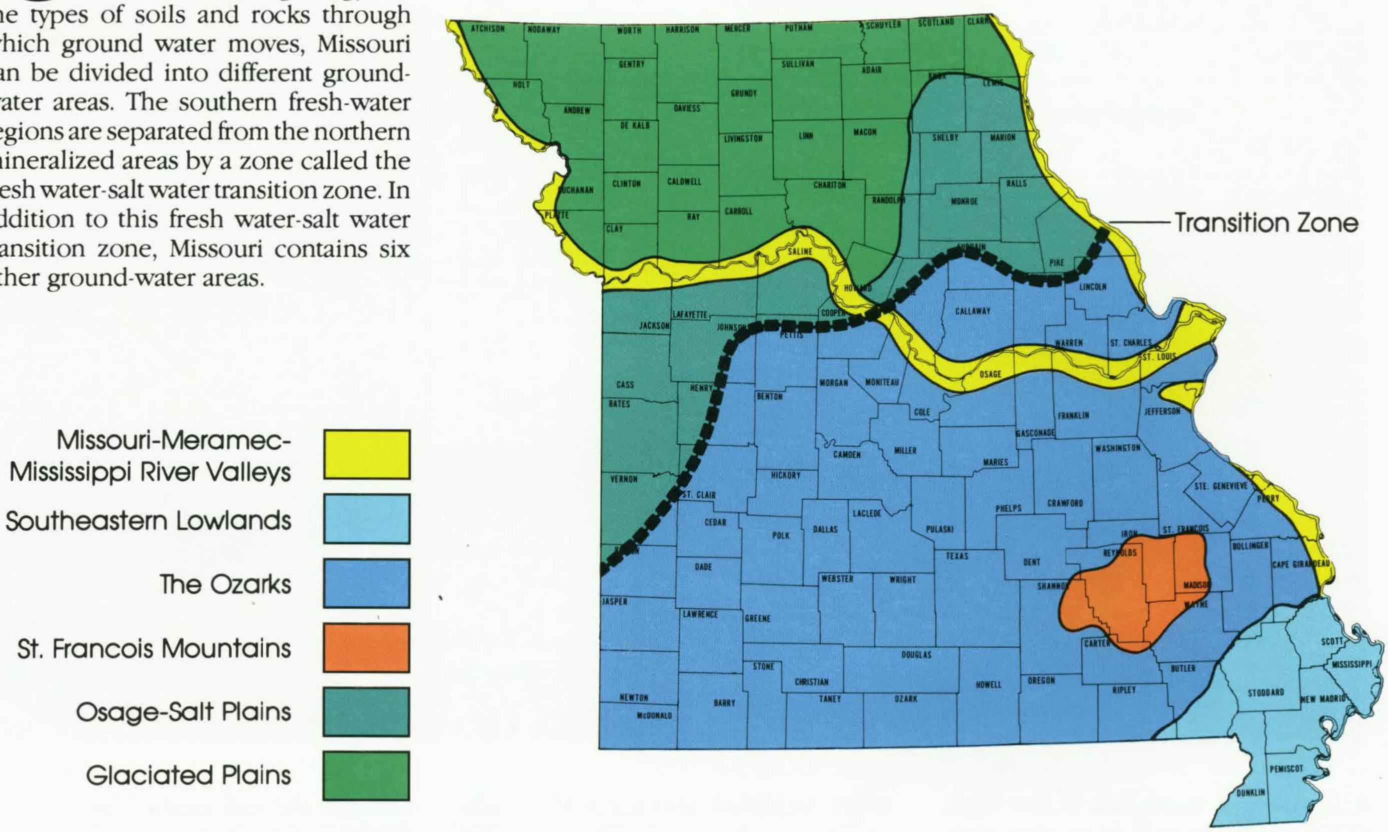
Ground water moves at various rates through the ground. Generally, it moves very slowly, sometimes only a few feet per year. Yet, in some areas such as southern Missouri, ground-water movement may be very rapid because of the geology and the types of rocks and soils through which water moves. Because ground water moves so slowly through the bedrock of northern and western Missouri, the prolonged contact creates very high mineral concentrations — particularly of sodium, chloride, and sulfate — in the ground water. At present, saline water is too expensive to treat, but it may be used in the future if technological improvements and increased demands warrant it.

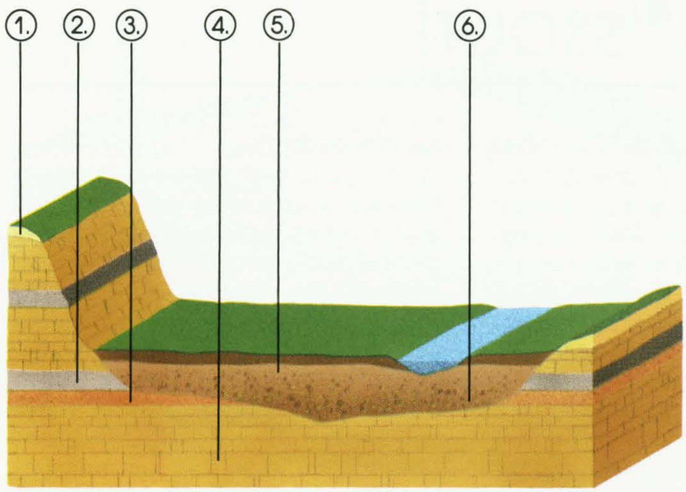
Many regions of Missouri are characterized by karst topography. Karst areas result from the dissolution and erosion of limestone and dolomite bedrock. Features of karst areas include permeable soil and rock, springs that bring ground water to the earth's surface, sinkholes that connect surface water to ground water, caverns and small openings that convey water through integrated underground channels, and losing streams that transport water underground. Because of such features, surface water, as well as contaminants, can enter the ground more readily and move underground more rapidly in karst regions than in other areas.

Ground-Water Regions of Missouri

Ground water varies greatly throughout the state. Based on similarities in geology and the types of soils and rocks through which ground water moves, Missouri can be divided into different ground-water areas. The southern fresh-water regions are separated from the northern mineralized areas by a zone called the fresh water-salt water transition zone. In addition to this fresh water-salt water transition zone, Missouri contains six other ground-water areas.

Ground-Water Regions





1. Weathered Bedrock; 2. Shale; 3. Sandstone; 4. Limestone; 5. Clay and Silt; 6. Sand and Gravel

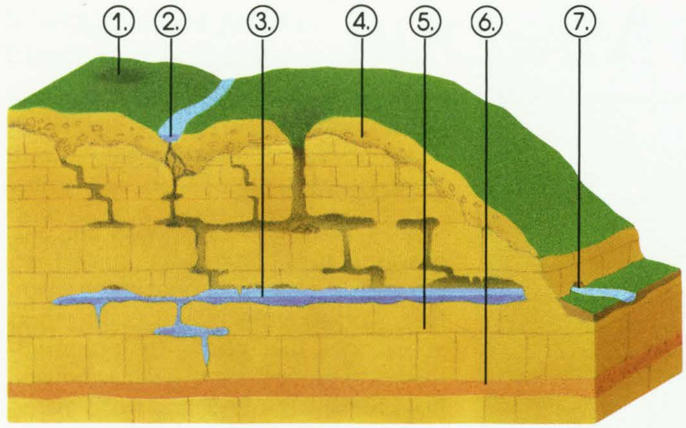
Missouri-Meramec-Mississippi River Valleys and Southeastern Lowlands

Because of the rapid recharge from the rivers in this area, unlimited volumes of ground water are available, with yields often exceeding 1,000 gallons per minute. The water table in the Missouri-Meramec-Mississippi river valleys is near the surface, so water may be pumped rapidly from shallow wells. Although the water in this region is hard and the iron content is high, the overall quality of the ground water is good.

Also referred to as the "Bootheel," the Southeastern Lowlands are in the extreme southeastern tip of Missouri. The quality of the ground water in the Bootheel varies depending on the aquifer and the depth of wells, but the overall quality is good. Aquifers in this area recharge rapidly and yield plentiful amounts of water. Because of the geology of the Bootheel, artesian wells are common in some of its sections.

The Ozarks

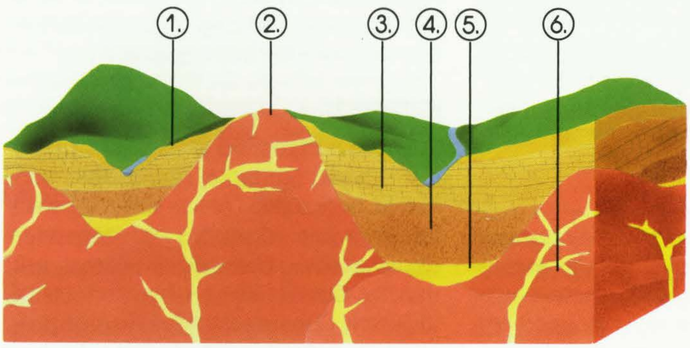
South of the fresh water-salt water transition zone is the Ozarks, which covers more than half of southern Missouri. The quality of the ground water in this area is considered good to excellent. The aquifers generally yield anywhere between 15- to 500-gallons per minute, although in the Springfield and Rolla areas ground-water yields may be as high as 1,000 gallons per minute. In some sections of central and southern Missouri there is a thickening of the unconfined aquifer. In these instances, aquifers made of similar materials are stacked on top of each other, creating one "superaquifer."



1. Sinkhole; 2. Losing Stream; 3. Cave; 4. Deeply Weathered Bedrock; 5. Limestone and Dolomite; 6. Sandstone; 7. Spring

St. Francois Mountains

Set within the southeastern section of the Ozarks are the St. Francois Mountains. Ground-water yields from this area are small, normally 45- to 50-gallons per minute. In some sections of the area, the volume of ground water is inadequate for domestic use.

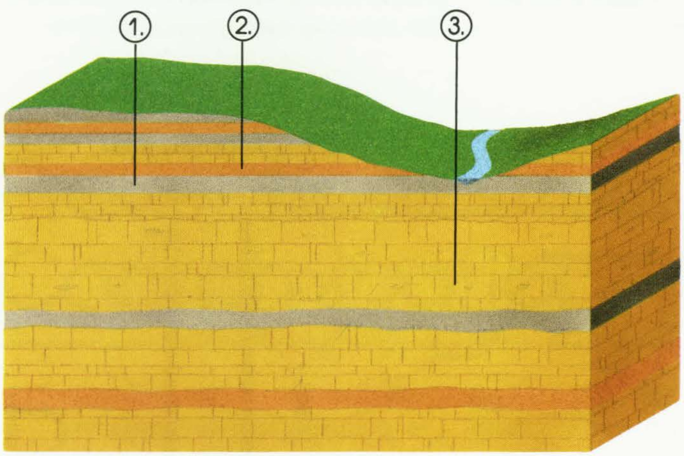


1. Weathered Bedrock; 2. Igneous Knob; 3. Limestone and Dolomite; 4. Sandstone; 5. Basal Arkose or Weathered Igneous Rock; 6. Igneous rock (granite, etc.)

Osage-Salt Plains

Aquifers in the Osage-Salt Plains of northern and western Missouri often yield highly mineralized water. Although small yields of fresh water may be obtained from some shallow wells, aquifers deeper than 400- to 500-feet are highly mineralized. Because of the poor quality of ground water in these areas, water supplies from wells usually are drawn from the alluvium (sand and gravel) underlying the flood plains of major streams.

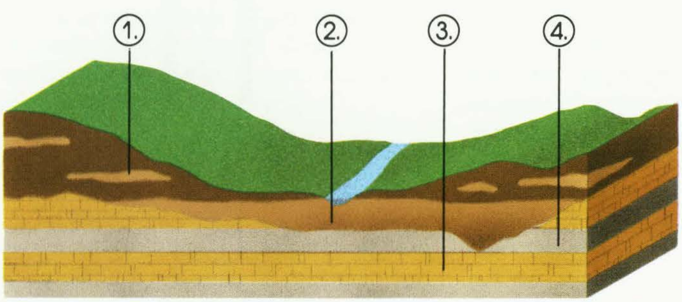
NOTE: Glacial deposits also cover the Salt River Plains of northeastern Missouri, but the deeper ground water is more similar to that of the Osage Plains area.



1. Shale; 2. Sandstone; 3. Limestone and Dolomite

Glaciated Plains

This area covers a large portion of northern Missouri. Aquifers in the Glaciated Plains yield only small amounts of ground water, normally only five- to 15-gallons per minute. The ground water in this area is generally very mineralized.



1. Clay and Silt; 2. Sand and Gravel; 3. Limestone; 4. Shale

Water Problems in Missouri

Missouri's ground-water quality is influenced both by natural conditions and by human activities. As Missouri's ground-water use increases, the need to protect our resources' availability and quality also increases. Good management of our ground water partly depends on knowledge of potential problems. The following are examples of human-related activities that may affect our ground water:

Quantity

In addition to natural conditions that affect ground-water availability, excessive irrigation and heavy pumping of water from wells can lower ground-water levels. As larger amounts of water are withdrawn from a well, the water table drops, forming a funnellike "cone of depression" around the well. An example of lowered water tables can be found in the Springfield area of southern Missouri where studies show declining water levels due to the increased use of water for industrial and municipal supplies.

Accidental Spills and Leaks

Accidental spills, resulting from collisions of trucks and derailments of railroad cars, are capable of endangering ground-water supplies. Thousands of gallons of liquid, primarily oil, may be lost in a single incident. However, the threat posed to ground water by major transportation accidents is considerably less than the danger caused by smaller spills and leaks at industrial complexes, where large volumes of liquids are routinely handled.

Water Wells

Nearly half of Missouri's existing private, domestic wells may be vulnerable to contamination as a result of poor construction. Wells that are not properly sealed allow direct recharge of ground water from surface water contaminated by septic tanks or animal wastes. Due to age, poor construction, or unsuitable siting, water wells that are directly recharged by contaminated water are the most common threats to ground water in Missouri's rural areas.

Underground storage tanks that are not properly installed may need to be dug up and replaced after only a few years.

Septic Tanks

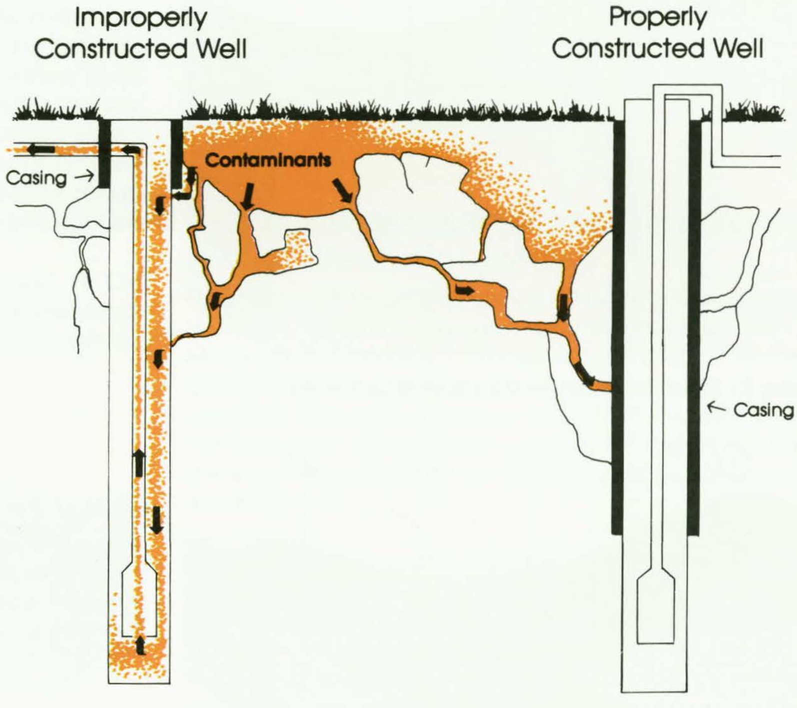
Improperly installed and maintained septic-tank systems may discharge poorly treated or untreated waste into ground water. Wastes from clogged or soaked septic fields may directly recharge water wells that have poorly sealed casings. Contamination is usually limited and isolated, but it could present a problem for homes that are located close together.

Storage Tanks

Most leaking storage tanks are old gasoline tanks that have rusted or cracked. In addition to containing gasoline, storage tanks may contain other substances that could be potential threats to ground water, such as household fuels, hazardous and toxic materials, diluted wastes, and diesel fuel. Some leaks may be so minute as to not be detectable for weeks or even years. Age, unsuitable soil conditions, settling fill, corrosion, and improper installation may account for leaking tanks.

Hazardous Wastes

Waste is classified as hazardous only if it is toxic, ignitable, radioactive, corrosive, or reactive (reacts violently with air or water, explodes, or generates toxic gases). Hazardous wastes are usually, but not always, by-products of industry. Consumers who do not properly store or dispose of such things as household cleaners, automotive fluids, and paint and varnish remover also are contributing to contamination. Improper storage and disposal of wastes can lead to ground-water pollution.



Wells that are not properly cased allow surface water that has been contaminated by septic tanks, animal wastes, or some other source to directly enter ground water.

Sewage Storage and Treatment Lagoons

In some cases, lagoons that have old, inadequate, or non-existent liners may allow polluted water to diffuse into nearby shallow aquifers. Lagoons are more likely to pose a problem if they are located near population centers or in highly permeable flood plains and if the underlying soils are unable to reduce or dissipate the contamination. Generally, lagoons are only a problem when they are not properly sealed.

Solid-Waste Landfills

Non-hazardous, solid-waste landfills are also possible sources of ground-water contamination. Leachate, or water that has percolated through landfills or dumps, may enter an aquifer used for drinking water and endanger the health of those who drink that water.

Animal wastes from feedlots and barnyards can filter through the ground and contaminate improperly constructed water wells.

Mining

Generally, abandoned coal and metal mines contribute more to ground-water pollution than do mines that are still in operation. Tailings piles (piles of crushed waste rock left in the mining process) and tailings ponds (settling basins that separate the sediments from the water used in mining processes) are examples of mining effects that pose potential threats to ground water. Water also may fill abandoned mines and become contaminated by oxidized or dissolved minerals. Any nearby aquifers that are replenished by this water would then be threatened with contamination.

Agriculture

Two types of agricultural activities may contribute to ground-water contamination. Chemical fertilizers and pesticides are potential contamination threats to ground water. Ground water also may be threatened when animal wastes filter through the ground from leaking treatment lagoons and when wastes migrate into poorly cased wells. Although animal waste problems may occur wherever animals are contained, they are more likely to be found in regions where wells and animal wastes are in close proximity.

Prevention of Ground-Water Contamination

Prevention of contamination is the key to protecting the quality of our ground water. By establishing and enforcing standards, collecting ground-water information, and properly managing and disposing of wastes, we can help protect our valuable ground-water resources.

Standards

The present numeric criteria that the state uses for determining water quality is equivalent to, and in some cases more restrictive than, national drinking water standards. A ground-water protection strategy will further ensure the quality of our ground water.

Major elements of a state ground-water protection strategy include defining contaminant sources, determining ground-water quality standards, and establishing protective regulations. Restrictive discharge permits already are required for the discharge of wastes to losing streams and ground-water recharge areas; for land application and rapid-infiltration wastewater systems; and for leaking storage and treatment lagoons.

One step that has been taken to protect our ground water from contamination due to poorly cased wells is the Water Well Driller's Act, which was passed in 1985. This act will help retard the problem of ground-water contamination by placing standards on the construction of new wells. Another step to protect our ground water is the registration of underground tanks storing regulated substances. Of the 50,000 to 100,000 underground storage tanks statewide, an estimated twenty-five percent leak.

Data

Many agencies with interests and responsibilities in ground water have generated a large amount of information about the subject. This information, however, is widely dispersed throughout the agencies and is not easily accessible by an electronic data system. A major objective of a ground-water protection strategy is to develop a data system so agencies may more efficiently manage ground-water information. Additional data is needed to futher determine characteristics that affect ground water, such as recharge areas, water, soil and rock chemistry, and aquifer parameters. A data management system would provide easy access to ground-water information and help officials identify new problems, ensure compliance with regulations, and evaluate the effectiveness of ground-water programs.

Citizen Participation

Once pollution is discovered, clean-up is very expensive. Therefore, the best protection for our ground water is to prevent its contamination. In addition to federal and state agencies that have taken actions to prevent contamination of the ground water, private citizens also play an active role in preventing contamination.

The protection and maintenance of ground-water quality greatly depends upon individual efforts to properly manage and dispose of wastes. It is essential to the protection of our resource that all citizens be aware of the effects their actions have upon the aquifers over which they live and work.

Individual actions that help protect ground water include water conservation; proper installation and maintenance of septic-tank systems; following proper water-well construction standards; following directions for use and disposal of household chemicals; and participation in recycling programs that help minimize the impact of solid-waste disposal sites. Public action, as well as opinion, is essential to Missouri's ground-water protection strategy.

Citizen involvement in local land and water planning, participation in public meetings and hearings on ground-water issues, and awareness of community activities, such as solid and hazardous waste disposal and location of storage tanks, help protect and maintain the quality of our ground water. Most ground-water quality problems are directly related to pollutants that are deposited on or near the surface of the land. Local citizens and governments are in the best position to exercise land-use controls because they have the knowledge necessary to best determine how their community's land should be allocated and used. In order to have successful ground-water protection, it is important for citizens, local governments, and state and federal agencies to work together. No longer can our ground water be taken for granted. If we hope to have a plentiful supply of fresh water for future use, we must take steps to protect it now.

For more information about ground water in Missouri, contact the

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