

Land & Water

Conserving Natural Resources in Illinois

University of Illinois at Urbana - Champaign, College of Agriculture, Cooperative Extension Service

Water Quality and the Hydrologic Cycle

How Water Movement Affects Water Quality

To understand how contamination of groundwater and surface water occurs, it is necessary to understand the **hydrologic cycle**—the endless circulation of water from the ocean, atmosphere, and land (see figure on page 2). By understanding how water moves on and through the soil, it becomes clear how contaminants can move with it.

The hydrologic cycle begins with precipitation in the form of rain, snow, sleet, or hail falling on the surface of the earth. As precipitation falls, some of it may evaporate directly into the atmosphere from bodies of water, and a portion may be intercepted by vegetation. The remainder reaches the ground where it can enter the soil by a process called **infiltration**.

Some of the infiltrating water remains near the soil surface and evaporates into the atmosphere. Another portion is extracted by plant roots and transported to leaves where it is lost to the atmosphere as a vapor. This process is called **transpiration**.

Water will infiltrate into the soil as long as the potential rate of infiltration exceeds the rate of precipitation. When the precipitation rate exceeds the infiltration rate, excess water builds on the soil surface and moves by overland flow called **surface runoff**. If surface runoff is excessive or concentrated, erosion can occur.

Still another portion of water that enters the soil can move vertically or laterally out of the plant root zone. Significant lateral movement of water through the soil is called **throughflow** or **interflow**. Downward movement of water through the soil is referred to as **percolation**.

Percolating water eventually makes its way to a **saturated zone**, where all spaces between rock and soil

The Cast of Terms in Order of Appearance

In discussions about water quality and water movement, it sometimes takes a dictionary to keep on top of what is being said. In this fact sheet, the following water quality terms are set apart in bold. That way, they can be easily spotted when it is necessary to clarify their meaning. (Many of the terms are also illustrated on page 2.)

Hydrologic Cycle	Baseflow
Infiltration	Aquifer
Transpiration	Aquitard
Surface Runoff	Aquiclude
Throughflow	Confined Aquifer
Interflow	Unconfined Aquifer
Percolation	Leaching
Saturated Zone	Run-in
Groundwater	Sinkholes
Recharge	Point Source Pollution
Water Table	Nonpoint Source Pollution

particles are filled with water. The water filling the spaces between soil particles and rock in the saturated zone is called **groundwater**.

Groundwater Flow

Recharge is the process in which water percolating through the soil replenishes groundwater. Because the amount of precipitation and evaporation varies seasonally, the rate at which groundwater is recharged will vary seasonally as well. In turn, the depth to the **water table** will vary. The water table is the upper boundary or top of the groundwater.

Water moves within the saturated zone under the influence of gravity from areas where the water table is high toward areas where the water table is lower. As it does, groundwater may flow into surface water, such as a

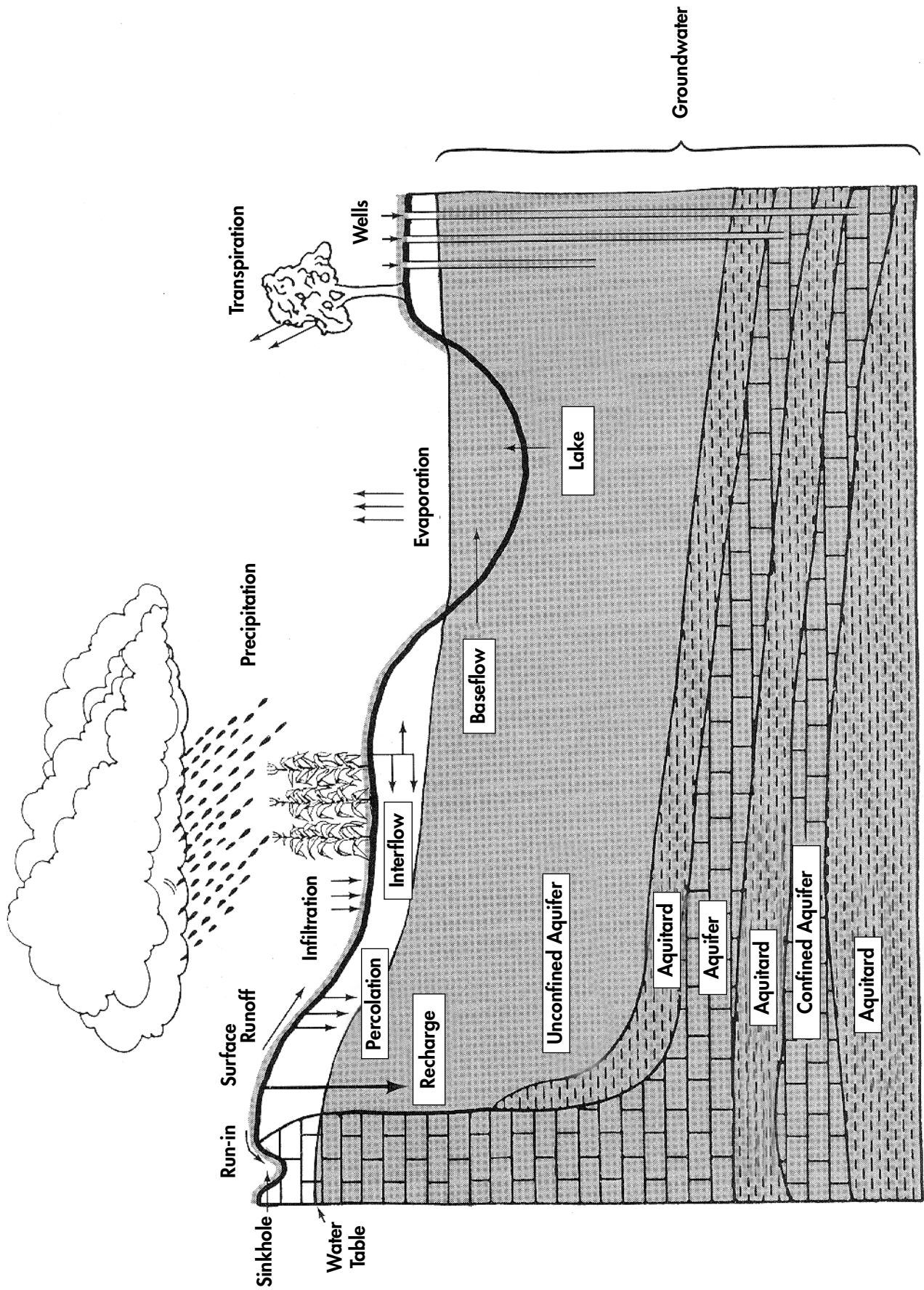


Figure 1. This illustration depicts many of the concepts described throughout the fact sheet. It shows how water moves on the land's surface and in the soil.

lake or river. In fact, this process, known as **baseflow**, accounts for most of the water that recharges perennial streams, rivers, and lakes.

One common misperception, however, is that groundwater moves somewhat rapidly. In reality, groundwater moves much more slowly than water in a river or stream. This is because groundwater must overcome friction to move through the small spaces between soil particles and rocks. While water in a stream may move several inches or feet per second, groundwater generally moves several inches or feet *per month*.

Because groundwater flows slowly, most wells draw on the groundwater that lies close to the point where it is withdrawn. This is why activities taking place on the land surface closest to the well have the greatest impact on water quality.

Aquifers and Aquitards

An **aquifer** is defined as permeable, geologic material through which significant quantities of water can move. Geologic materials that serve as aquifers include unconsolidated material, such as sand and gravel; permeable sedimentary bedrock, such as sandstone, limestone, and dolomite; and fractured crystalline bedrock.

Geologic material through which significant quantities of water *cannot* move is referred to as an **aquitard** or **aquiclude**. Clays, shales, dense crystalline and sedimentary bedrock, and other very slowly permeable materials are common aquitards.

Aquifers and aquitards vary in their occurrence, thickness, continuity, and depth. A **confined aquifer** is bounded on the top and bottom by aquitards. In contrast, **unconfined aquifers** are overlaid by permeable layers and are generally found close to the land surface.

Groundwater Contamination

One way that groundwater becomes contaminated is when substances are carried down or **leached** to the groundwater with or by percolating water. Some groundwater contamination occurs naturally, but contamination usually is the result of human activities on the land surface.

In certain geologic settings, water can be transported directly to groundwater by a process called **run-in**. Run-in occurs where there are karst-carbonate aquifers—fractured and/or solution-riddled limestone or dolomite at or near the land surface. In areas where such aquifers exist, there may be **sinkholes**, which are cavities in the bedrock that are open to the atmosphere. Water containing contaminants can enter a sinkhole and then reach groundwater either directly or after some percolation through the soil.

An aquifer overlaid by an aquitard is less susceptible to contamination than one that is not because contaminated water has difficulty percolating through the aquitard. In

addition, deep aquifers are less susceptible to contamination than shallow aquifers because the distance the contaminant must move in the soil before reaching a deep aquifer is farther. If a shallow aquifer becomes contaminated, it may be possible to drill a deeper well to obtain water from an aquifer that has not been contaminated.

When groundwater becomes polluted, the risk of surface water contamination also increases. This is because, as mentioned earlier, groundwater recharges surface water more than any other source, including precipitation.

Point, Nonpoint Source Pollution

Point sources of contamination are identified by a well-defined point of entry where pollutants reach a body of water. Typical examples are landfills, leaking underground storage tanks, and municipal and industrial treatment facilities, where treated wastewater is discharged into rivers or streams.

Nonpoint sources of contamination have no easily identified point of entry where pollutants reach a body of water. Contaminants originate from a wide variety of sources over a wide area, and they enter surface water and groundwater at many locations, by many processes. Pesticides and fertilizers applied to cropland, effluent from septic systems, and leaching of highway de-icing salts are commonly identified as nonpoint sources of pollution.

What's Beneath Your Land?

After becoming familiar with these concepts, the next step is to determine where your well water is obtained. Does your well draw from a shallow or deep aquifer? Is the aquifer confined or unconfined? And what is the potential for contamination?

To find answers to such questions, contact the company that drilled the well. These companies keep a well log, a record of the geologic materials encountered and their thickness and depth.

If the company that drilled the well is not known, information may be obtained from the Illinois Geological Survey, 124 Natural Resources Building, 615 E. Peabody Dr., Champaign, IL 61820. (217) 333-4747.

The local Cooperative Extension Service adviser also may be able to assist in finding out information about the aquifers beneath your property and their potential for contamination.

Protecting Your Water Supply

If you learn that your well draws from a shallow, unconfined aquifer, pay particularly strict attention to the handling and disposal of potential contaminants, such as

pesticides, fertilizers, cleaning solvents, and motor oil. Mix and handle chemicals as far from the well as possible.

In addition, if pesticides are mixed and handled on the farm, consider installing a concrete pad and rinsate collection system, far from the well. Chemicals can be mixed and handled there safely.

Whether the potential source of contamination is point or nonpoint, individuals should keep two other points in mind: We can help protect groundwater by recognizing that activities on the land can and do affect groundwater; and we should manage our activities accordingly.

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