UNIVERSITY OF FLORIDA

IFAS EXTENSION

Ground Water: The Hidden Resource [1]

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WHY WORRY ABOUT GROUND WATER?

Ground water is the water found in spaces between soil particles and rocks, and within cracks of the bedrock. Some ground water can be found beneath the land surface in most of the southeastern United States. Because of its availability and general good quality, ground water is widely used for household needs and other water purposes.

Ground water is often taken for granted, but recent circumstances indicate that ground water is seriously vulnerable to *pollution* and *depletion*. In the Southeast, pollution poses the greater threat. Contaminants which threaten people's health have been found in many of the region's important ground water reservoirs. Some of the contaminants may be so expensive to remove that they make the water virtually unusable for years. Because of this threat, it is important to understand the processes that make ground water available for use and how human activities sometimes threaten this resource.

GROUND WATER IN THE WATER CYCLE

Ground water is an integral part of the water cycle as illustrated in Figure 1 . The cycle starts with precipitation falling on the surface. *Runoff* from precipitation goes directly into lakes and streams. Some of the water which seeps into the ground is used by plants for *transpiration* . The remaining water, called *recharge water* , drains down through the soil to the *saturated zone* , where water fills all the spaces between soil particles and rocks.

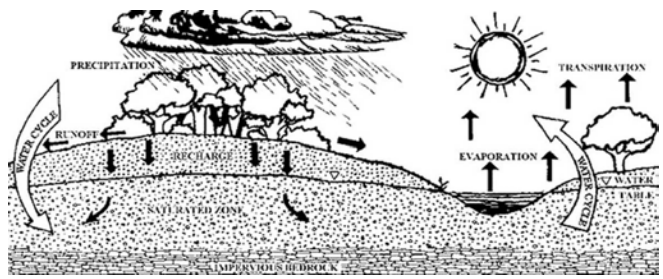

Figure 1.

The top of the saturated zone is the *water table* , which is usually the level where water stands in a well, if the local geology is not complicated. Water continues to move within the saturated zone from areas where the water table is higher toward areas where the water table is lower. When ground water

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comes to a lake, stream, or ocean, it discharges from the ground and becomes *surface water* . This water then *evaporates* into the atmosphere, condenses, and becomes *precipitation* thus completing the water cycle.

THE OCCURRENCE OF GROUND WATER

Water can be found beneath the ground almost everywhere. About 97 percent of the world's fresh water is ground water. The quality and amount of ground water which is available varies from place to place. Major reservoirs of ground water are referred to as *aquifers* .

Aquifers occur in two types of geologic formations. *Consolidated formations* are those composed of solid rock with ground water found in the cracks. The amount of ground water in a consolidated formation depends on how many cracks there are and the size of the cracks. For example, consolidated limestone formations often contain caverns with much water in them.

Unconsolidated formations are composed of sand and gravel, cobblestones, or loose earth or soil material. The amount of ground water in an unconsolidated formation varies depending on how closely packed the solid materials are and how fine grained they are. Sand and gravel, and cobblestone formations are generally high yield aquifers, whereas, finer grained earth materials may have low yields.

Ground water may come to the surface naturally as a spring or be drawn to the surface from a well. A spring occurs where the water table meets the land surface, as illustrated in Figure 2.

GROUND WATER AND SURFACE WATER

Most people are more familiar with surface water than ground water. Surface water bodies such as lakes, streams and oceans can be seen all around, but not ground water bodies. Some important differences between ground water and surface water bodies are worth noting.

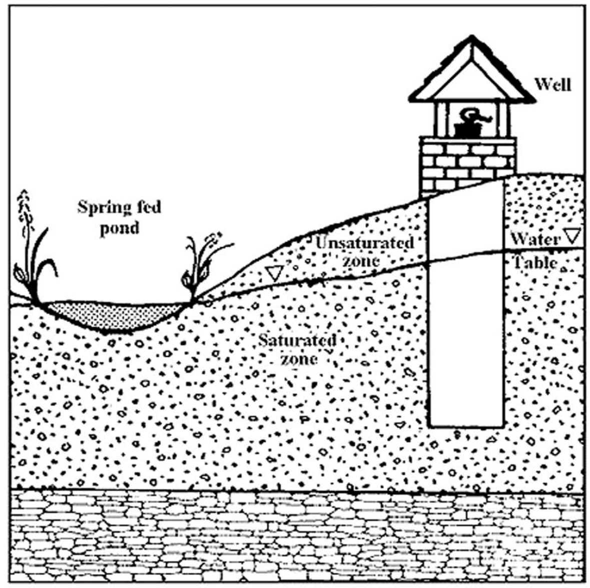

Figure 2.

Ground water usually moves much slower than surface water. Water in a stream may move several feet per minute, but water in an aquifer may move only several feet per month. This is because ground water must overcome more friction or resistance to move through small spaces between rocks and soil underground. There are exceptions to this rule. An example is underground streams in limestone caverns where the water may move relatively fast.

The exchange of water between surface water bodies and aquifers is important. Rivers usually start as small streams and get larger as they flow downstream. The water they gain is often ground water. Such a stream is called a *gaining* stream. It is also possible for streams to lose water to the ground at some points. In these cases, aquifers are replenished or *recharged* by water from the *losing* stream. A stream which flows near the surface of an aquifer will lose water to the aquifer if the water surface in the stream is higher than the water table of the aquifer. A stream will gain water if the water surface of the stream is lower than the water table in the adjacent land. Losing and gaining streams are illustrated in Figure 3a and 3b .

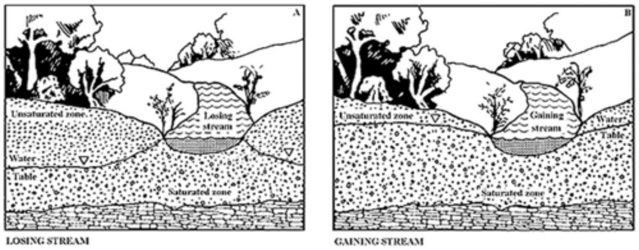

Figure 3.

POLLUTION AND DEPLETION THREATEN GROUND WATER

Ground water becomes *polluted* when toxic substances become dissolved in water at the land surface and are carried down, or leached, to the aquifer with the *percolating* water. To determine whether a particular substance will pollute a particular aquifer, the properties of the toxic substance and the soil above the aquifer need to be considered along with the amount of toxic substance available for leaching.

Sometimes ground water contamination occurs naturally, but serious contamination is usually the result of human activities on the land surface. An aquifer provides a plentiful water supply that often attracts a multitude of people to the overlying land. The water is used for such activities as drinking, personal hygiene, residential maintenance, and industrial and agricultural purposes. Many of these activities involve the use and disposal of chemicals which are potential pollutants. When these chemicals are used or disposed of incorrectly, unacceptable amounts can get into the ground water and contaminate it. Several valuable aquifers in the Southeast have been polluted by the people living and working above them.

Since ground water moves slowly, many years may pass before a pollutant released on the land surface above the aquifer is detected in water taken from the aquifer some distance away. Unfortunately, this means that contamination is often widespread before being detected. Even if release of the contaminant is stopped, it may take many years for an aquifer to purify itself naturally.

Although water can be treated to remove contaminants, this can be very costly. The best protection against water pollution is prevention.

Ground water becomes *depleted* in an area where more water is being drawn out of an aquifer and *consumptively used* than is entering, or recharging, the aquifer. This usually causes a lowering of the water table, making the ground water more difficult and expensive to obtain. This is a major problem in the dry western part of the United States. In the Southeast, precipitation continuously replenishes ground water supplies, and so depletion has only been found to be a

problem in certain localized situations, or during droughts. A situation may involve someone pumping a

large amount of water from a small aquifer and causing a neighbor's well to go dry (lowering the water table below the well screen). Rapidly expanding urban areas often impose an extra burden on ground water supplies in the form of depletion and pollution. In coastal areas, chronic overpumpage can cause *salt water intrusion* as shown in Figure 4. Salt water intrusion takes place in coastal areas where fresh water removal from the aquifer permits saline water from the ocean to intrude into the aquifer.

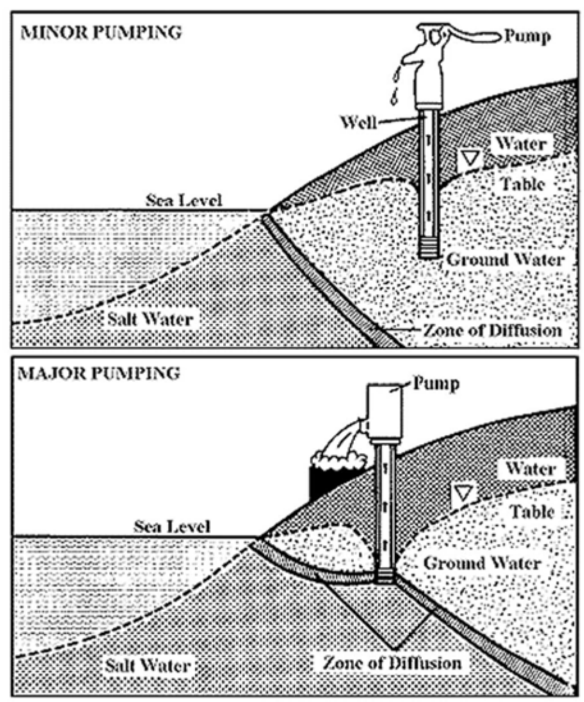

Figure 4.

CAUSES OF GROUND WATER POLLUTION

Most human activities at the land surface cause some change in the quality of water in the aquifer beneath them. The importance of the effect of a particular activity is related to the amounts and types of contaminants released. The severity of an occurrence is also related to the ability of the soil and ground water system to degrade or dilute the contaminants, and the degree to which the contamination will interfere with uses of the water. Contamination is usually more serious in a drinking water supply than in water for other uses.

Except where contaminated water is injected directly into an aquifer, essentially all ground water pollutants enter the aquifer through recharge water from the land surface. Examples of contaminants are:

- synthetic organic chemicals, such as, pesticides and petroleum products
- certain heavy metals, such as, mercury, arsenic, cadmium, chromium and lead
- nitrate nitrogen
- bacteria and viruses; and
- petroleum residues and combustion products from automobiles along roadways.

These are considered harmful if ingested with drinking water, and may be carried into surface water bodies by ground water.

Each human activity has a particular impact on ground water. Some agricultural activities add nitrate nitrogen and pesticides to ground water. Residential areas with septic systems usually add nitrate nitrogen, bacteria, viruses, and synthetic organics used in household cleaning products and septic tank cleaners. Industrial activities tend to add organic chemicals and metals, though in widely varying amounts. Gasoline storage areas (including service stations) may have leaks and spills of petroleum products. Roadways contribute petroleum pollutants leaked from vehicles and metals from exhaust fumes. The most concentrated impact comes from older sanitary landfills, whose leachate may contain many different chemicals at relatively high concentrations (Figure 5).

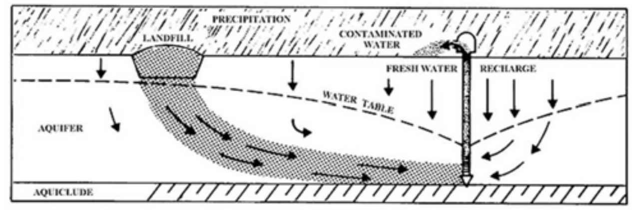

Figure 5.

GROUND WATER PROTECTION

Protecting our ground water from contamination will require thoughtful management and cooperation on the part of citizens and the various levels of government. In many cases, land use planning is the best instrument available for protecting aquifers still containing good quality water. If potential contamination sources are prevented from locating over critical recharge areas, the risk of contamination can be greatly reduced.

Careful use and proper disposal of the chemicals causing contamination is also necessary. Industries, farmers, and homemakers located above ground water supplies need to practice good management with respect to the use and disposal of chemicals. Regulations which govern the use and disposal of hazardous wastes need to be enforced. An equally important step is to make people aware of their potential impact on ground water. Action is needed now to protect our valuable ground water resources in many parts of the Southeast.

NEED MORE INFORMATION?

The following EDIS publications may help:

- Basics of Soil and Water Relationships series:
    - SL-37 Part I *Soil as a Porous Medium* explains fundamentals of soil structure, particularly particle and pore size, total porosity and soil bulk density (http://edis.ifas.ufl.edu/SS108).
    - SL-38 Part II *Retention of Water* explores the influence of soil structure on retention of water (http://edis.ifas.ufl.edu/SS109).

- SL-39 Part III *Movement of Water* deals with fundamental principles of water flow in soil (http://edis.ifas.ufl.edu/SS110).

- SL-40 *Behavior of Pesticides in Soils and Water* discusses the pathways of pesticide losses, the relationship between solubility and absorption, biological degradations and estimating pesticide loss (http://edis.ifas.ufl.edu/SS111).

- WQ101 *Florida's Water Resources* discusses the hydrologic-cycle, rainfall, runoff, principal Florida aquifers, salt water intrusion and springs (http://edis.ifas.ufl.edu/WQ101).