Pines Update

Issue 7, April 2005
Town of Pines, Indiana

What is Groundwater?

Introduction

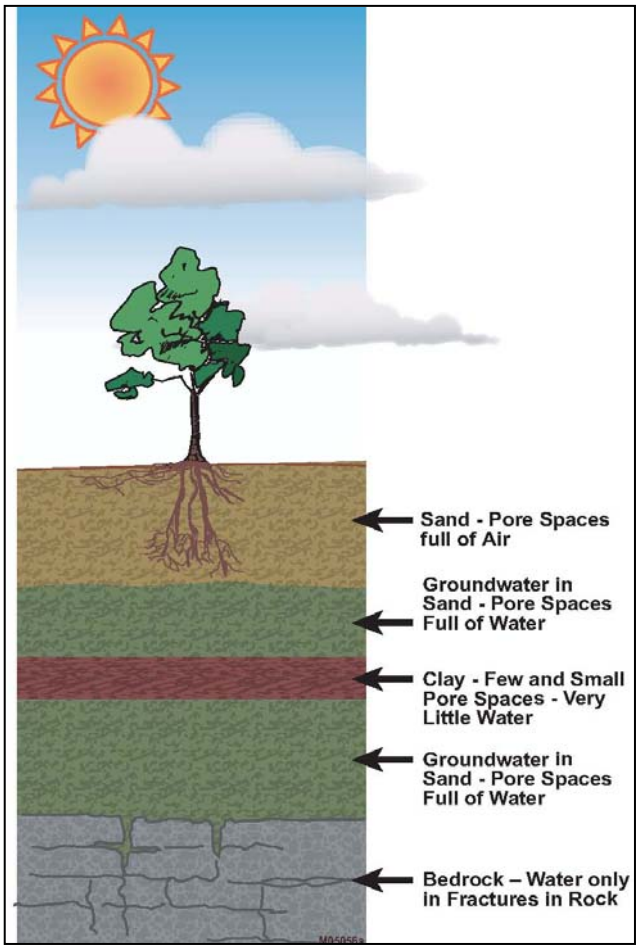
Northern Indiana Public Service Company (NIPSCO) and Brown Inc. (Brown) are conducting an investigation of the nature and occurrence of coal combustion by-products in an Area of Investigation in the vicinity of Pines, Indiana. This investigation is being conducted under a Consent Order that these parties have signed with the US Environmental Protection Agency (USEPA). Recently, NIPSCO and Brown submitted a draft work plan for the investigation to the USEPA for review. The investigation will include a study of groundwater. This *Pines Update* provides general information about groundwater, which may be helpful in understanding the groundwater portion of the investigation. This review of groundwater is not intended to be a comprehensive review of conditions in the Area of Investigation, but rather a general overview of groundwater in the environment.

What is groundwater?

Groundwater is water present beneath the ground surface in spaces between dirt and sand (called "pore spaces") or in cracks in rocks. It is only very rarely present in underground rivers or lakes. Groundwater is present beneath most of the surface of the earth. Some is found at shallow depths, while some may be much deeper.

Groundwater is usually collected by installing a well. The well provides a long, narrow hole in the ground by which the water can be accessed. Typically, a metal or plastic pipe is placed in the hole to keep out the dirt and rocks. A pump is used to bring the water to the surface.

Groundwater may be present in many types of geologic materials, including sand, clay, and rock. When it is present in clay or solid rock, it is difficult to retrieve because these materials do not allow groundwater to flow easily through them (these materials are considered "not permeable" and underground expanses of them are referred to as aquitards). When groundwater is present in sand or some large cracks in rocks, it is relatively easy to retrieve because these materials allow water to flow readily through them (these materials are considered "permeable" and underground expanses of them are called aquifers).



The amount or level of groundwater beneath the ground fluctuates in response to the season and climate. During the growing season, plants use a great deal of water, and groundwater levels often drop. Outside the growing season and following heavy rains, groundwater levels typically rise.

Where does groundwater come from?

Groundwater is part of the earth's water, or hydrologic, cycle. This cycle begins with precipitation (rain). Rain falls from the atmosphere and lands on the earth's surface. Some of this rainwater may run off to storm sewers and/or nearby rivers or lakes, but much of this rainwater soaks (or infiltrates) into the ground where it can be used by plants. Water that infiltrates past the roots of plants will eventually reach the level where groundwater occurs (called the water table). Below the water table, all the spaces between the soil particles and fractures in rock are filled with groundwater.

Groundwater can generally move (flow). In temperate areas of the world (like in Indiana), groundwater generally flows beneath the ground from uplands (areas of higher elevation) towards lowland areas (for example, wetlands). The rate of this flow is typically very slow, on the order of inches or feet per year. When groundwater reaches a lowland area, it can leave the ground (discharge) and enter a wetland, river, or lake. As groundwater flows, a portion of it evaporates up into the atmosphere, which creates moisture that again falls as rain,

thus completing the hydrologic cycle. Water is also returned to the atmosphere through evapo-transpiration, that is, use of water by plants.

What is groundwater used for?

Most of the world's fresh (unfrozen) water is stored as groundwater. Groundwater provides the primary source of drinking water to 50% of Americans. In addition to providing drinking water, groundwater is used for irrigation and industrial purposes (for process water or cooling water). It supports rivers and other aquatic systems during dry periods of the year. In the absence of irrigation, plants rely on groundwater for growth.

Not all groundwater is suitable for all possible uses. Where groundwater is present in clay or solid rock, it is difficult to extract and cannot be considered a resource. Where groundwater is located near the ocean or in very deep aquifers, it may be salty or contain too many minerals, which also makes it unsuitable for all uses.

Man-made conditions also affect how groundwater is used. In heavily industrialized areas and in areas of high density housing (such as cities), groundwater may not be suitable for drinking water due to man-made impacts (for example, runoff from roadways infiltrating the ground).

How old is groundwater? An interesting fact….

The amount of tritium in groundwater can help us understand the age of groundwater in a particular area. Tritium is a special form, or isotope, of hydrogen (i.e., hydrogen atom containing three neutrons). Tritium began appearing in the atmosphere only after testing of nuclear weapons started in the mid-20th century. Therefore, groundwater that contains tritium is known to have been impacted by the atmosphere within the last 50 years, and is therefore relatively "young." Groundwater in shallow aquifers will contain tritium. Deeper aquifers often contain groundwater that is much older and so it generally contains little or no tritium.

What is the chemistry of groundwater?

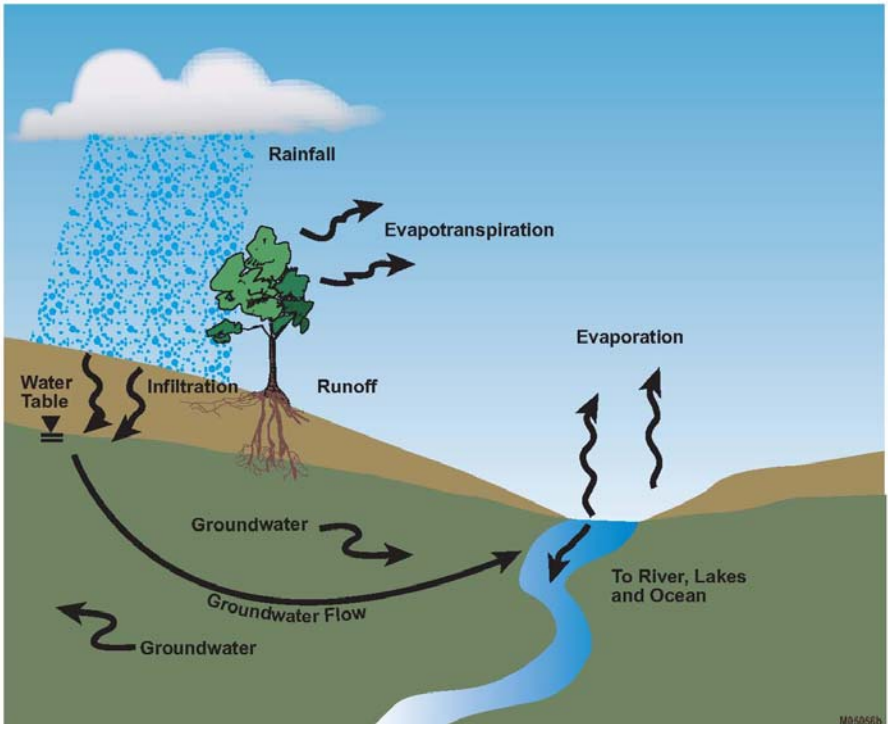
As groundwater moves through the subsurface, it is in constant contact with soil, sands, and/or rocks. As it slowly travels through these materials, it picks up minerals that are contained in particles or rocks. These minerals are slowly transferred from the materials into the groundwater, where they become dissolved (that is, they mix completely with the water). The dissolved minerals are a natural part of groundwater, affecting its taste and contributing trace elements and nutrients to our diet. Deeper groundwater generally has higher levels of minerals because it has traveled longer and farther through more geologic materials. In some cases, the natural level of dissolved minerals may be unpleasantly high, such as with very hard water or salty water near oceans.

What affects groundwater?

Groundwater exists under many different conditions, which can impact its quality. Shallow groundwater is much more vulnerable than deep groundwater, because the deeper groundwater is more isolated from potential impacts. Also groundwater in sandy aquifers is more easily impacted (compared to less permeable geologic materials), because water moves more quickly, reducing the time available for filtration.

The most common man-made impacts to groundwater quality include residential septic systems, gasoline stations, road de-icing, and farming:

- In areas where shallow groundwater is used for drinking, septic systems can directly impact the quality of drinking water (see text box and figure #3).
- Hydrocarbons and metals can be released from gasoline stations through leaks in the underground tanks and/or piping, improper filling of the tanks, or surface spills at the fuel dispensers.
- In winter, salts are commonly used to melt snow and ice, especially on roadways. As the snow and ice melt, the water containing the salts infiltrates into the groundwater.



What is in bedrock in the Area of Investigation Another interesting fact…

The type of rock located below the sands and clays at the Pines Area of Investigation is called "Atrium Black Shale." US Geologic Survey studies have shown that this formation contributes relatively high levels of many minerals to groundwater that passes through it. This results in higher levels of these minerals in the aquifers located above the Antrim Shale. It is interesting to note that if the bedrock formation were limestone (instead of the Atrium Black Shale), as it is beneath much of northern Indiana, it would cause higher levels of calcium and magnesium in the groundwater rather than the higher levels of boron.

- Agricultural products such as pesticides and fertilizers are applied over very large areas and they have been detected in large numbers of wells.

Other activities may affect groundwater are overproduction of groundwater (when too much groundwater is withdrawn from the earth), industrial manufacturing and processing, mining, and management of waste materials.

How do spills or leaks impact groundwater?

When materials are released or placed at or just below the ground surface, rainwater can fall and trickle through these materials. Just as minerals in geologic materials gradually transfer into groundwater, various components of these man-made materials can transfer. Rainwater infiltrates down through the ground carrying the components with it to groundwater. Some of them are relatively harmless but others may not be. They flow with the groundwater once they reach it.

How is groundwater treated naturally?

The groundwater system typically has natural processes for treating or filtering these chemicals out of the water. These processes include biodegradation (natural microbes degrade or eat the chemicals, such as in a septic leach field), adsorption (where chemicals are physically absorbed by the geologic materials and so removed from the water), physical precipitation (where chemicals are changed chemically to a form that precipitates out of solution and is removed from the water), and dispersion (where concentrations are decreased with travel distance as the chemicals mix with non-impacted groundwater). These processes acting in combination are called "attenuation."

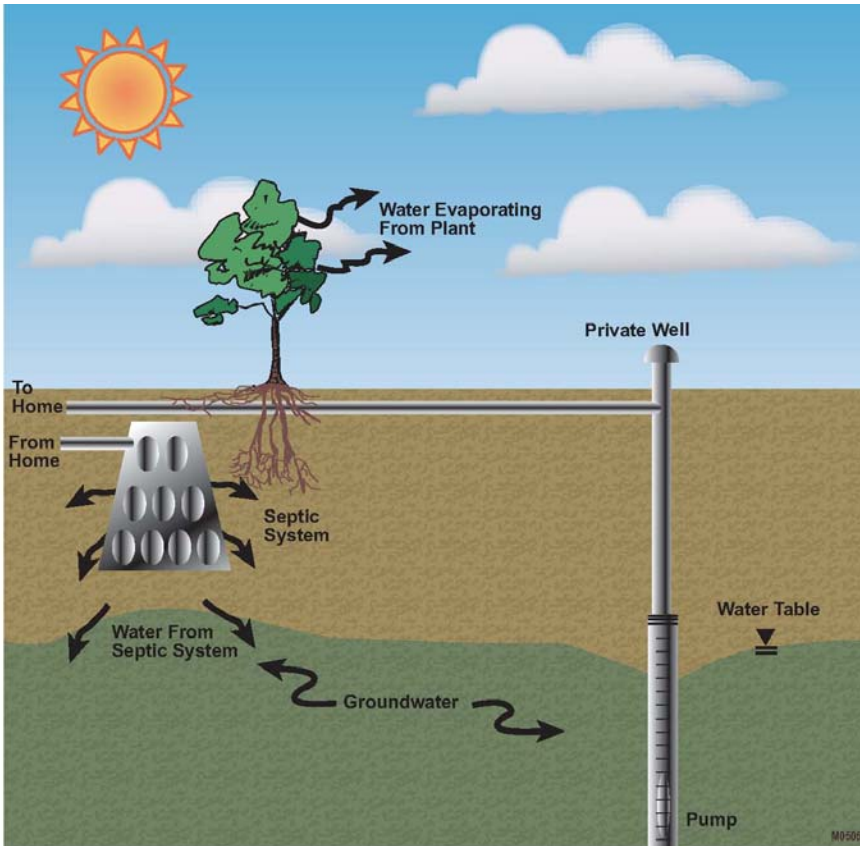
Is all groundwater useable?

Not all groundwater is or should be considered suitable for all uses. Groundwater near the ocean may be naturally salty or groundwater beneath major cities can be heavily impacted by man-made activities. These groundwaters are a lower priority because they would not be suitable for use as a drinking water source without treatment. Both the quantity and quality of groundwater must be protected.

Engineering Principles of Septic System Design

Geologic soils provide a mechanism of treatment or filtration for septic waste, so these wastes are filtered out of the waste before it reaches groundwater or moves very far. Where conditions are suitable and septic systems installed properly, domestic sewage can be effectively treated with minimal impacts to the groundwater.

However, many older septic systems were installed in unsuitable conditions and/or before adequate design standards were in place (today, Indiana has regulations on the design of septic systems, including how far a system can be placed from a drinking water well or surface water body). In areas where shallow groundwater is used for drinking, septic systems can directly impact the quality of drinking water.



How is groundwater protected?

The following is a short list of some of the ways in which groundwater is protected:

- Federal and state regulations and laws address storage and handling of fuels, chemicals, and wastes.
- Many states have laws requiring permits to withdraw large amounts of groundwater, to ensure the resource is not overused.
- During droughts, conservation measures may be implemented to ensure that groundwater resources are not overused.
- Indiana protects groundwater by requiring well drillers to be licensed, requiring permits for installing wells, and specifies certain standards for the construction of wells.
- Indiana and local health departments protect groundwater from septic impacts by specifying design and other requirements for septic systems.
- The US government and states have developed programs such as the Comprehensive State Groundwater Protection Program, the sole source aquifer program, and wellhead protection programs.
- Local zoning and planning can regulate land use in a way that considers groundwater vulnerabilities.

Where can I get more information about groundwater?

National Groundwater Association: www.ngwa.org ; www.wellowner.org

USGS: http://water.usgs.gov ; http://capp.water.usgs.gov/GIP/gw_gip/index.html

Indiana Department of Natural Resources: www.in.gov/dnr ;

http://www.in.gov/dnr/water/ground_water/

USEPA: www.usepa.gov ; http://www.epa.gov/seahome/groundwater/src/ground.htm

Our Commitment….

NIPSCO and Brown are committed to keeping you informed on the progress of the municipal water service extension and the investigation of the Pines Area of Investigation. Look for future *Pines Updates* (such as this one) to update you to our progress. We have also created a website to provide continual updates on the project: **www.pinesupdate.com**

Please contact the Communications Coordinator at the address listed below to be placed on the mailing list.

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