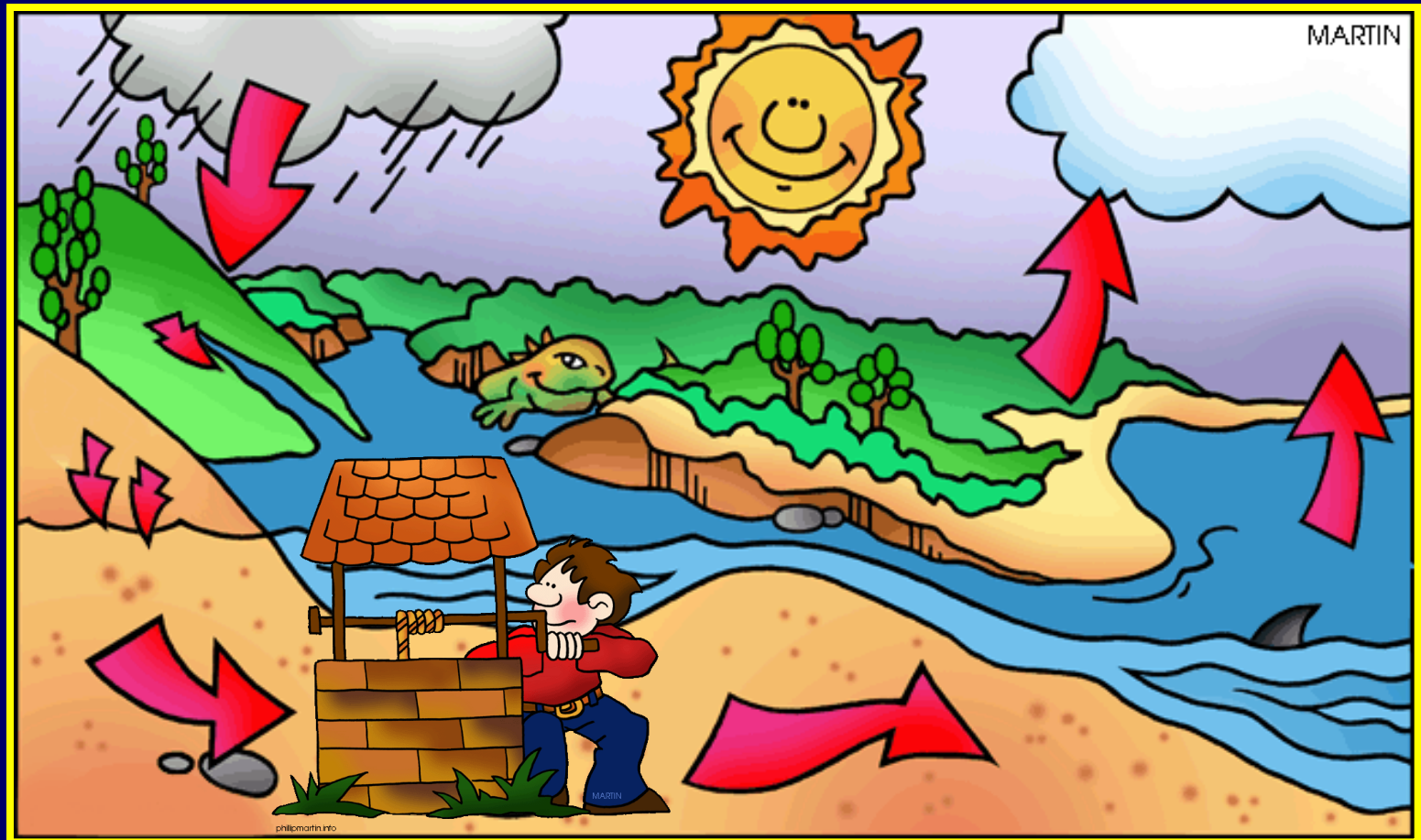


# Groundwater



# Essential Standard 2.3

Explain the structures and processes within the hydrosphere.

## Learning Objective 2.3.2

Explain how groundwater and surface water interact.

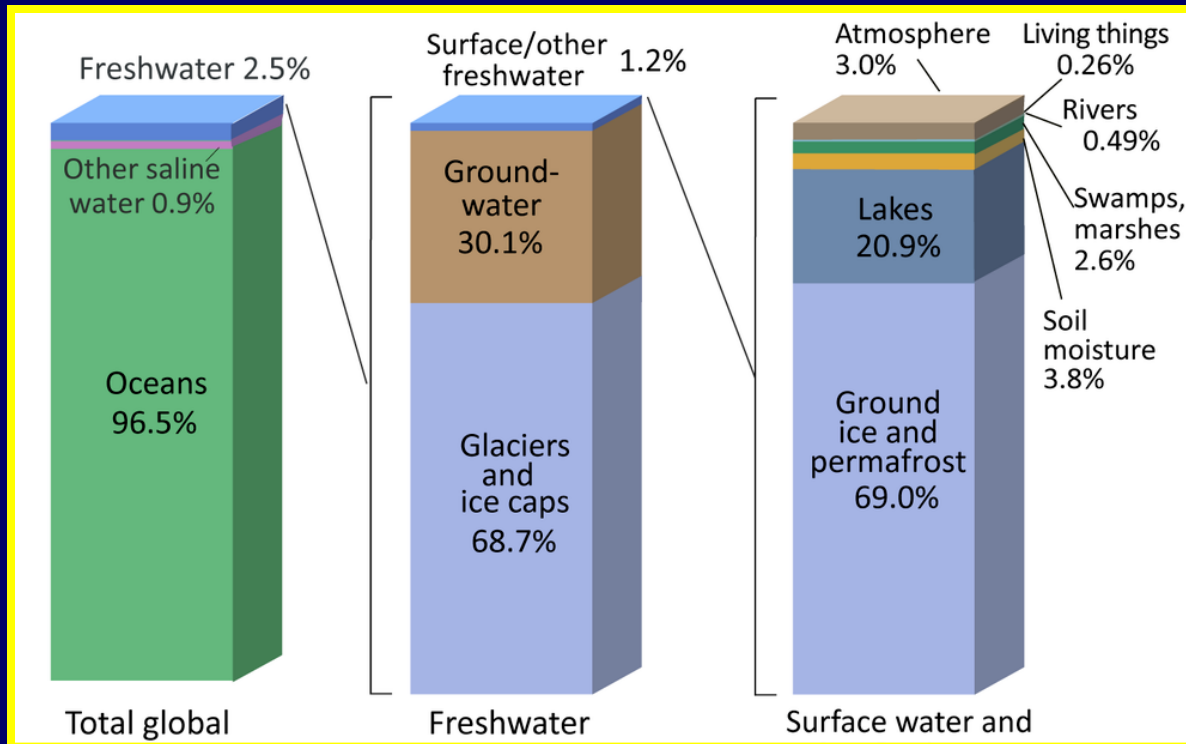
# I Can Statements

At the end of this lesson, you should be able to say, with confidence:

- I can list four factors that affect the rate of infiltration of groundwater.
- I can describe the relationship between the unsaturated zone, saturated zone, and the water table.
- I list several features formed when groundwater intersects the land surface.
- I can distinguish between a confined aquifer, unconfined aquifer, and an aquiclude.

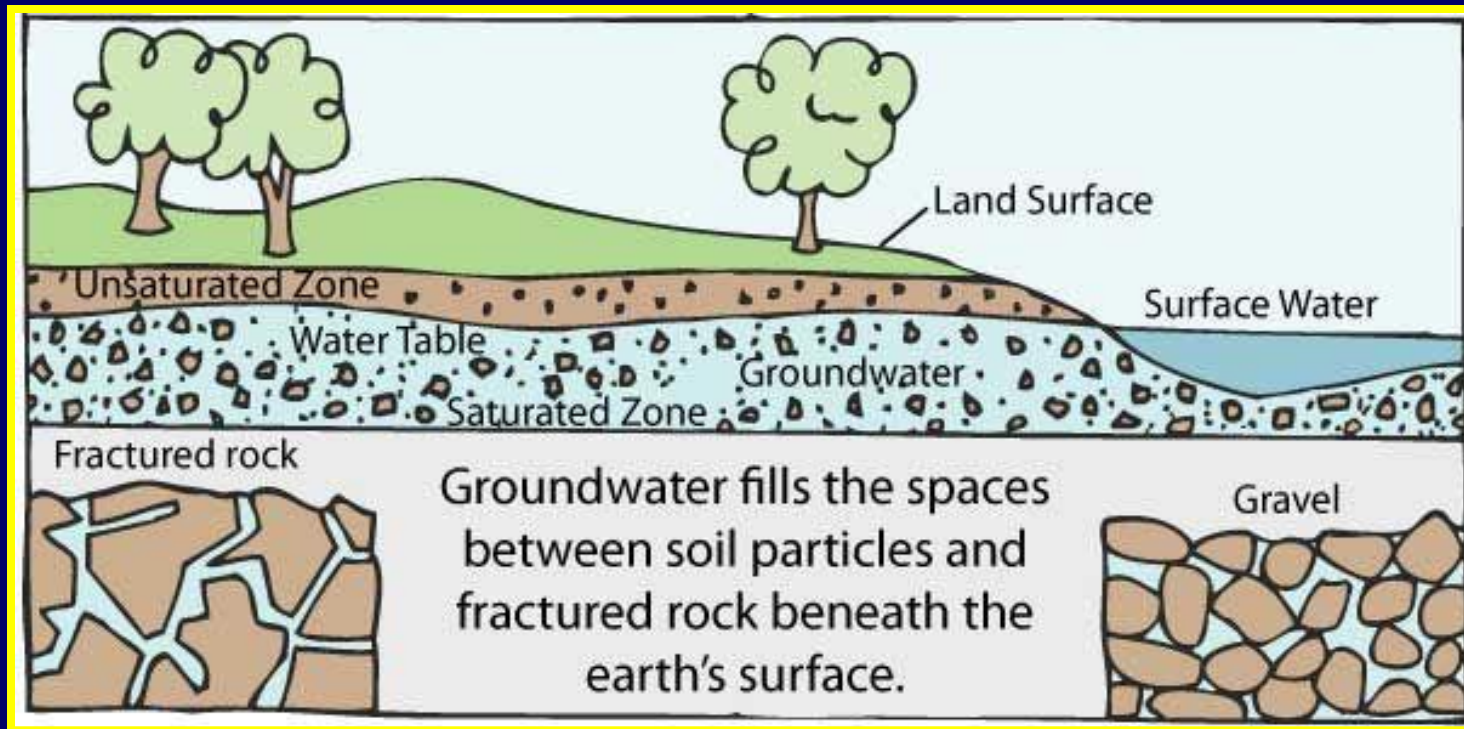
# Distribution of Earth's Water

Only 2.5% of Earth's water is freshwater and of that amount, 30.1% is groundwater, which makes groundwater the largest supply of freshwater that is available for use.



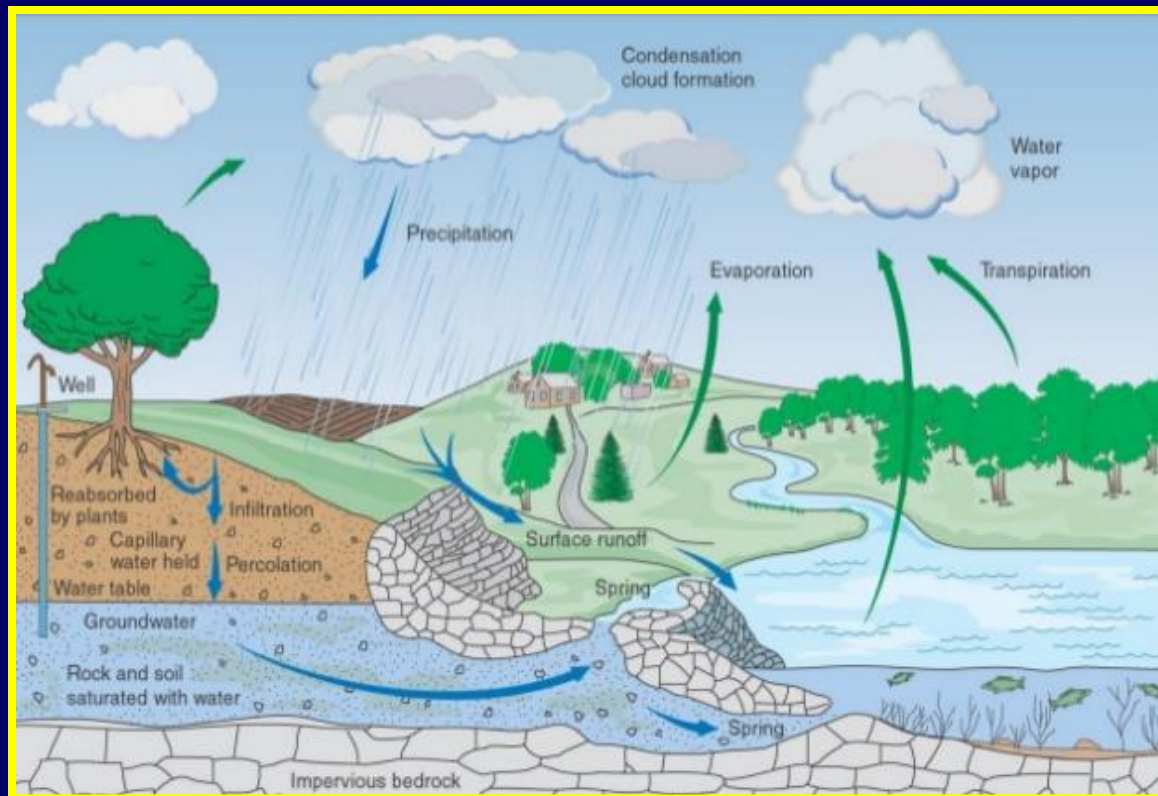
# Groundwater

Groundwater includes any water found below the surface of the land and usually fills the spaces between soil particles and fractured rock.



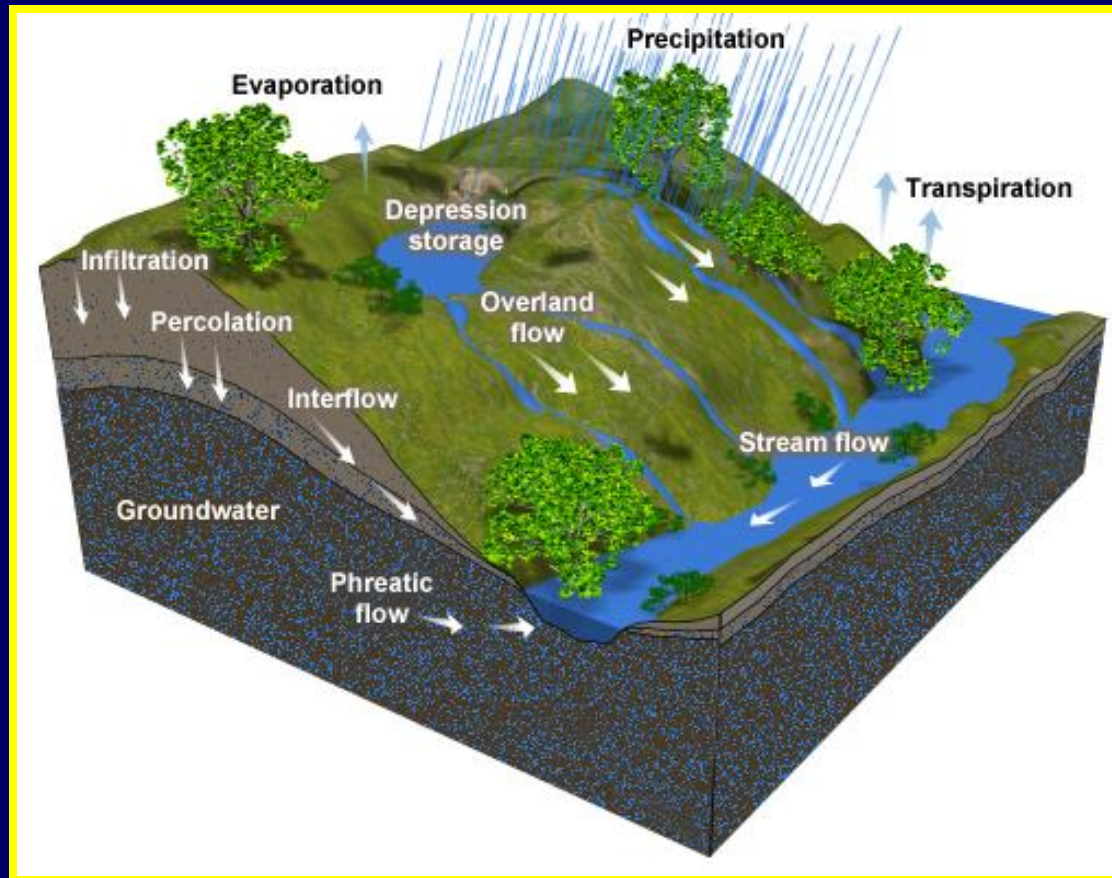
# Groundwater & Surface Water

All groundwater eventually becomes surface water at springs or by recharging ponds and lakes.



# Infiltration

Water becomes groundwater when rain or melted snow infiltrates or percolates into the ground.



# Rate of Infiltration



Light, gentle rains infiltrate the ground fairly easily.

Torrential downpours can exceed the rate at which water can infiltrate and result in more surface runoff.





# Land Surface

The type of land surface can also influence water infiltration.



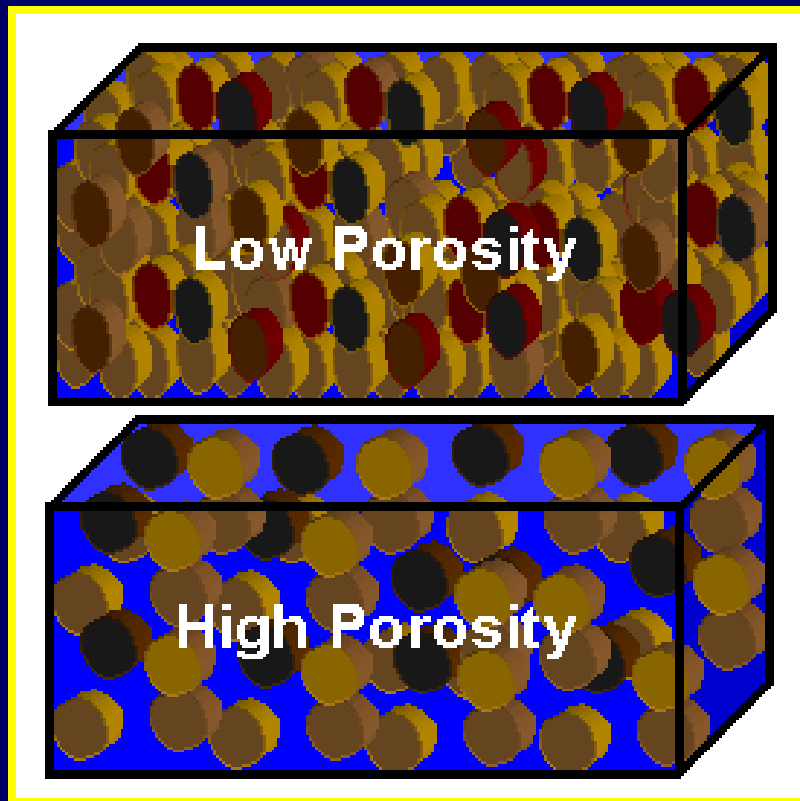
A pervious surface is one in which water infiltrates easily, such as grass, soil, sand, or gravel.

An impervious surface, such as cement, does not allow any water to infiltrate.



# Soil Type

Soil type, sand, silt, or clay, can also determine the rate of infiltration.



Porosity refers to the amount of pores there are in a sample of soil.

The higher the amount of pores there are in soil, the higher the higher the rate of infiltration.

# Porosity

Soil type such as if its sand, silt, or clay, can also determine the rate of infiltration.

Sand particles tend to be large and irregularly shaped, so it has a lot pore space and a thus, high porosity.



Clay particles tend to be very small and regularly shaped, so they fit together very tightly, allowing for little pore space and have a low porosity.

# Compaction of Soils



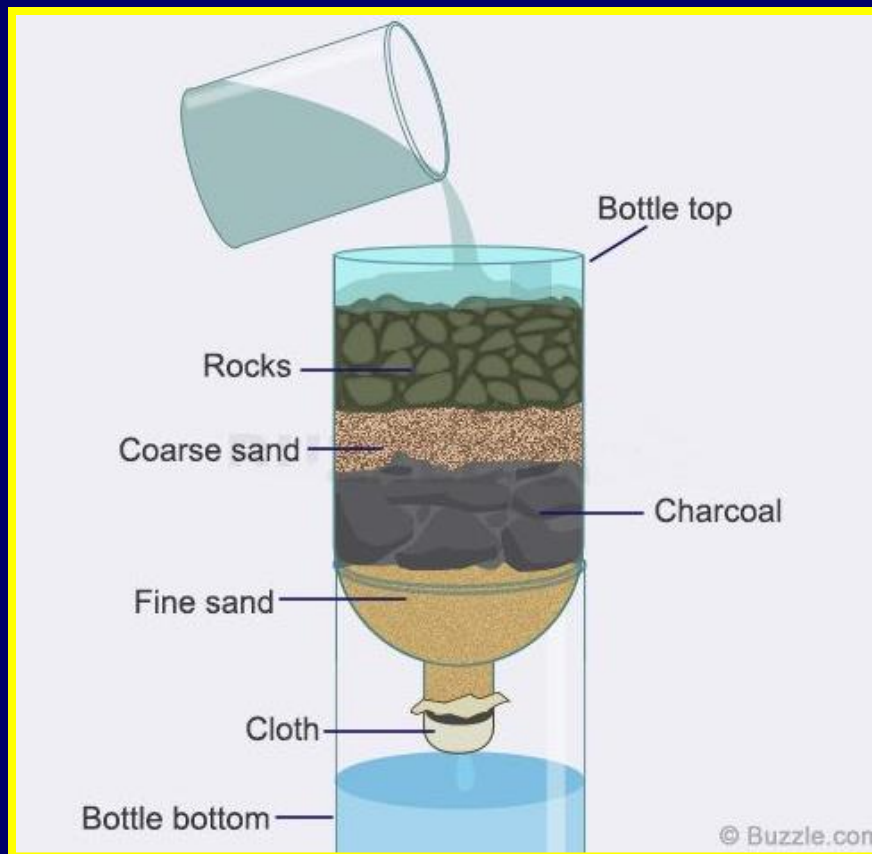
Loose soils tend to have a lot of pore space or high porosity, allowing water to easily infiltrate.

Compacted soils tend to have very little pore space and so have low porosity and allow for little infiltration.



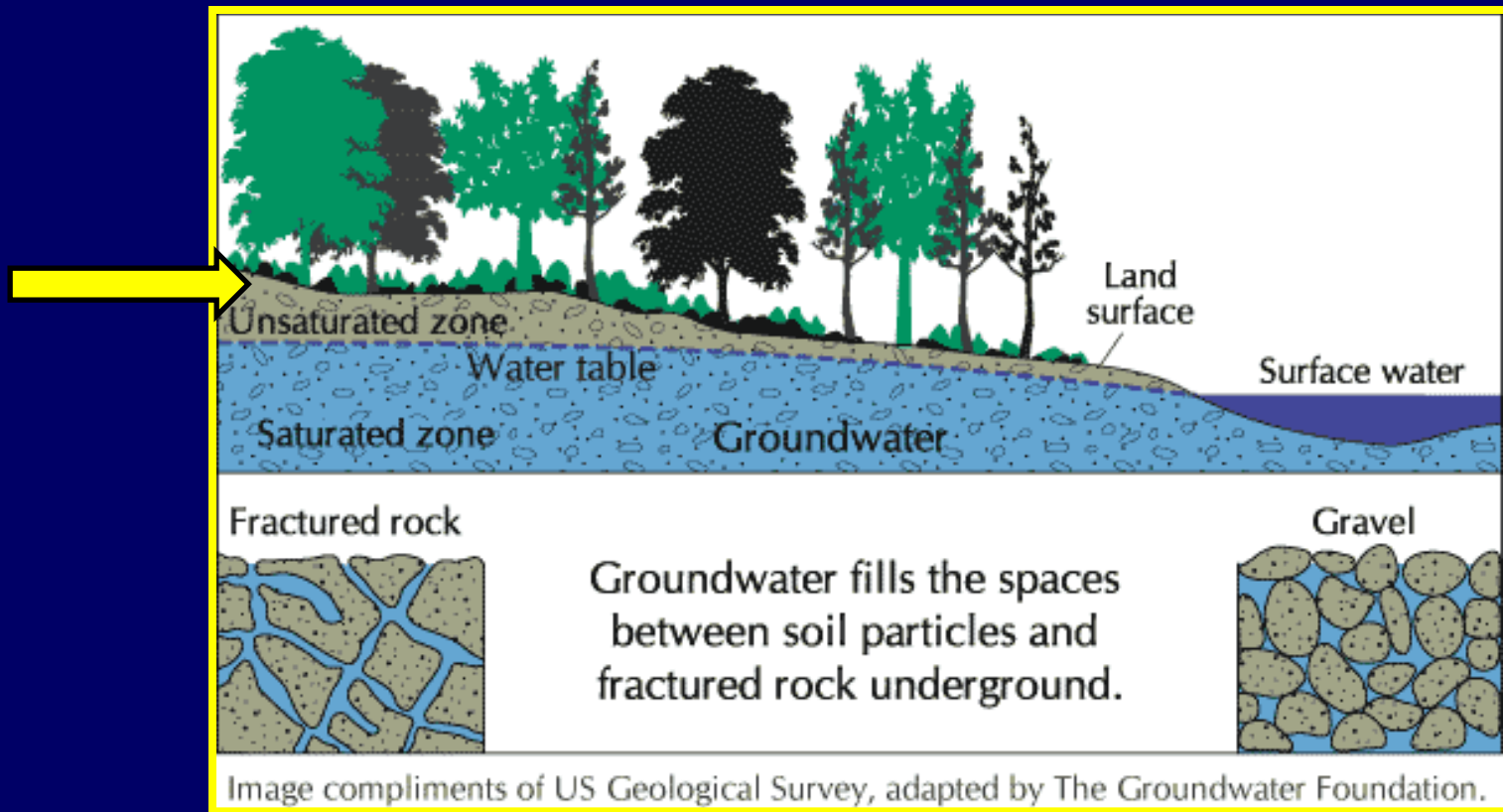
# Filtering of Groundwater

As water infiltrates through the sediments in the ground, the water is filtered and most impurities are removed.



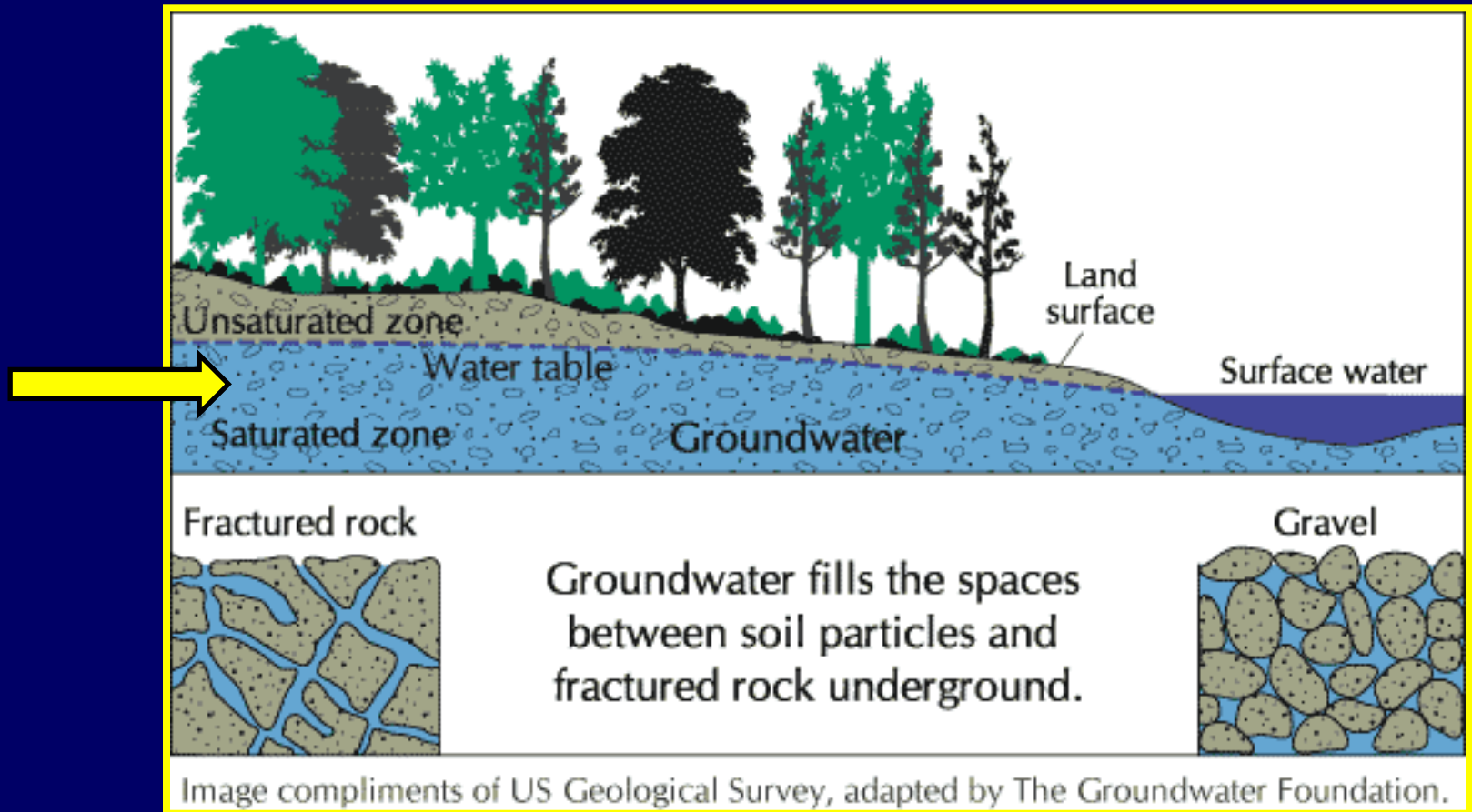
# Unsaturated Zone

The top part of the soil usually contains pores that are full of air or only partially filled with water and so is said to be part of the unsaturated zone.



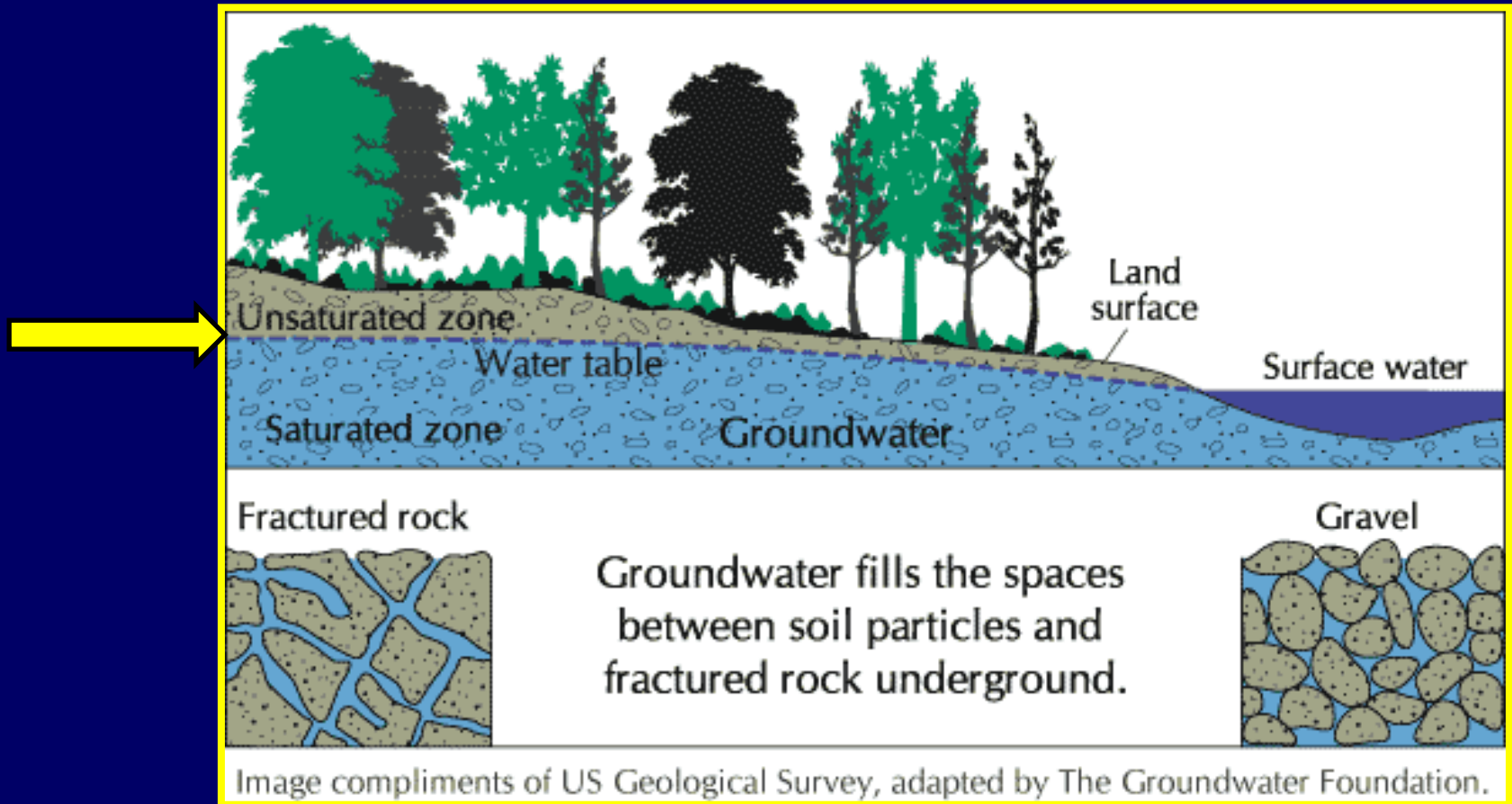
# Saturated Zone

The lower layer of soil and rock, in which all the pores are filled with water, is said to be the saturated zone.



# Water Table

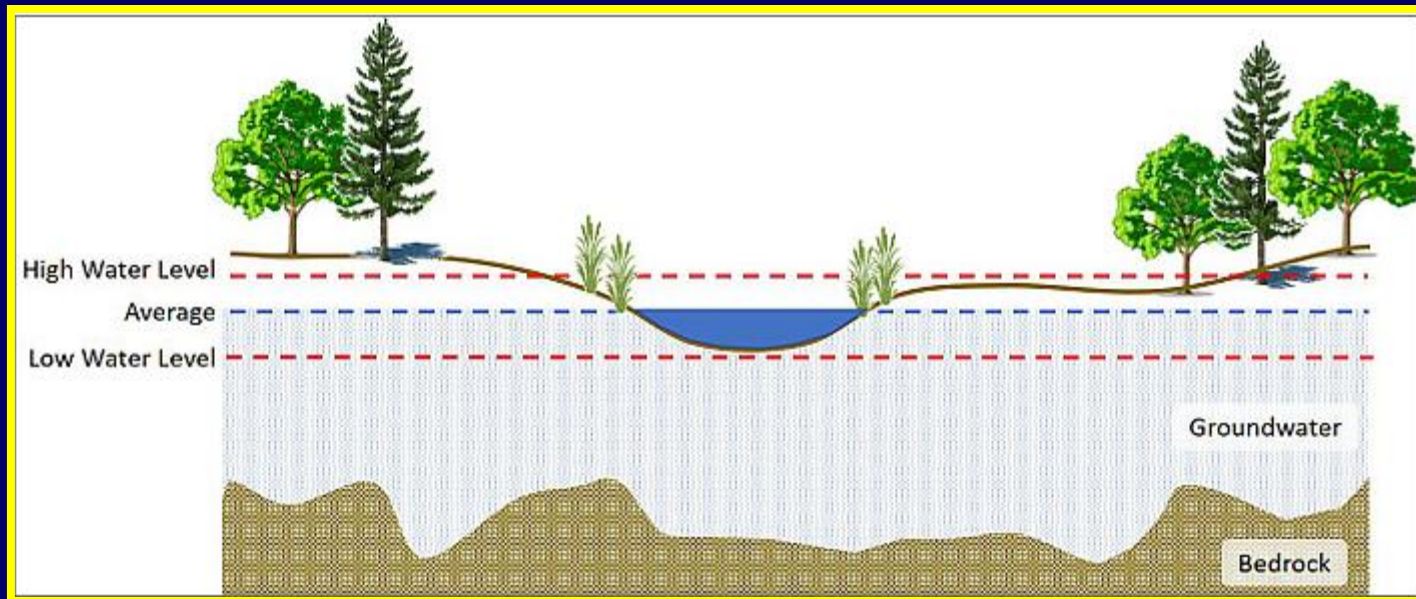
The boundary between the unsaturated zone and the saturated zone is called the water table.





# Variations in the Water Table

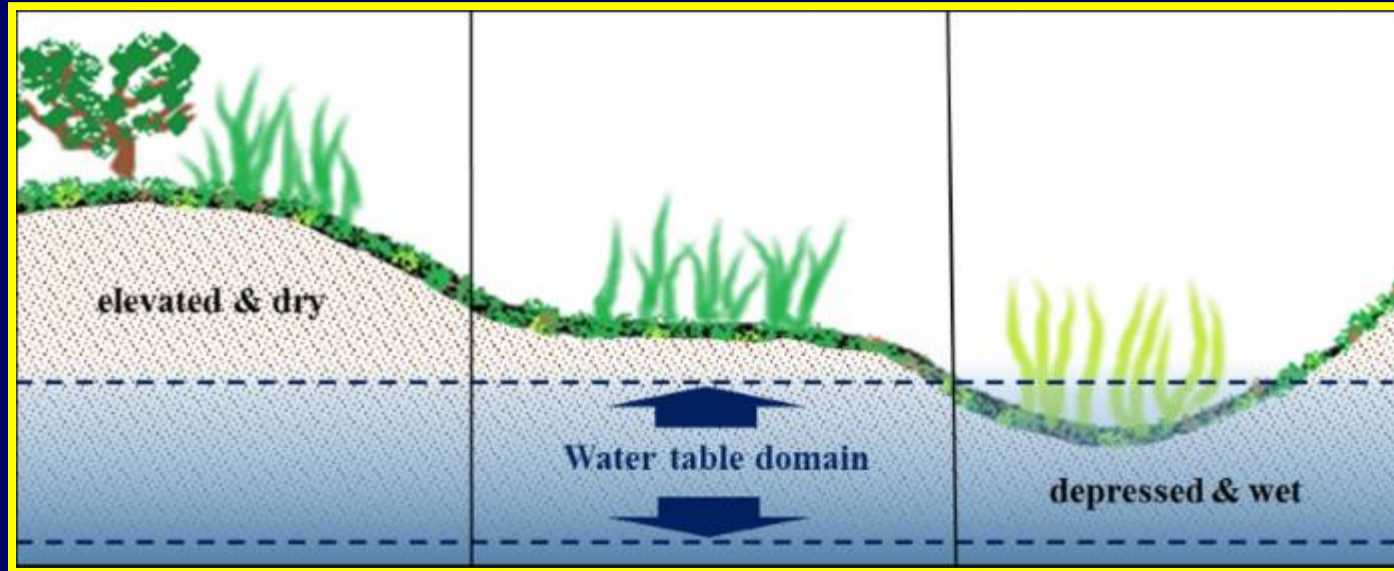
The height of the water table can vary with the amount of rainfall.



During times of low rainfall, the water table drops.  
During times of high rainfall, the water table rises.

# Variations in the Water Table

The water table can also vary with topography.



Hills and mountains

Water Table

Far Below Surface

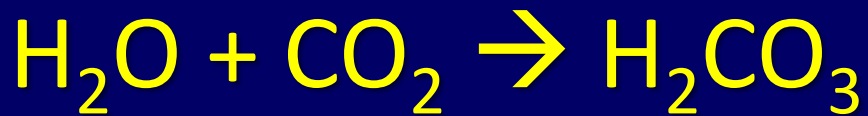
Wetlands

Water Table

Near or at Surface

# Formation of Caverns

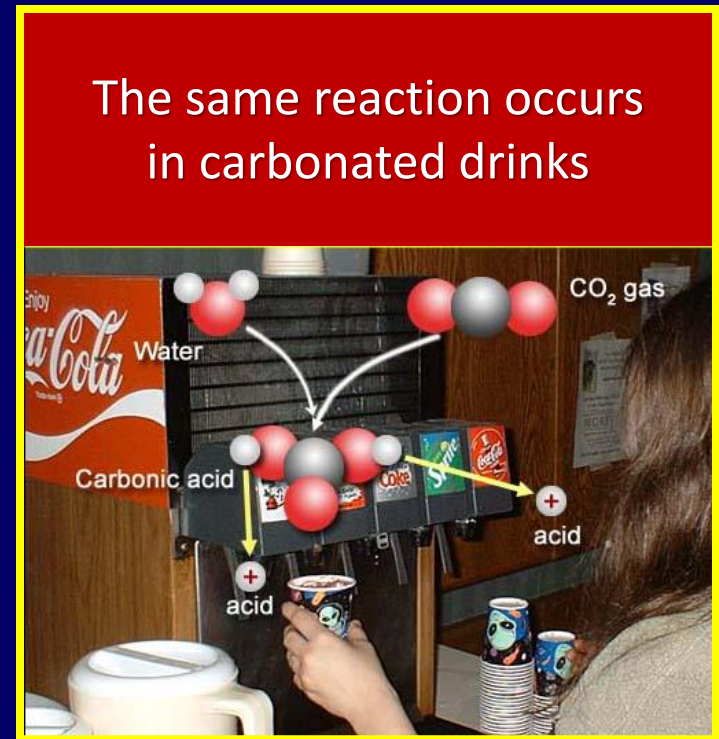
Groundwater often mixes with carbon dioxide gas in the soil, released during animal respiration and decomposition, to form carbonic acid.



$\text{H}_2\text{O}$  = Water

$\text{CO}_2$  = Carbon Dioxide

$\text{H}_2\text{CO}_3$  = Carbonic Acid



# Sinkholes

In areas where there is a lot of limestone bedrock, the carbonic acid breaks down the limestone to produce sinkholes.



Limestone regions that have a lot of sinkholes are said to have karst topography.

# Formation of Caverns

Caverns are often found in limestone areas where the water table is lowered as mountains are uplifted due to tectonic forces.

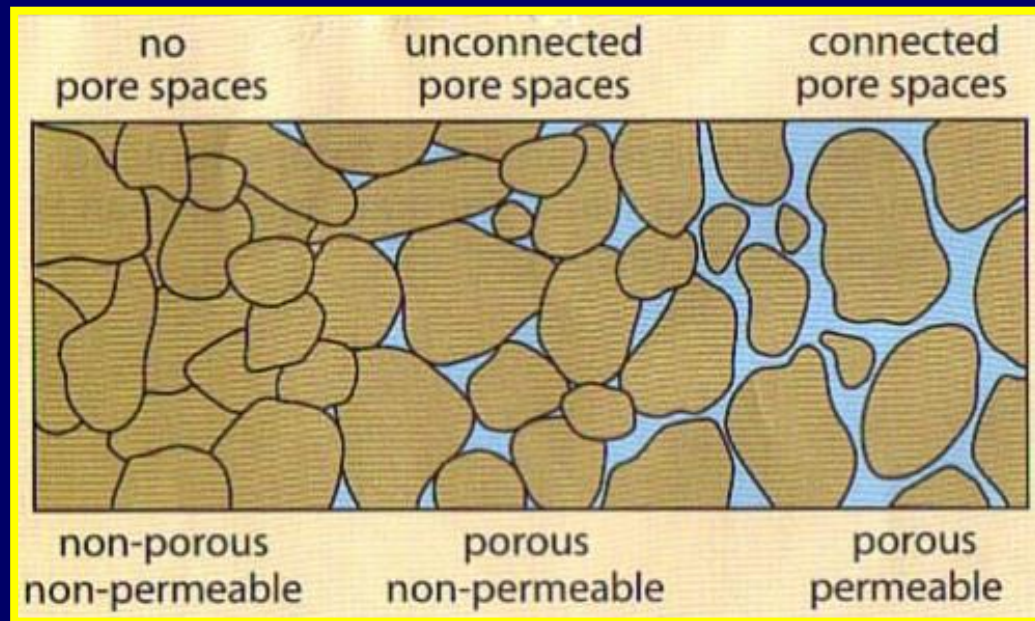
Stalactites  
Ceiling

Stalagmites  
Ground



# Groundwater Movement

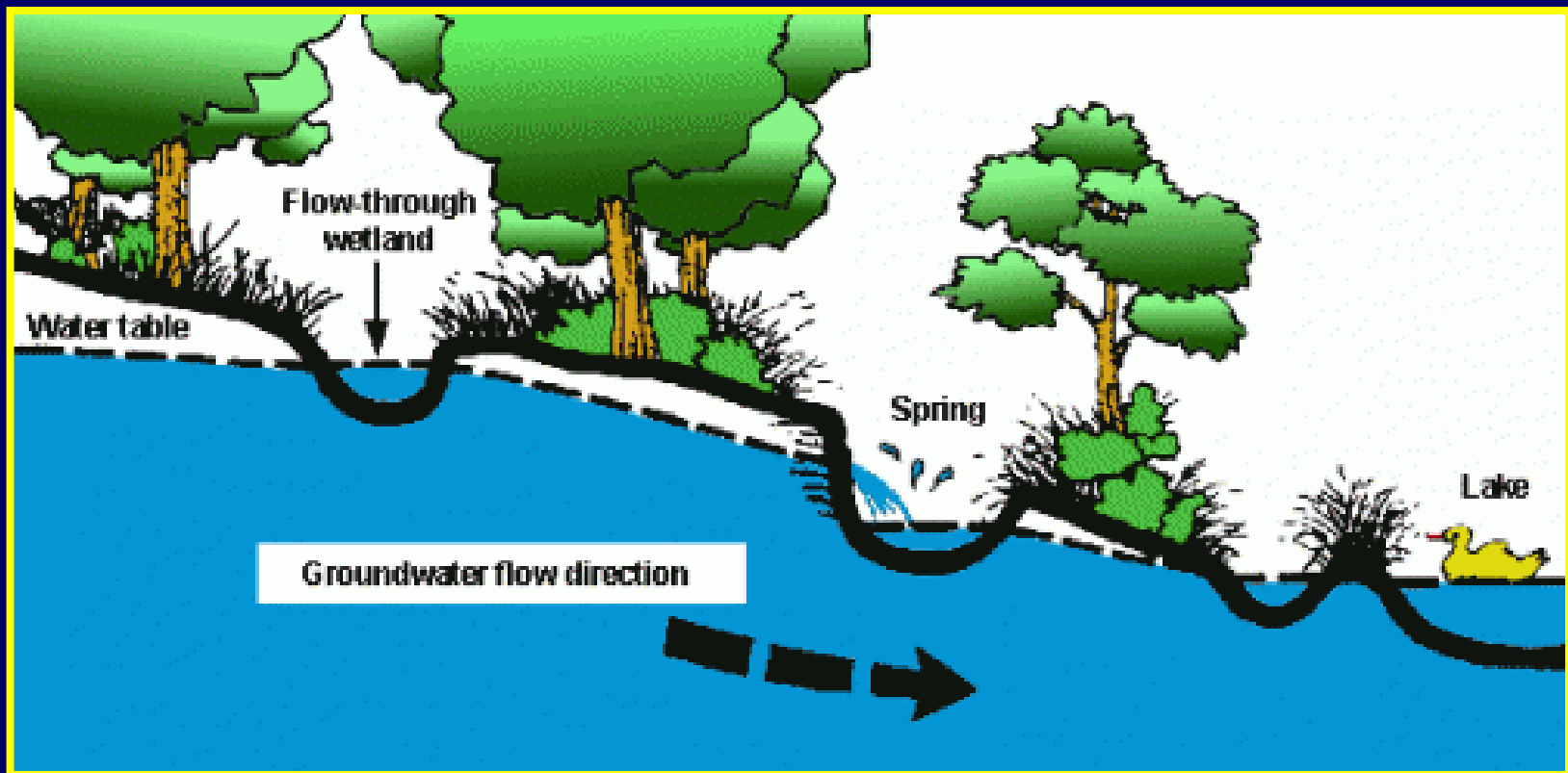
Like surface water, groundwater also moves downhill. But in order to move, the ground must be permeable.



The ground is permeable when the pores between sediments are connected so that water can flow freely through.

# Groundwater Meets Surface

When the water table intersects the land surface, groundwater will flow out onto land at a spring, wetland, pond, or lake.



# Springs

Most streams begin at springs, where groundwater flows out onto the surface.



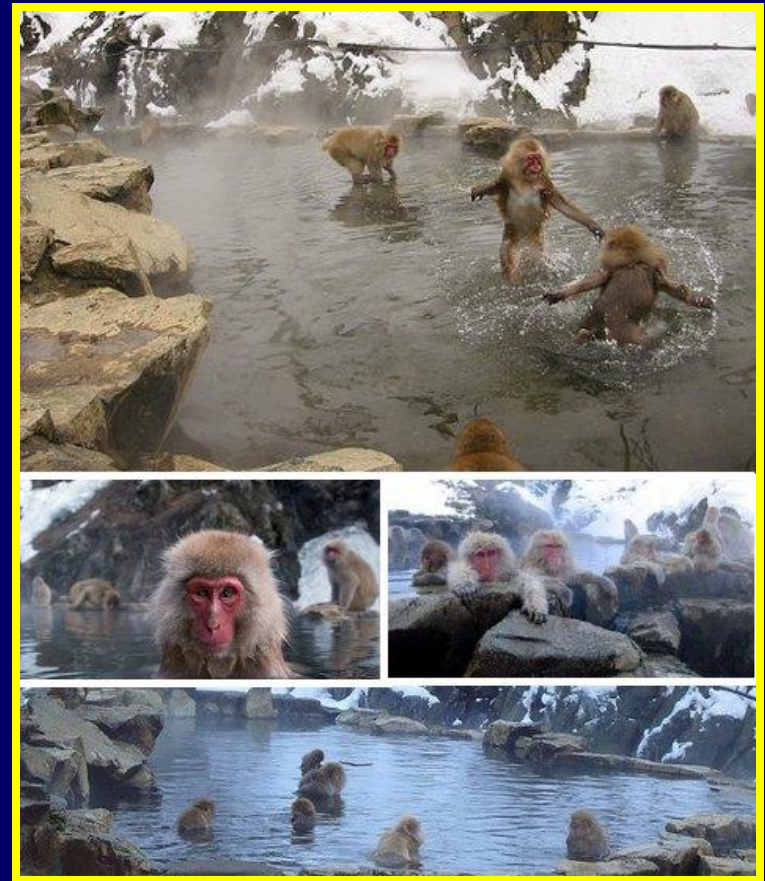


# Hot Springs

Hot springs occur where the groundwater source is close to the mantle and the water is heated.



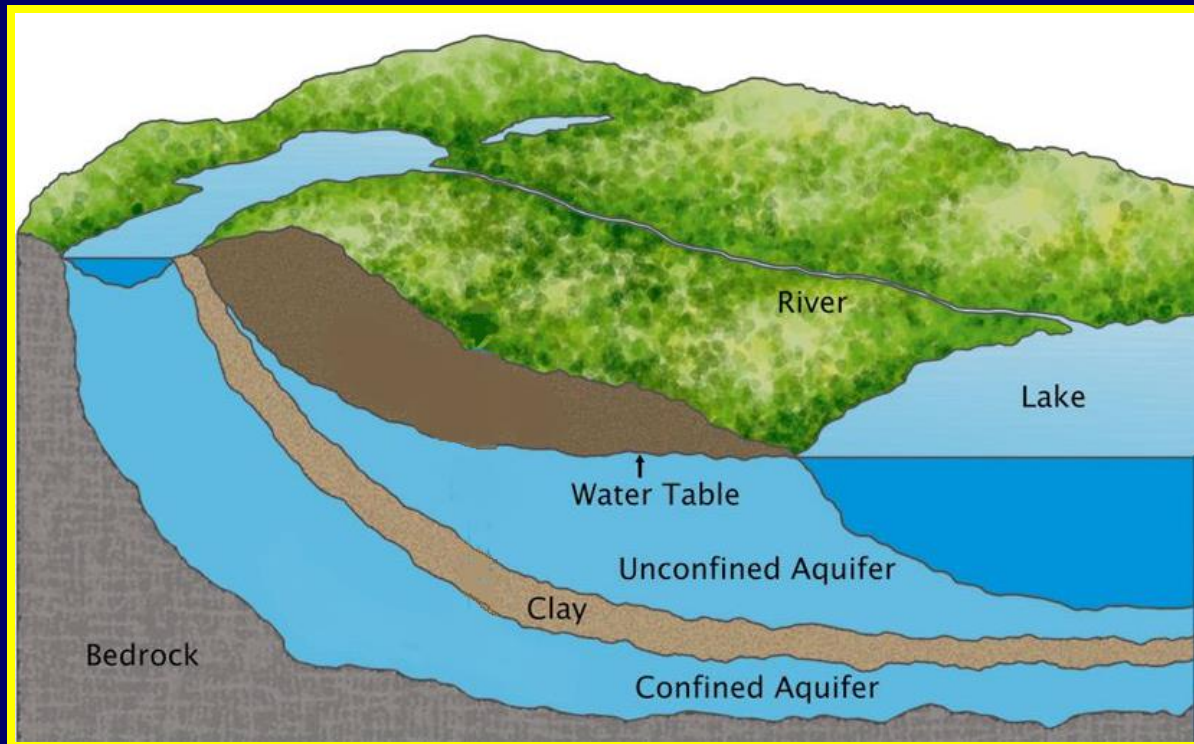
Iceland, being located on the Mid-Atlantic Ridge, is known for its hot springs.



Snow Monkeys in at hot springs in Japan

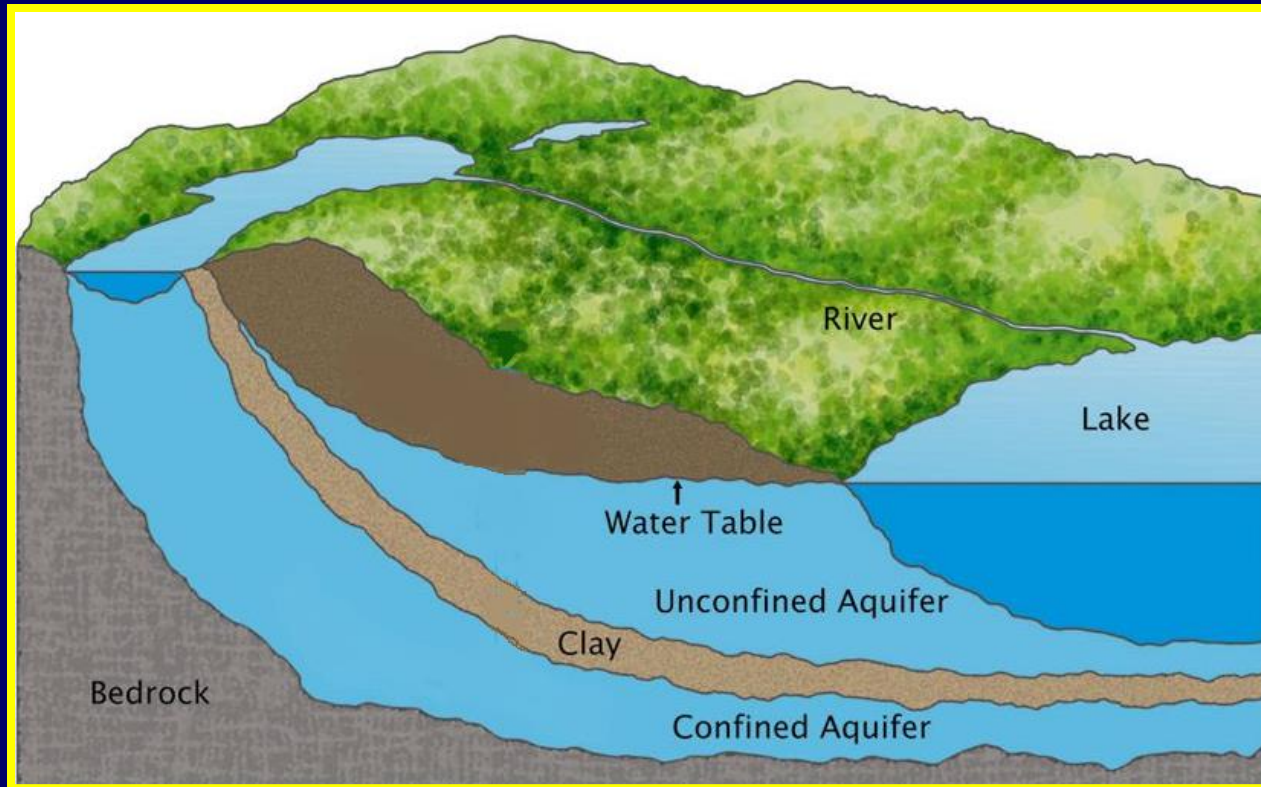
# Groundwater Storage

Areas under the water table that contain saturated, permeable sediment that allow water to flow easily through but can also store water for long periods of time are called aquifers.



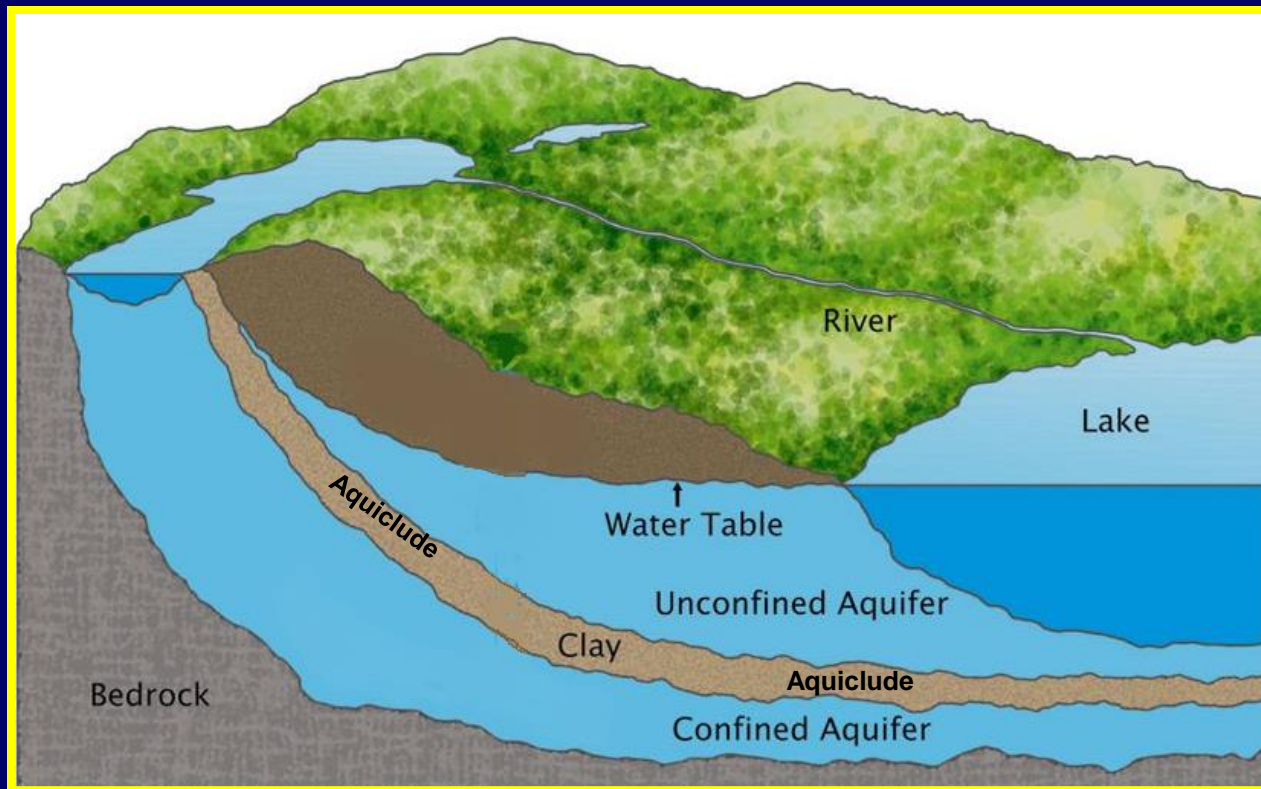
# Unconfined Aquifer

An aquifer that is able to be recharged with rainwater that infiltrates the soil, directly overhead, is said to be an unconfined aquifer.



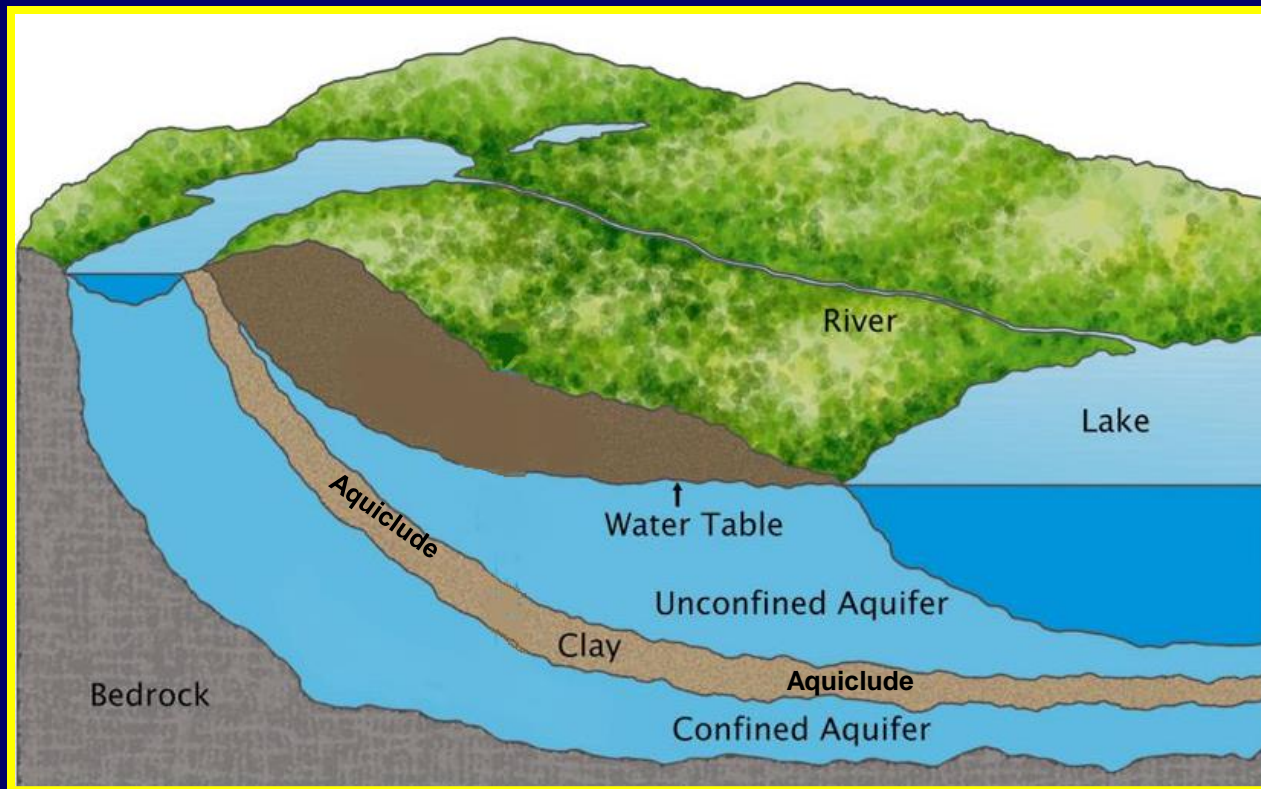
# Aquiclude

Layers of clay or rock that prevent water flow through the soil are called aquicludes because they exclude water.



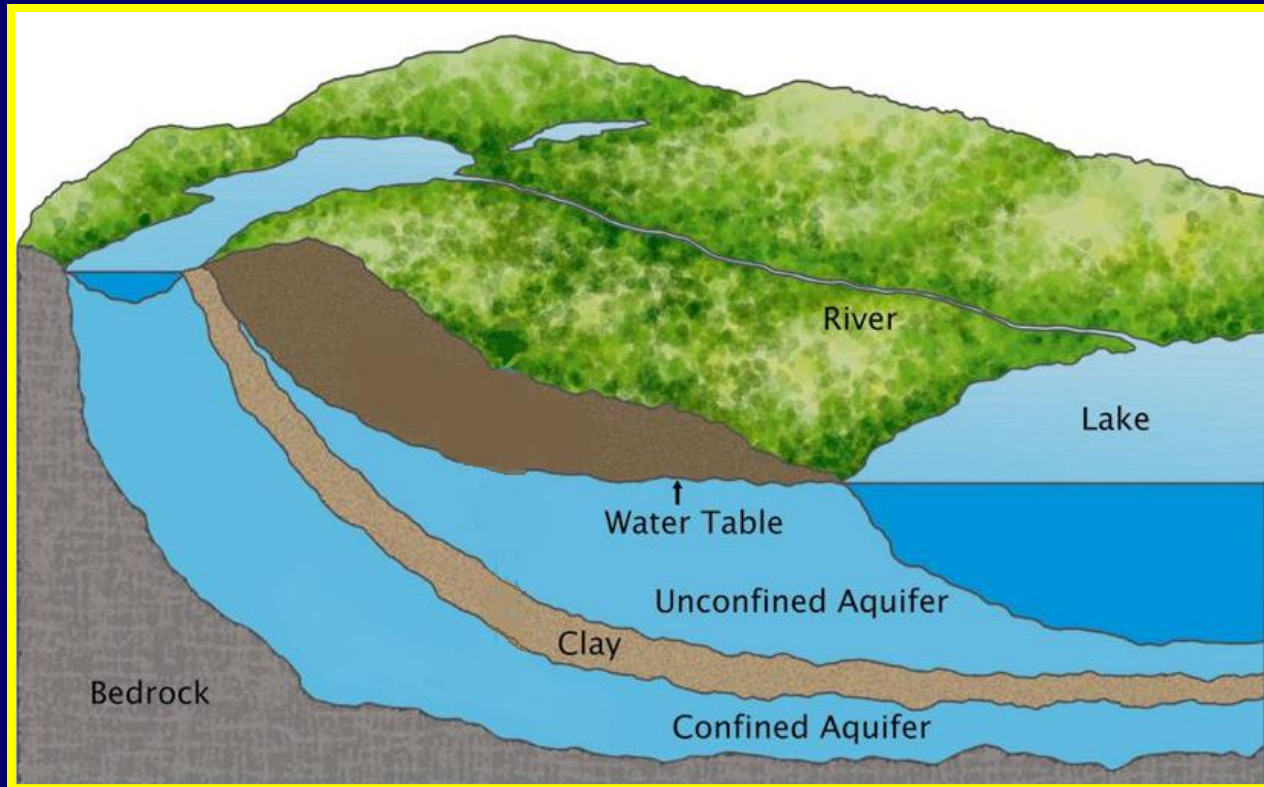
# Confined Aquifer

An aquifer that has an overlying aquiclude, that prevents infiltration of rainwater, is said to be a confined aquifer.



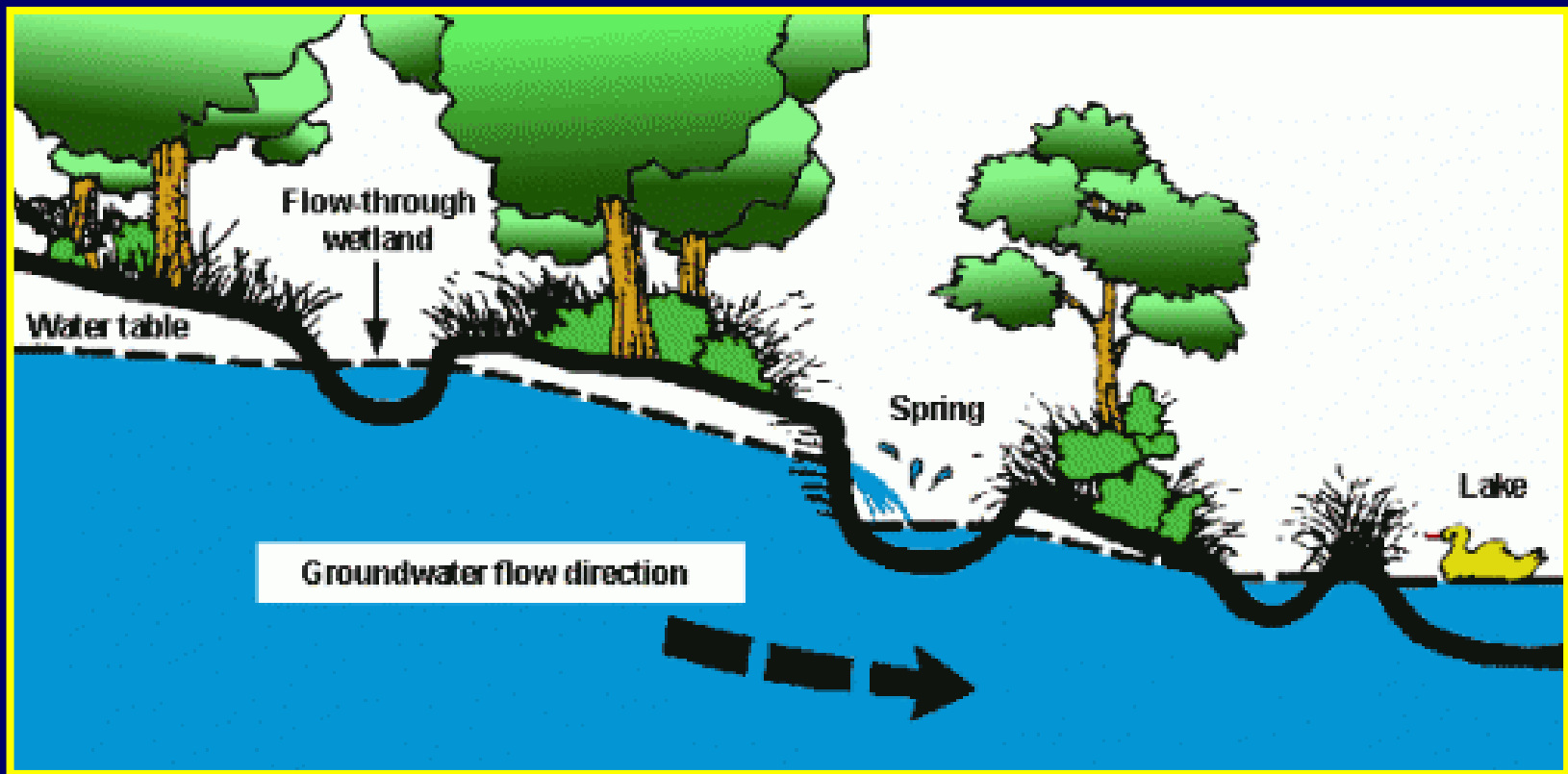
# Recharge of Confined Aquifers

Water can only enter confined aquifers in places where there are openings in the aquiclude and they can take thousands of years to recharge.



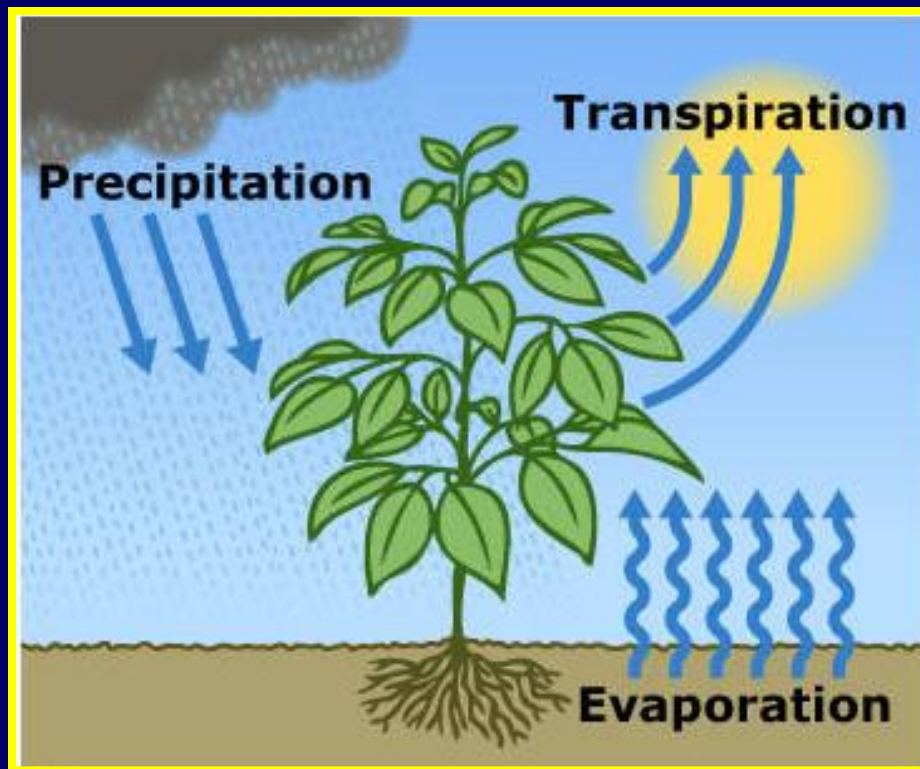
# Removal of Groundwater

As mentioned earlier, anytime the water table intersects the surface of land, groundwater will flow out onto the surface such as in a wetland, spring, pond lake.



# Removal of Groundwater

Groundwater can also be naturally removed and entered back into the water cycle by trees and other plants during transpiration, or water can simply directly from the soil.





# The End

