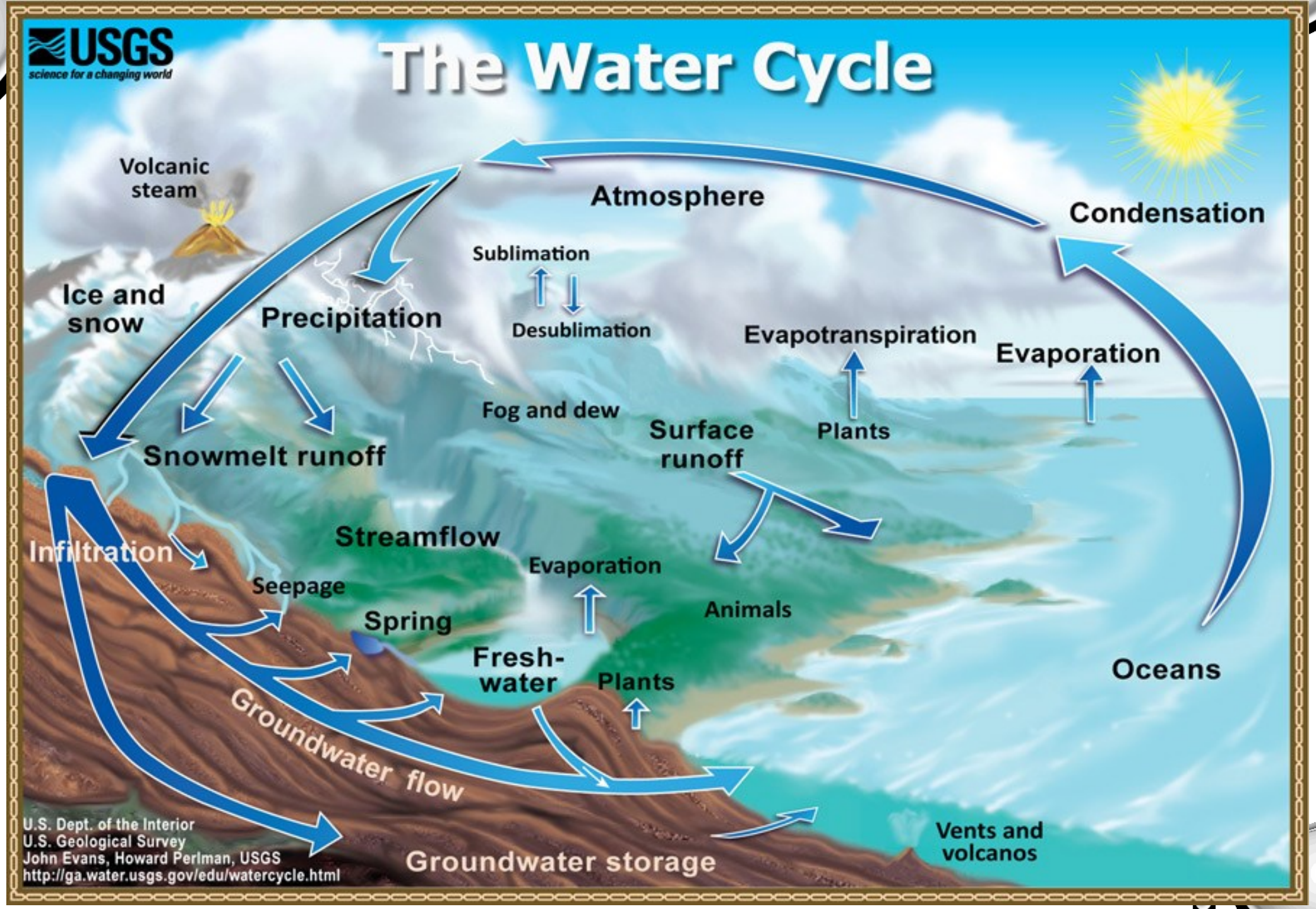
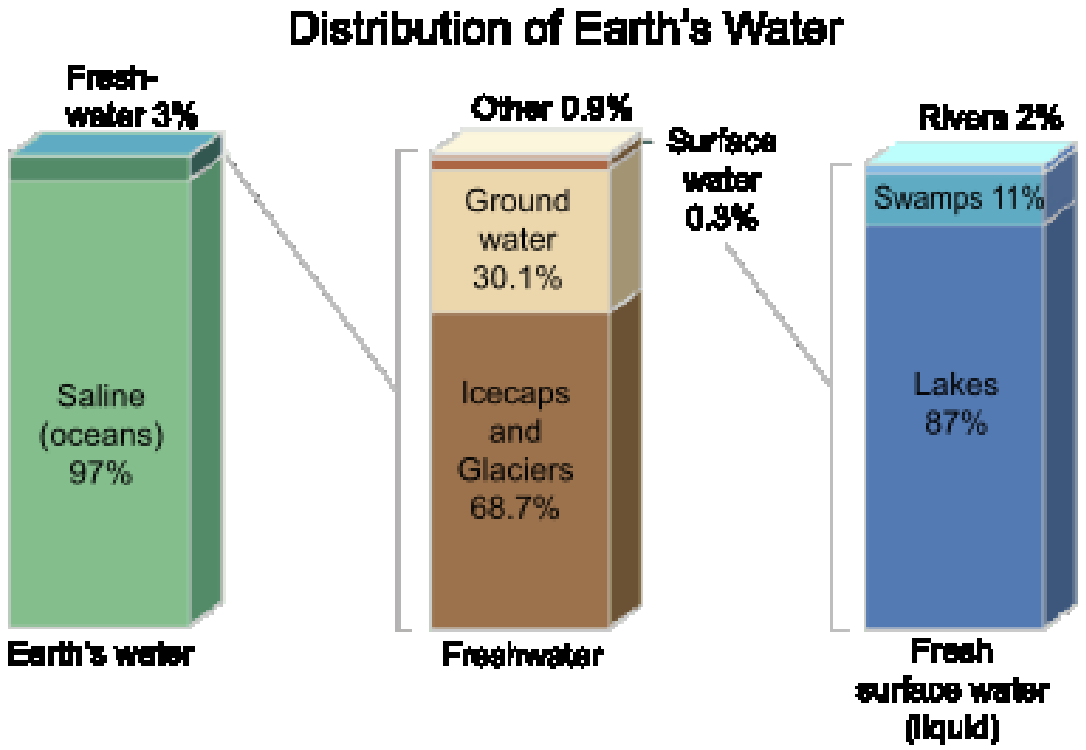
GROUNDWATER


USGS
science for a changing world
The Water Cycle
Volcanic steam
Atmosphere
Condensation
Sublimation
Desublimation
Ice and snow
Precipitation
Evapotranspiration
Evaporation
Fog and dew
Surface runoff
Plants
Snowmelt runoff
Streamflow
Infiltration
Evaporation
Seepage
Animals
Spring
Fresh-water
Plants
Oceans
Groundwater flow
Vents and volcanos
Groundwater storage
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html

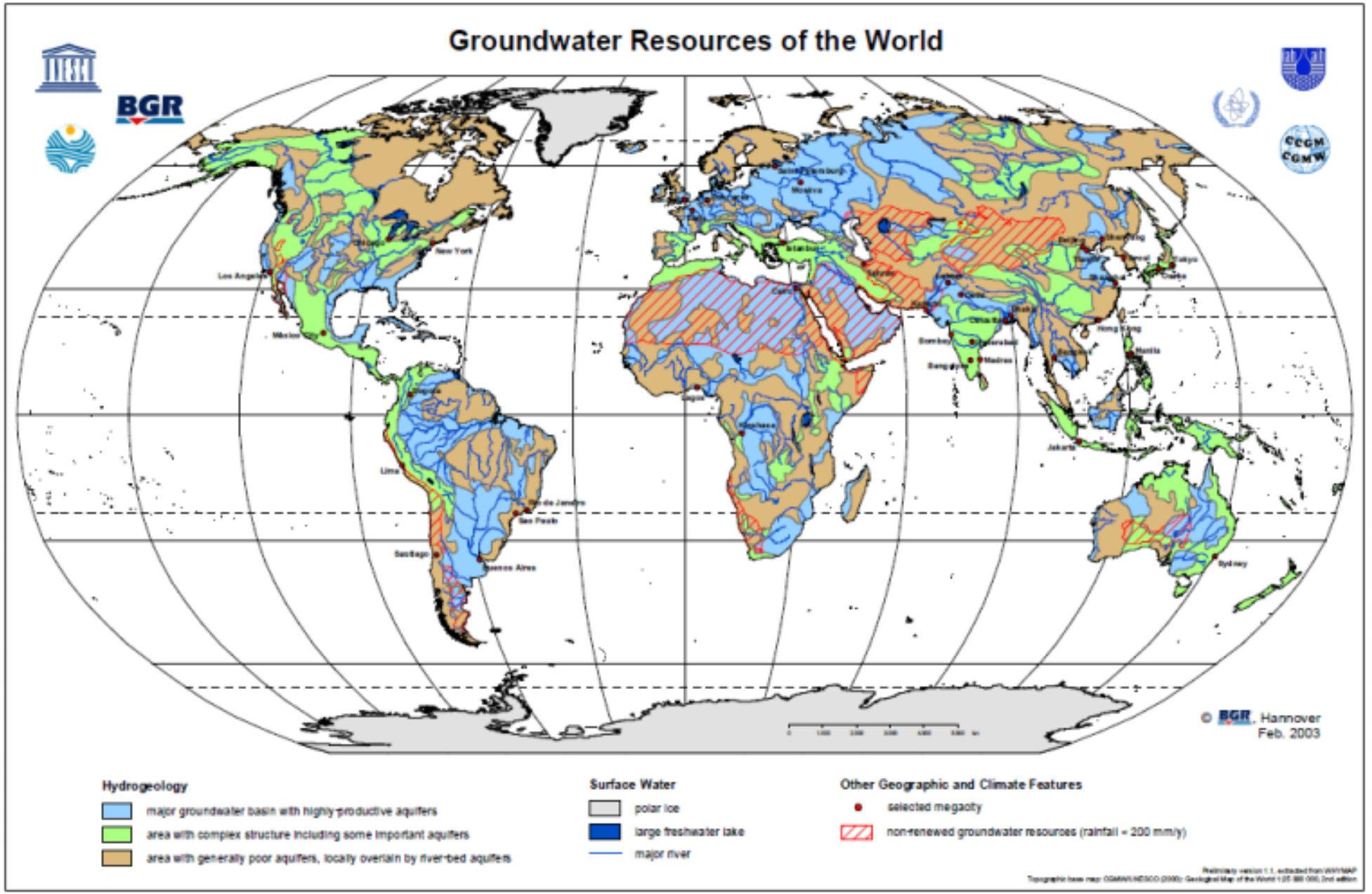
WATER IN THE GROUND

- Groundwater is defined as all the water in the ground occupying the pore spaces within bedrock and regolith.
- The volume of groundwater is 40 times larger than the volume of all water in fresh-water lakes or flowing in streams.
- Less than 1 percent of the water on earth is ground water.
- Most ground water originates as rainfall.

- Only 3% of Earth’s water is fresh water, and most of that is frozen as ice and snow. So only about 1% of Earth’s water is fresh liquid water.
- This fresh liquid water is found both on and below Earth’s surface.
- This tiny percentage of Earth’s water must meet the large demand that all living things have for fresh, clean water.

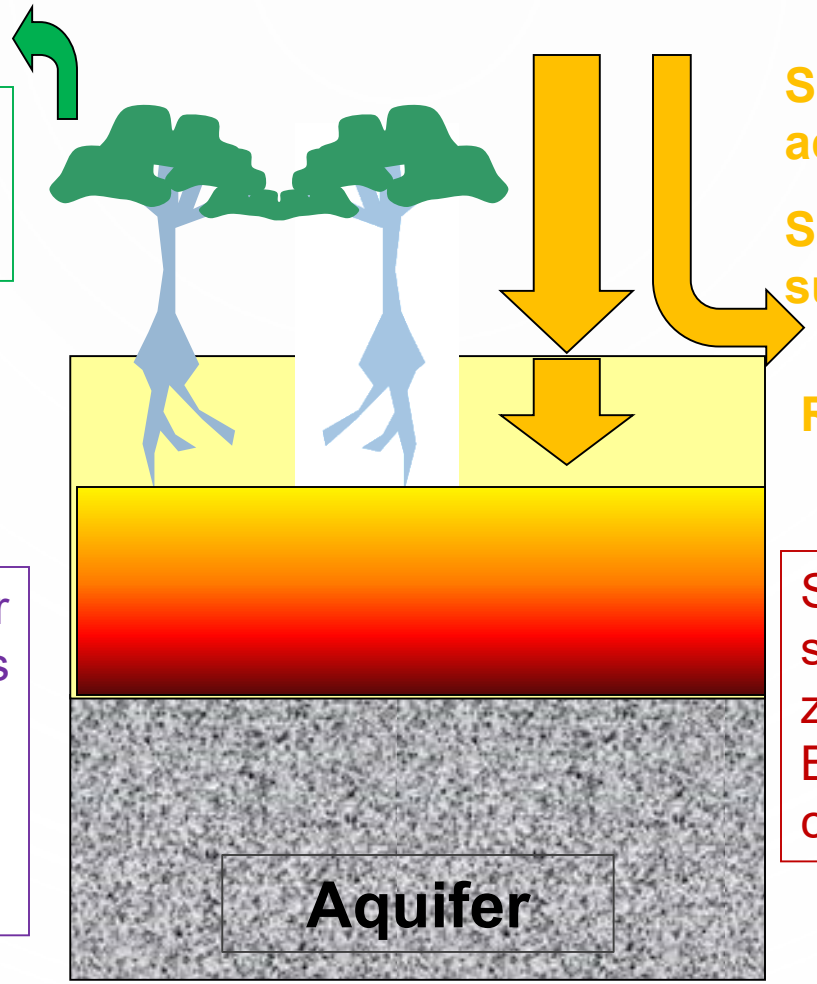


WORLD GROUNDWATER RESOURCES



RAINFALL TO GROUNDWATER

Water entering the soil is used by plants ***(Evapotranspiration)***



RAINFALL

Some rainfall runs off across ground surface,

Some evaporates at the surface

Remainder enters soil

Water that isn't used or stored in the soil seeps down below water table

– becomes Groundwater

- known as ***recharge***

Storage of water in the soil (unsaturated zone)
Becoming wetter closer to water table

AQUIFER

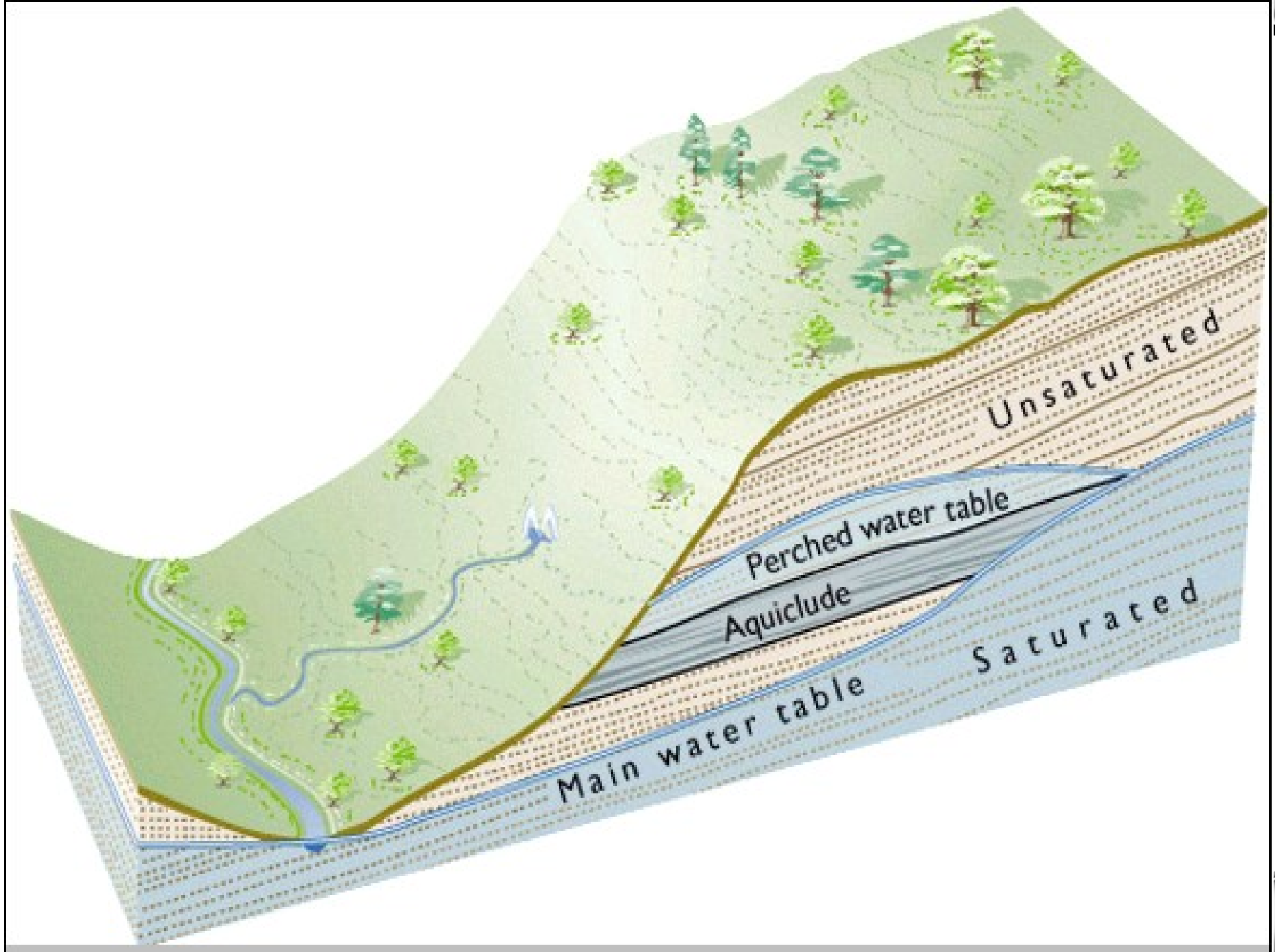
Recharge: process of replenishment of ground water by infiltration, migration and percolation

Aquifer: a rock that holds enough water and transmits it rapidly. porous and permeable. sandstone and coarse clastic sedimentary rocks make good aquifers

Aquitard and aquiclude: rocks of low and very low permeability e.g., shale, slate

Aquitard: a layer of soil or rock that has relatively lower porosity and/or permeability than the surrounding layers, limiting the movement of groundwater through it and the capacity to extract useable quantities of water.

Perched water table: local aquifer in vadose zone


Unsaturated
Perched water table
Aquiclude
Main water table
Saturated

CONFINED AND UNCONFINED AQUIFER

Unconfined aquifer: open to atmosphere e.g., overlain by permeable rocks and soils

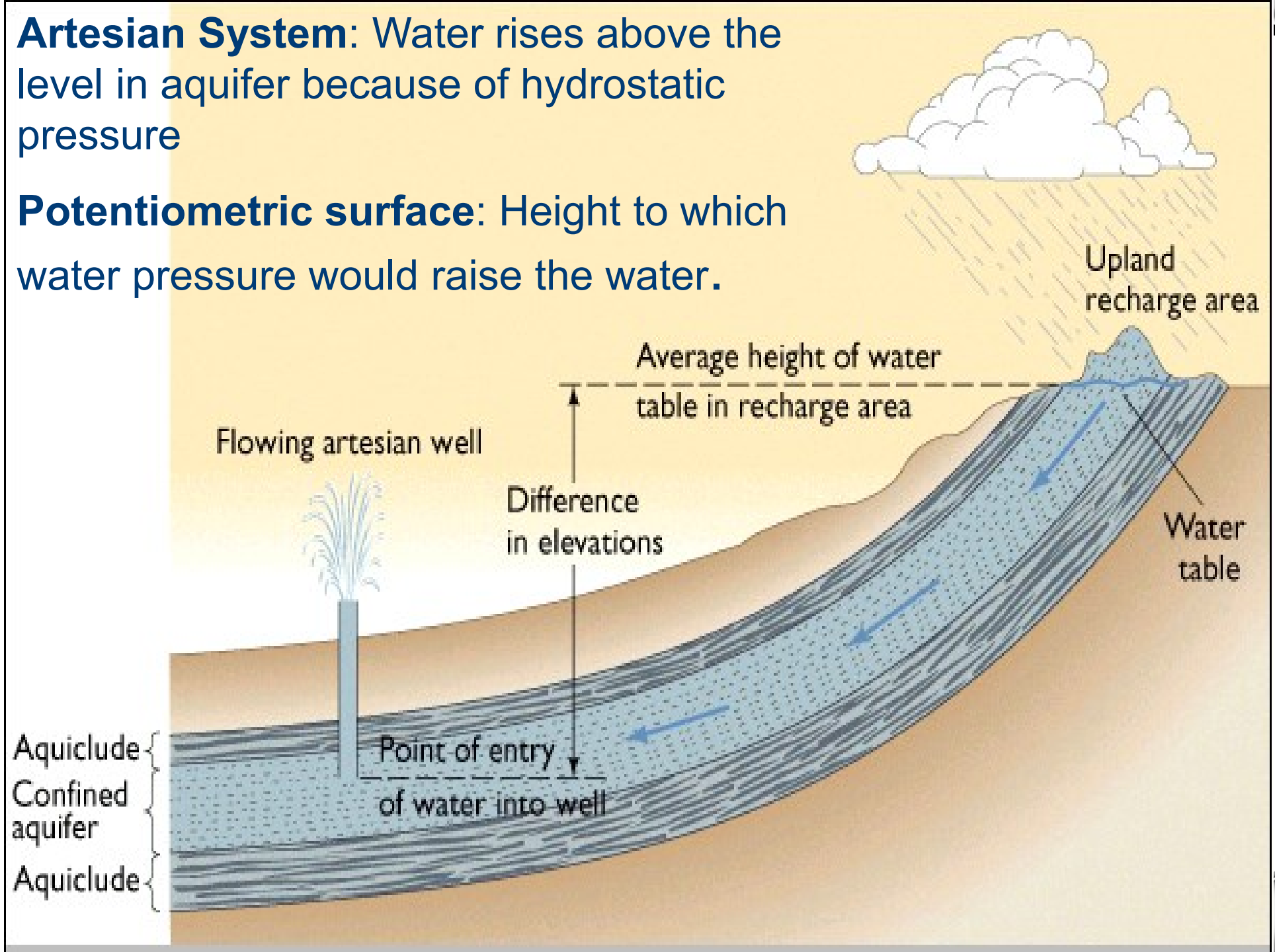
Confined aquifer: sandwiched between aquitards

Artesian system: water rises above the level in aquifer because of hydrostatic pressure

Potentiometric surface: height to which water pressure would raise the water.

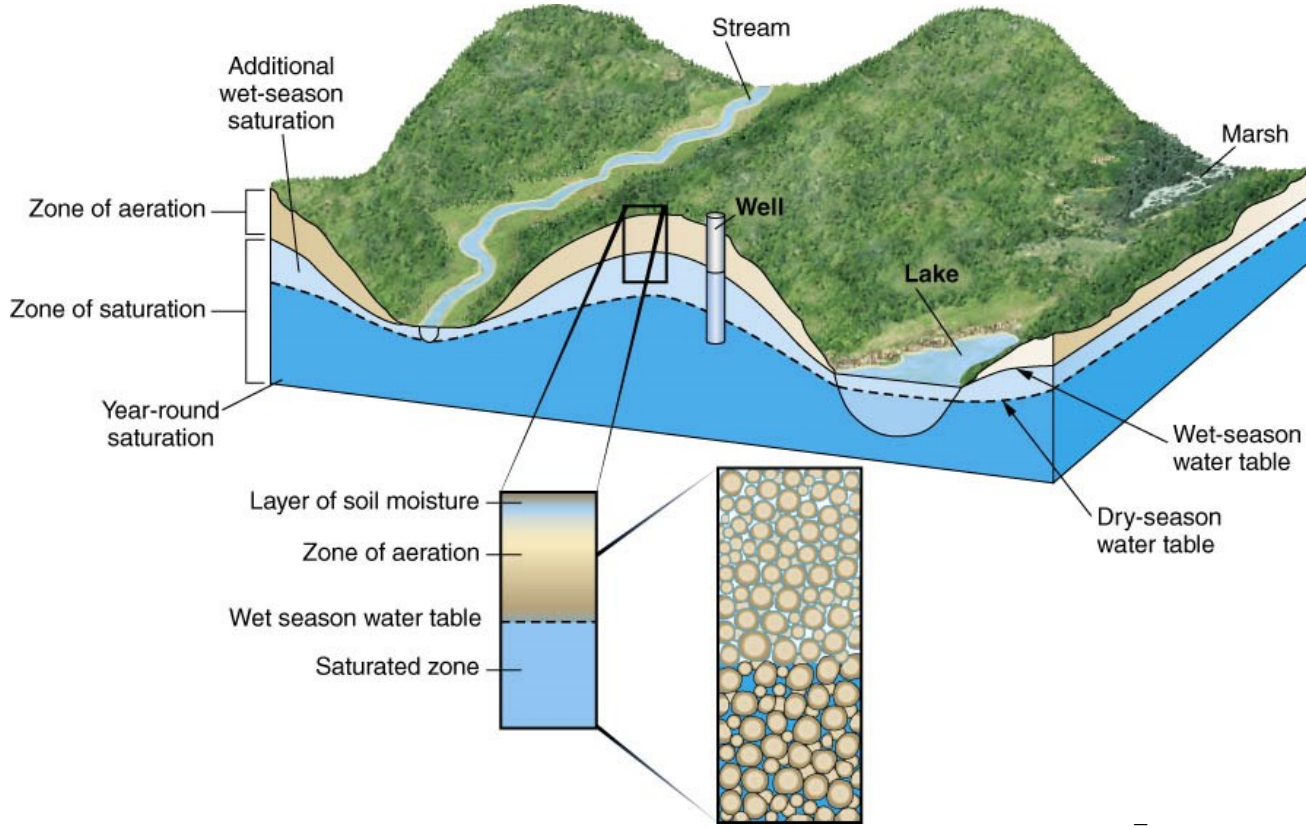
Artesian System: Water rises above the level in aquifer because of hydrostatic pressure

Potentiometric surface: Height to which water pressure would raise the water.

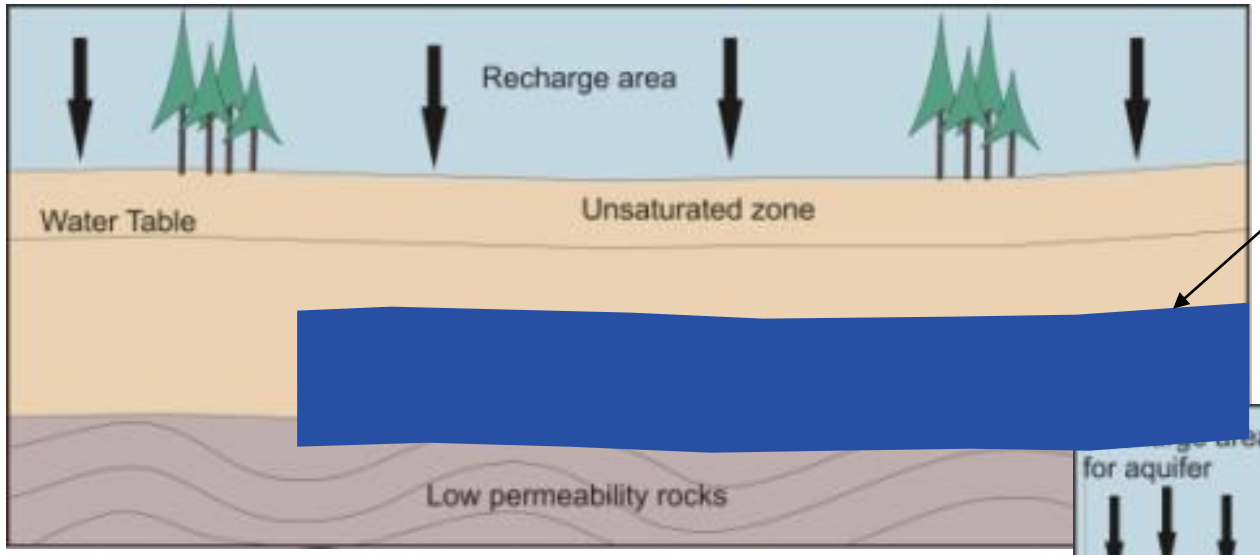


THE WATER TABLE

- The **zone of aeration** (also called the **unsaturated zone**) is a layer of moist soil followed by a zone in which open spaces in regolith or bedrock are filled mainly with air.
- Beneath the unsaturated zone is the **saturated zone,** a zone in which all openings are filled with water.
- The upper surface of the saturated zone is the **water table.**

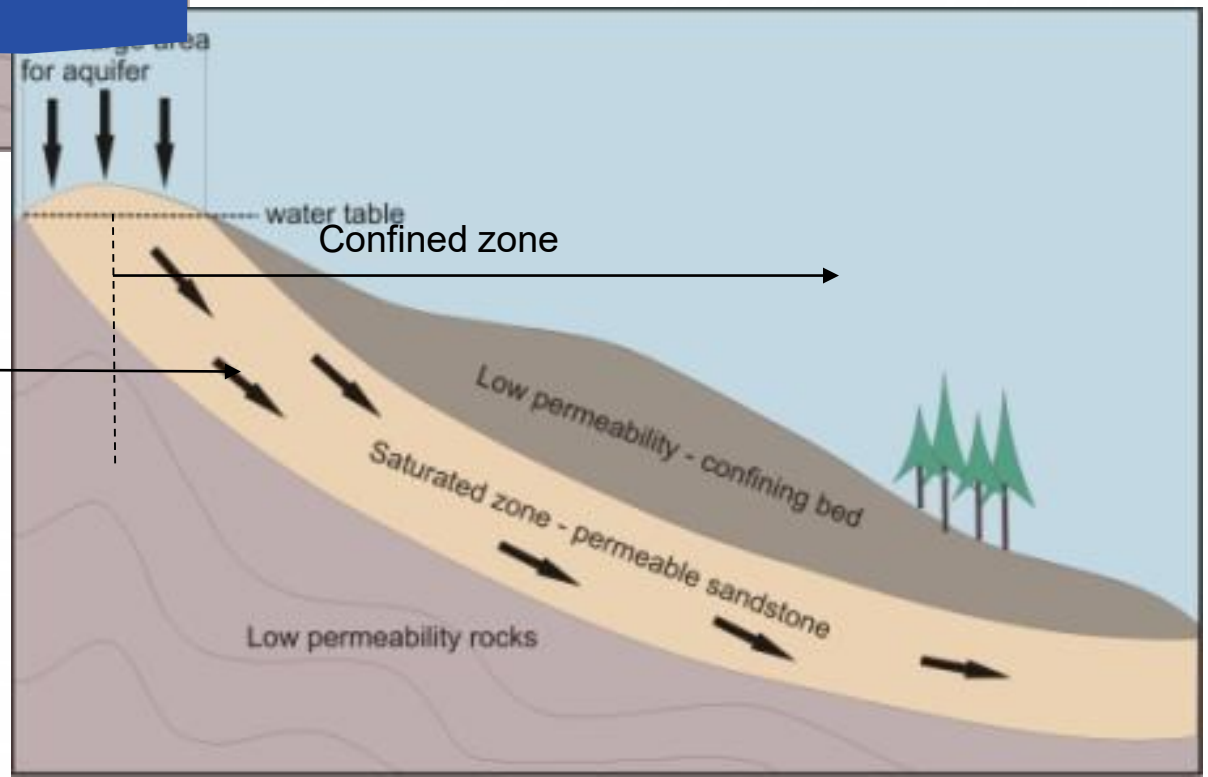


CONFINED AND UNCONFINED AQUIFERS



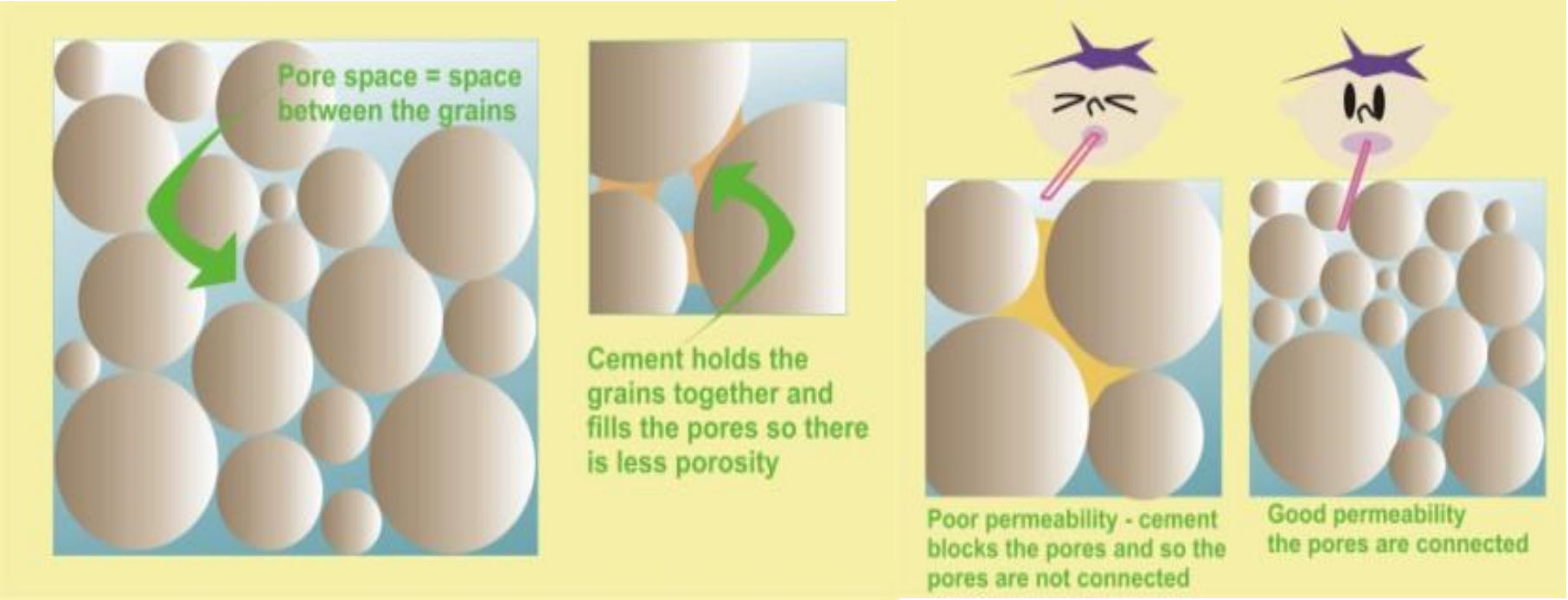
Unconfined: Surface of the groundwater (the watertable) is at the same pressure as the atmosphere.

Confined: The "surface" of the groundwater is constrained by an aquitard. It is under pressure. If the aquifer is tapped, the water level will rise up in response to the pressure. The distribution of pressure is called the **potentiometric** surface.



POROSITY AND PERMEABILITY

Porosity = the gaps between the soil and rock particles

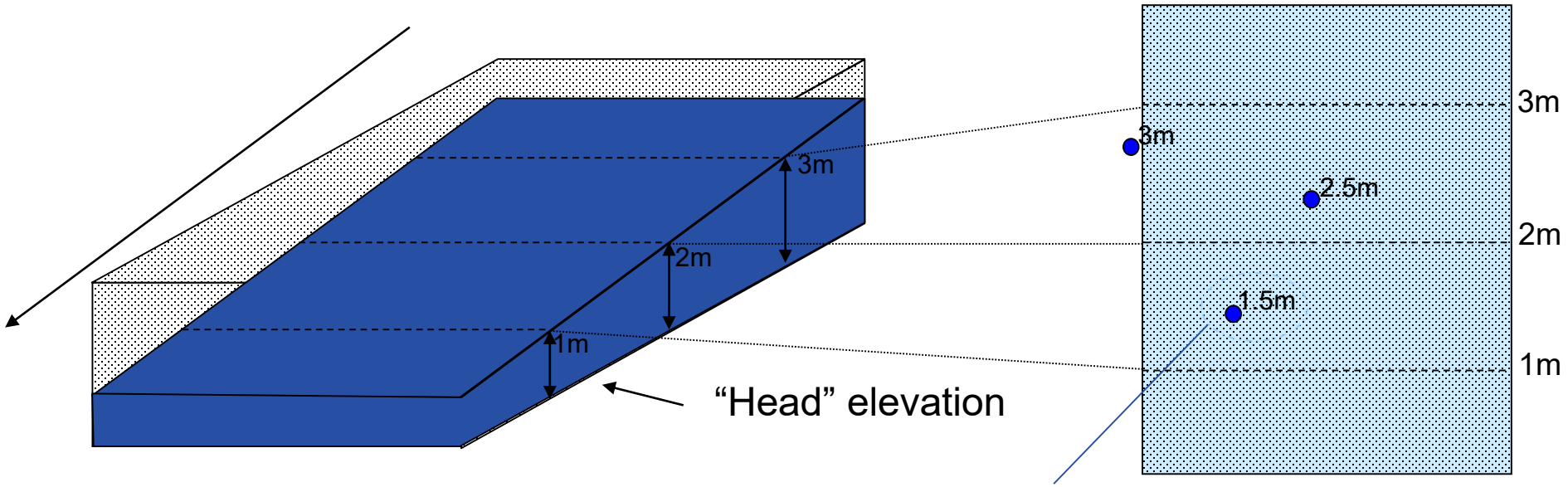


Permeability = how well the gaps are connected to allow water to move between them

FLOWING WATER UNDERGROUND

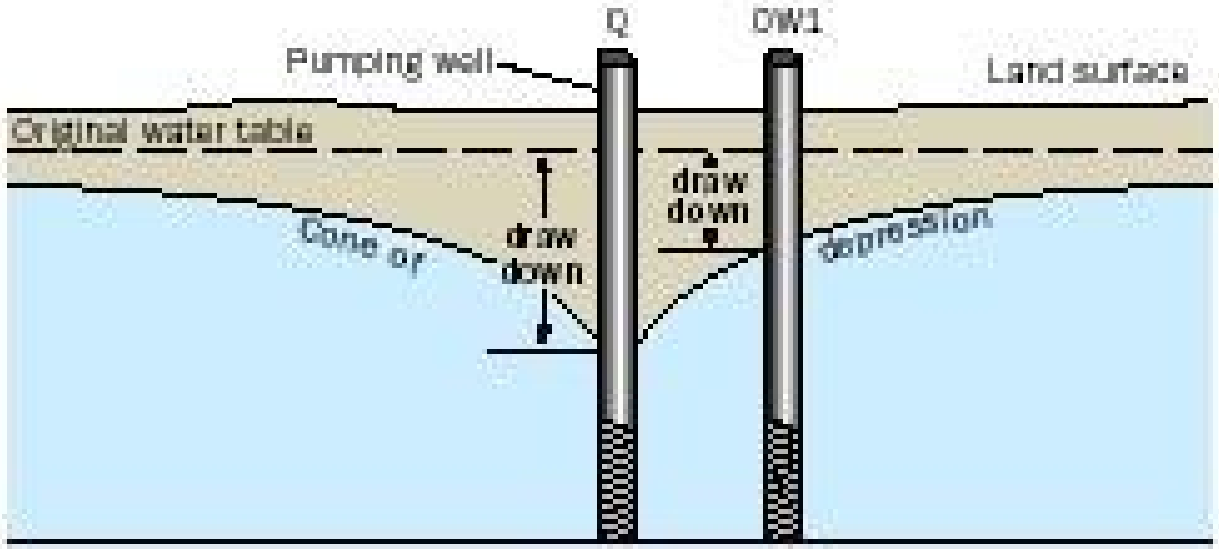
"Gradient" of the groundwater surface

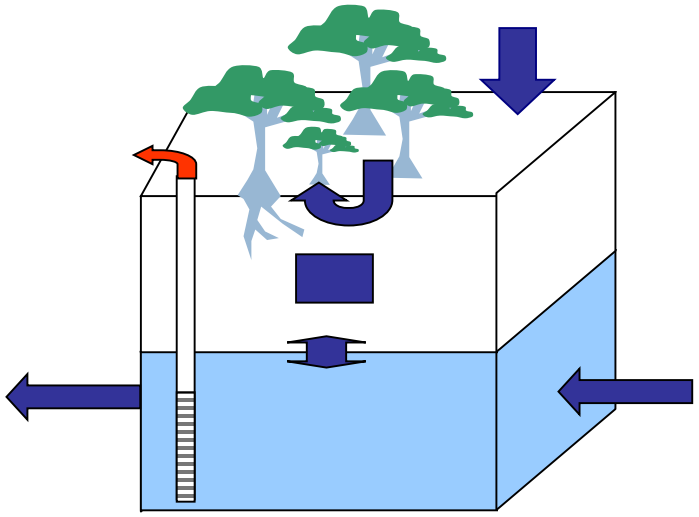
"Contours" of the groundwater surface

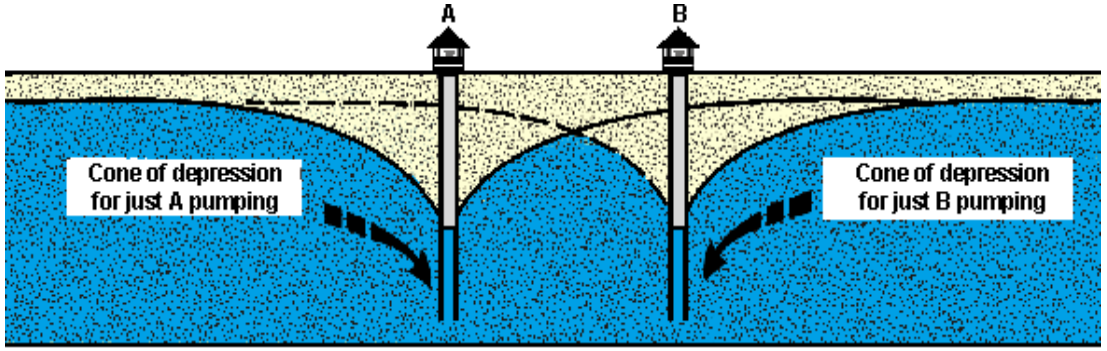


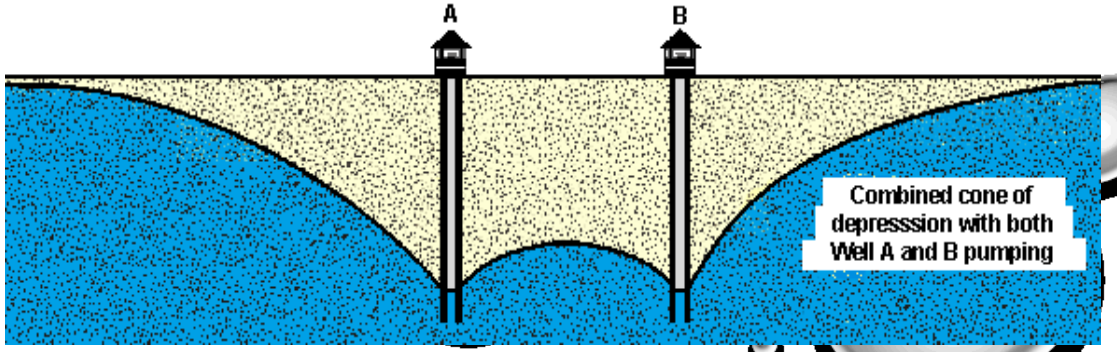
Groundwater flows from the higher "head" to the lower "head" – the hydraulic head of the system.

GROUNDWATER PUMPING







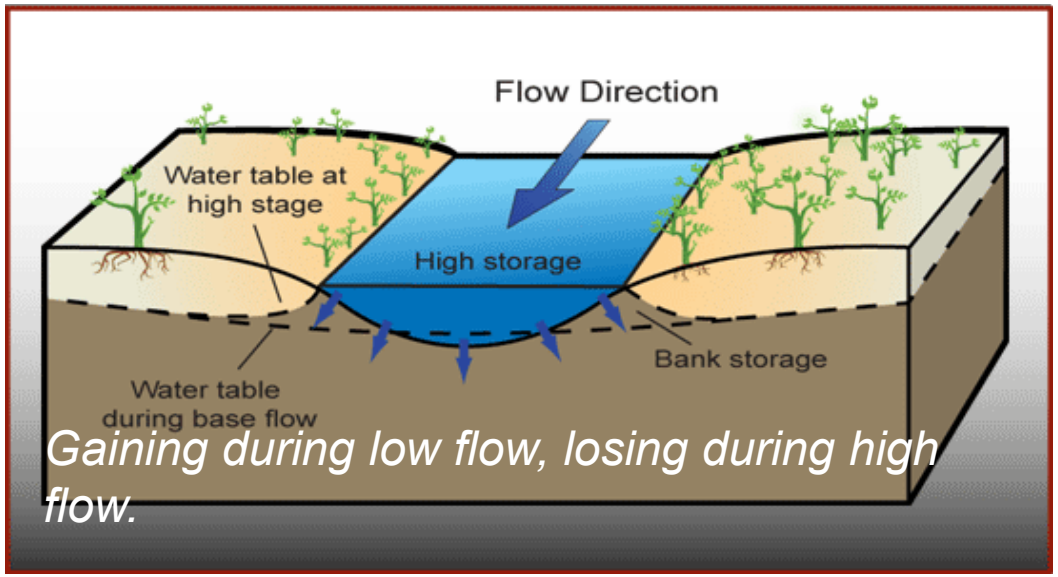


Takes water from storage by reducing level or pressure.

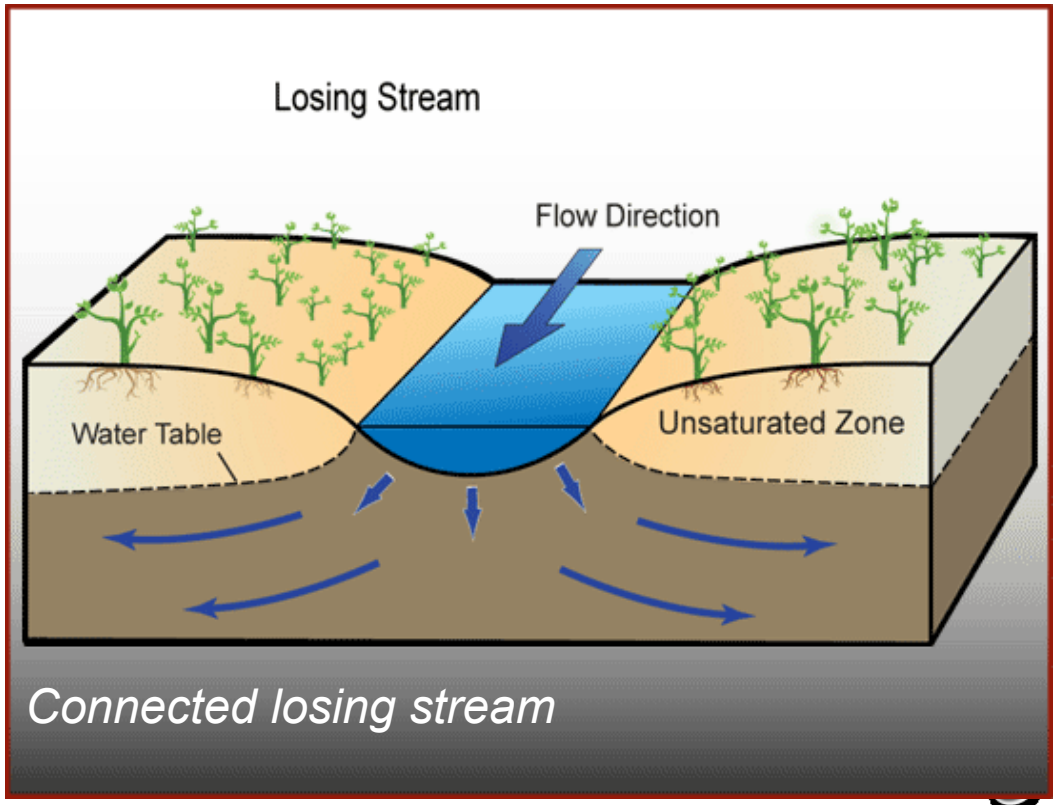
Changes flow patterns

Changes recharge / discharge relationships

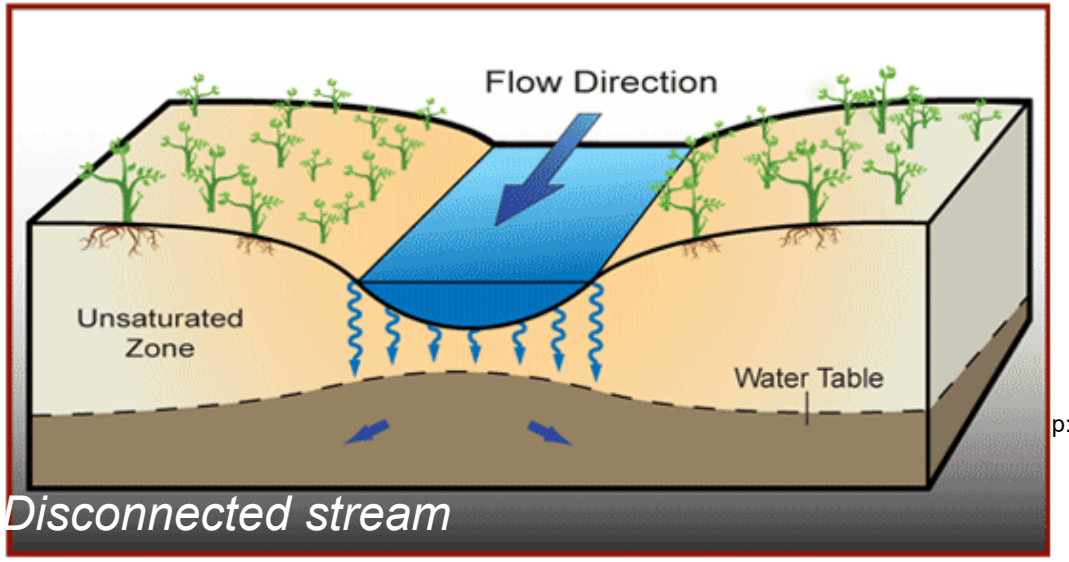
GROUNDWATER AND WATERWAYS



Gaining during low flow, losing during high flow.



Connected losing stream



Disconnected stream

p://www.connectedwater.gov.au/processes