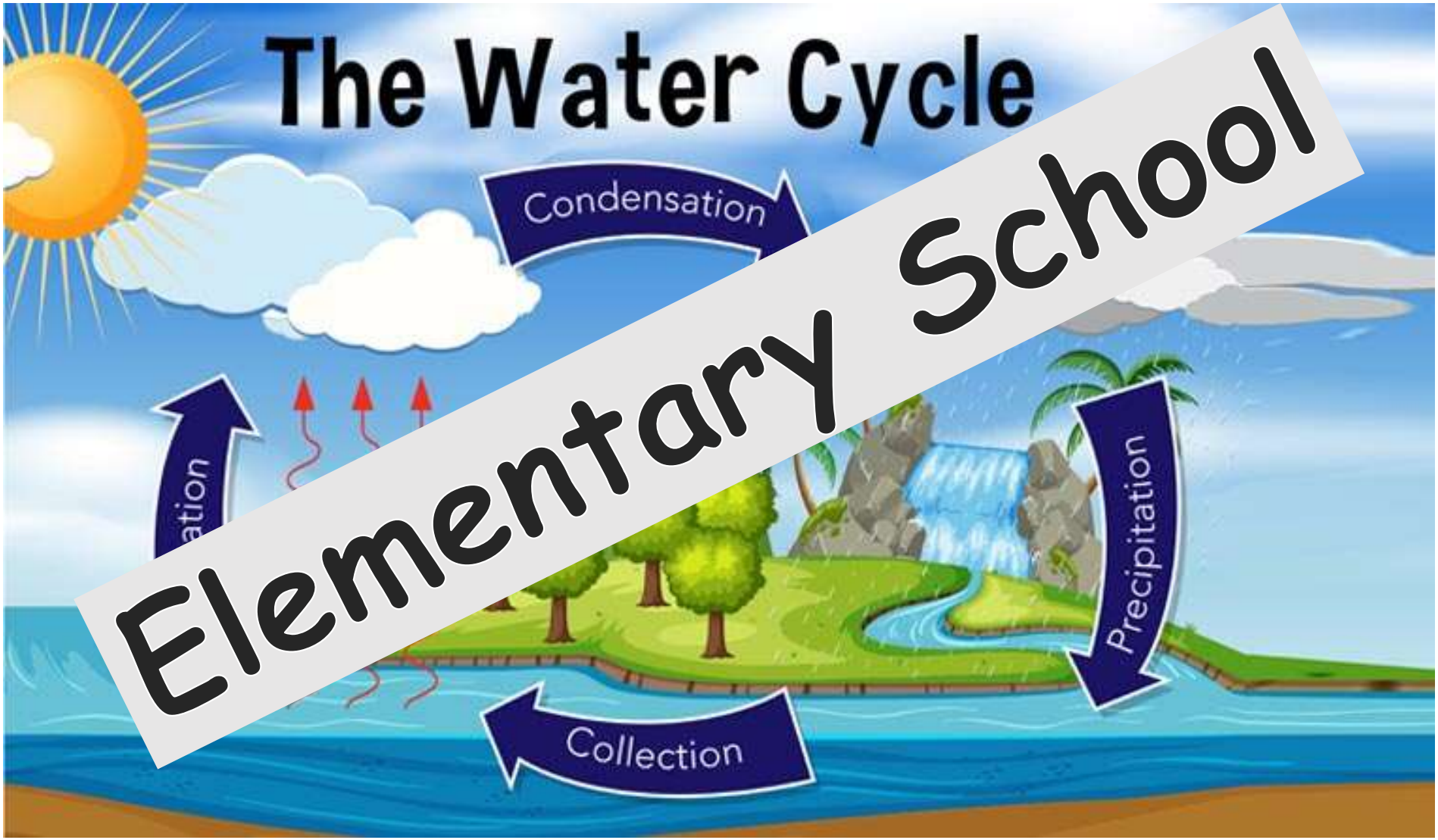
218 Hydrology and Streams

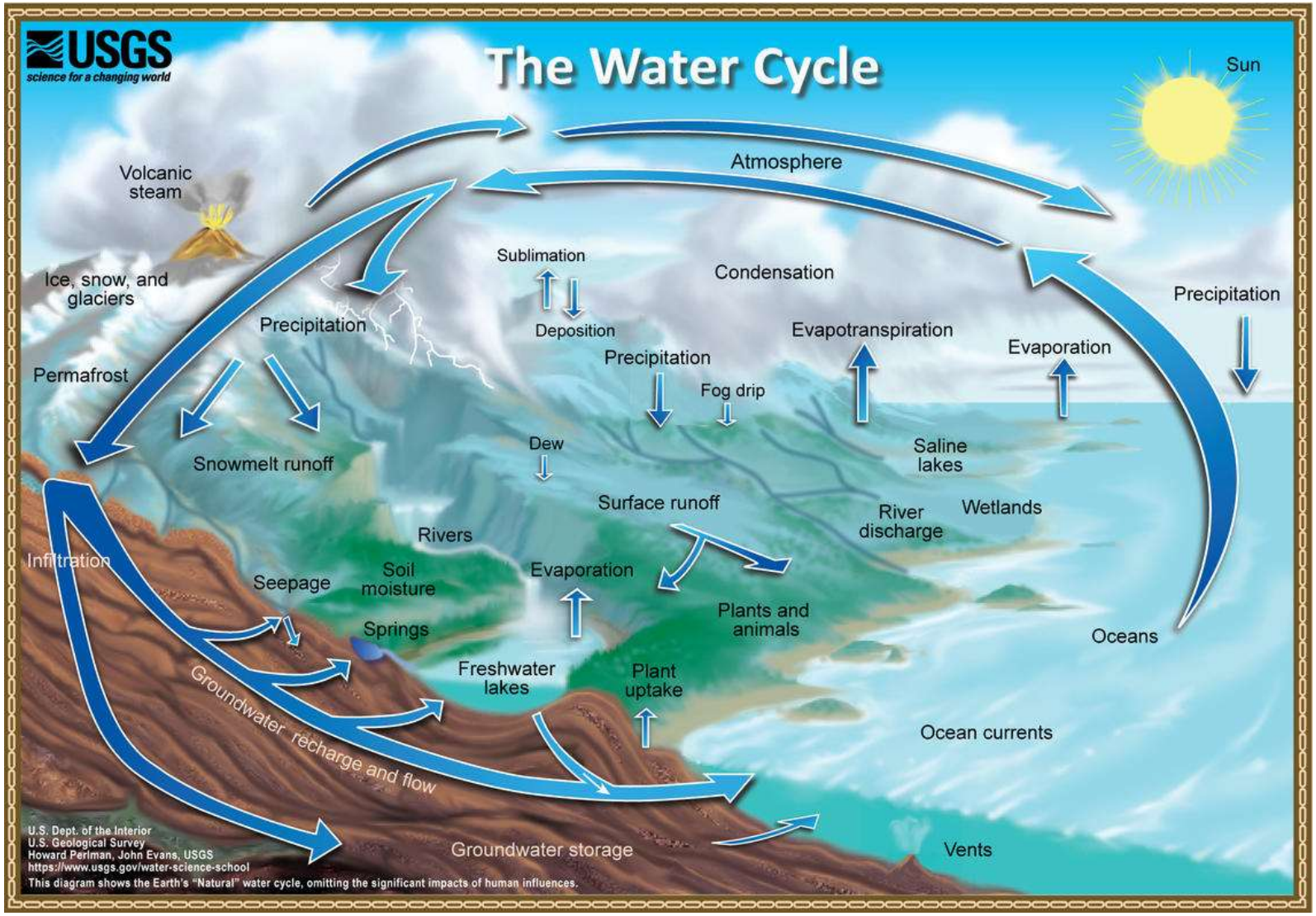
218 Hydrology and Streams

Lecture Day 1

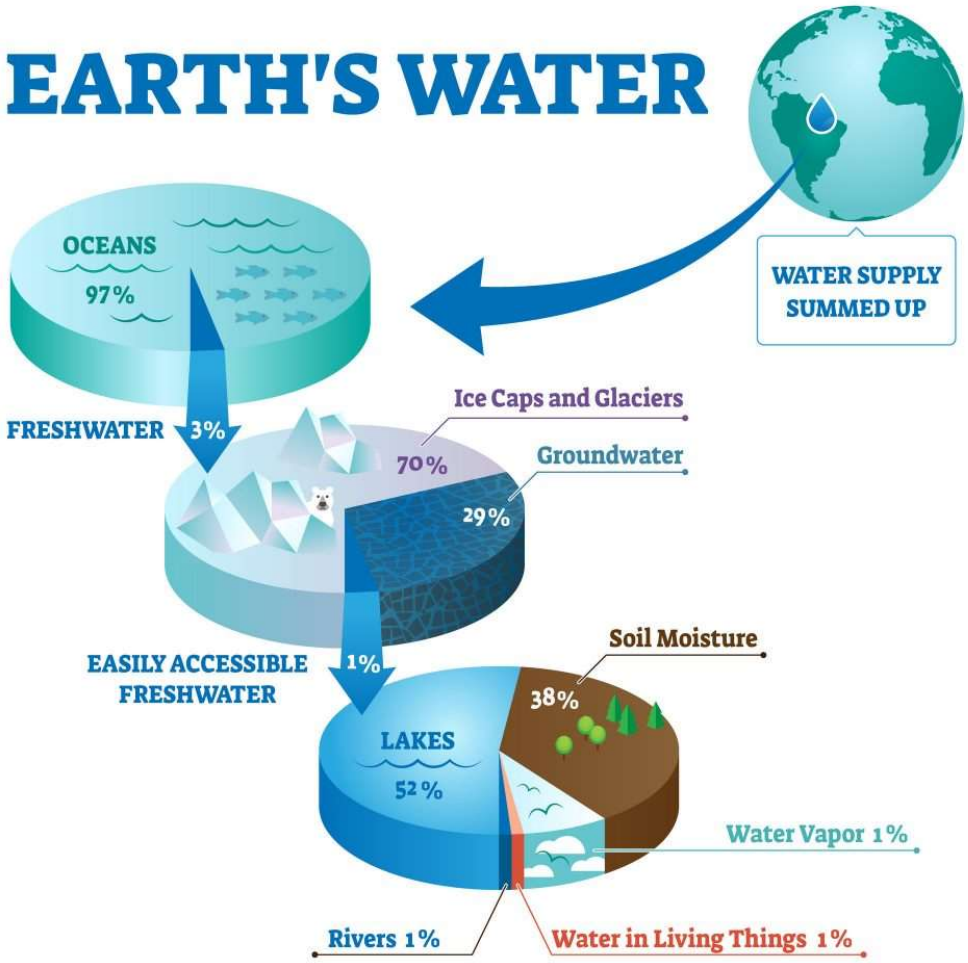
Warmup: What are the parts of the Water Cycle?

(Or is it the Hydrologic Cycle?)


The Water Cycle
Condensation
Precipitation
Collection
Elementary School


USGS
science for a changing world
The Water Cycle
Sun
Atmosphere
Volcanic steam
Ice, snow, and glaciers
Sublimation
Condensation
Deposition
Precipitation
Precipitation
Evapotranspiration
Evaporation
Precipitation
Permafrost
Precipitation
Fog drip
Dew
Saline lakes
Snowmelt runoff
Surface runoff
River discharge
Wetlands
Rivers
Infiltration
Seepage
Soil moisture
Evaporation
Plants and animals
Springs
Oceans
Freshwater lakes
Plant uptake
Groundwater recharge and flow
Ocean currents
Groundwater storage
Vents
U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, John Evans, USGS
https://www.usgs.gov/water-science-school
This diagram shows the Earth's "Natural" water cycle, omitting the significant impacts of human influences.

So Where is All the Water on Earth?



Composition of Earths water Copyright : [normaals]

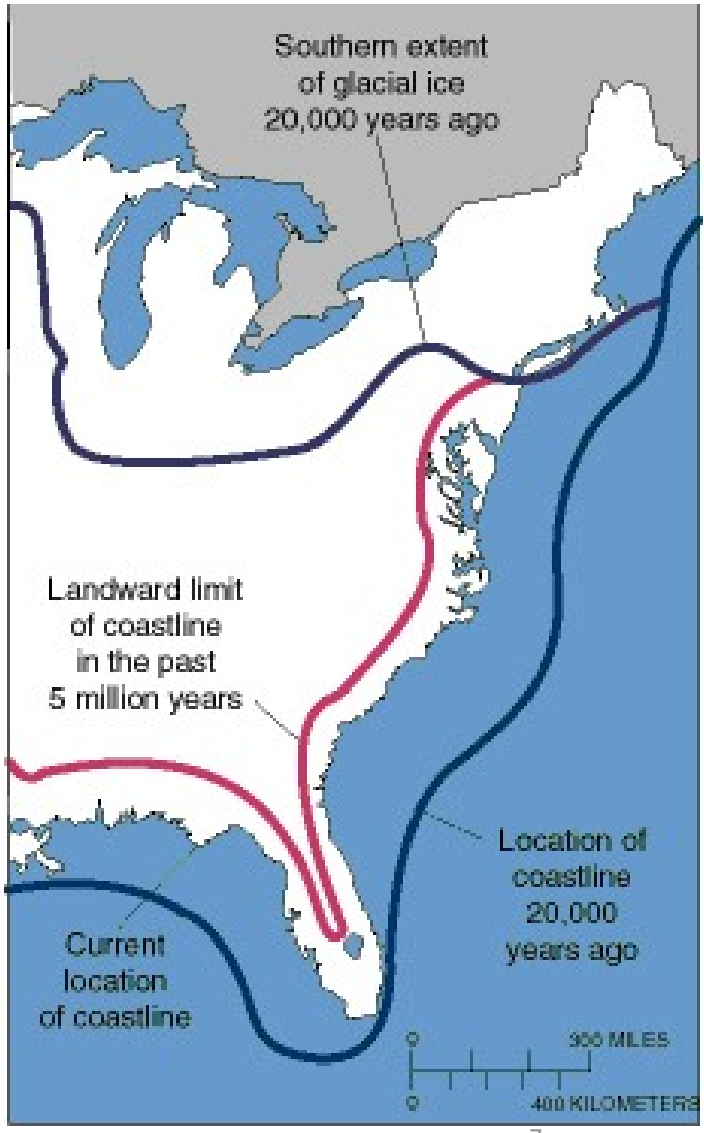
Ocean Levels Change?

- Glaciers = Lower Sea Level and More Land

Note: Chesapeake Bay and SOMD were underwater 5 million years ago.

←Fossil hunting anyone?

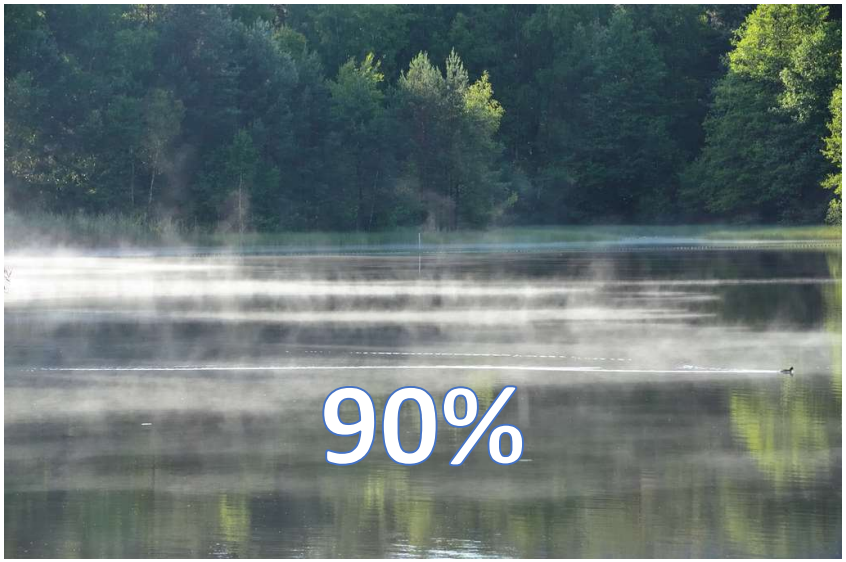
Next stop, Shark Tooth Island!



Water Sources

How does the Stored Liquid turn to Vapor?

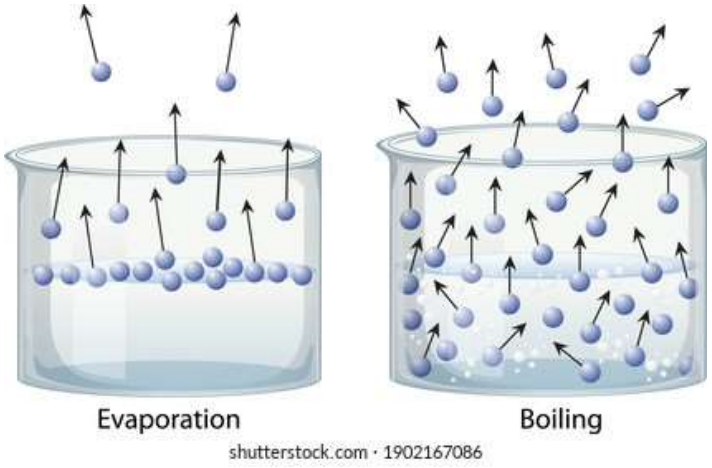
Evaporation



Transpiration

Evaporation (90%)

- Energy breaks bonds that hold molecules together
- Removes heat from the environment



Primary mechanism for surface-to-atmosphere water transport

Transpiration and Respiration (10%)

- Plants release water
  - Stomata: Holes in the undersides of leaves

- Humans exhale water when they breath

Evaporation versus Precipitation

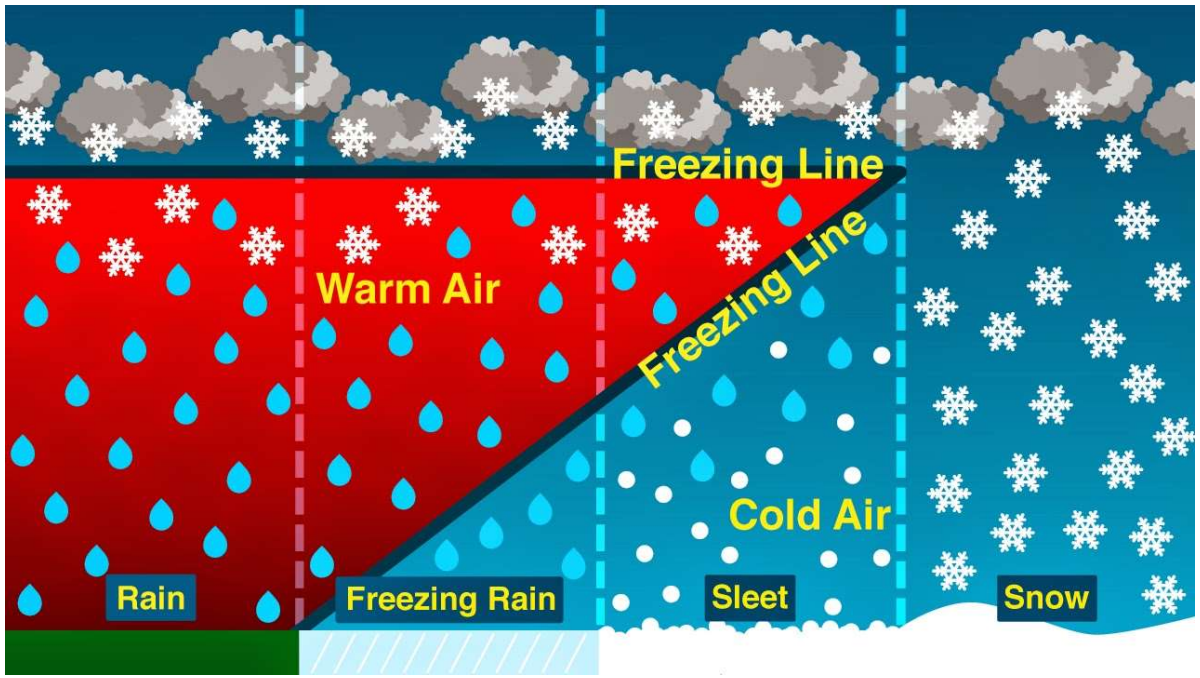
- About equal on a global scale
- Evaporation more prevalent over the oceans than precipitation
- Over land, precipitation exceeds evaporation
- 10% of water evaporated from the ocean falls as rain on land
- Once evaporated, a water molecule spends ~ 10 days airborne

Condensation

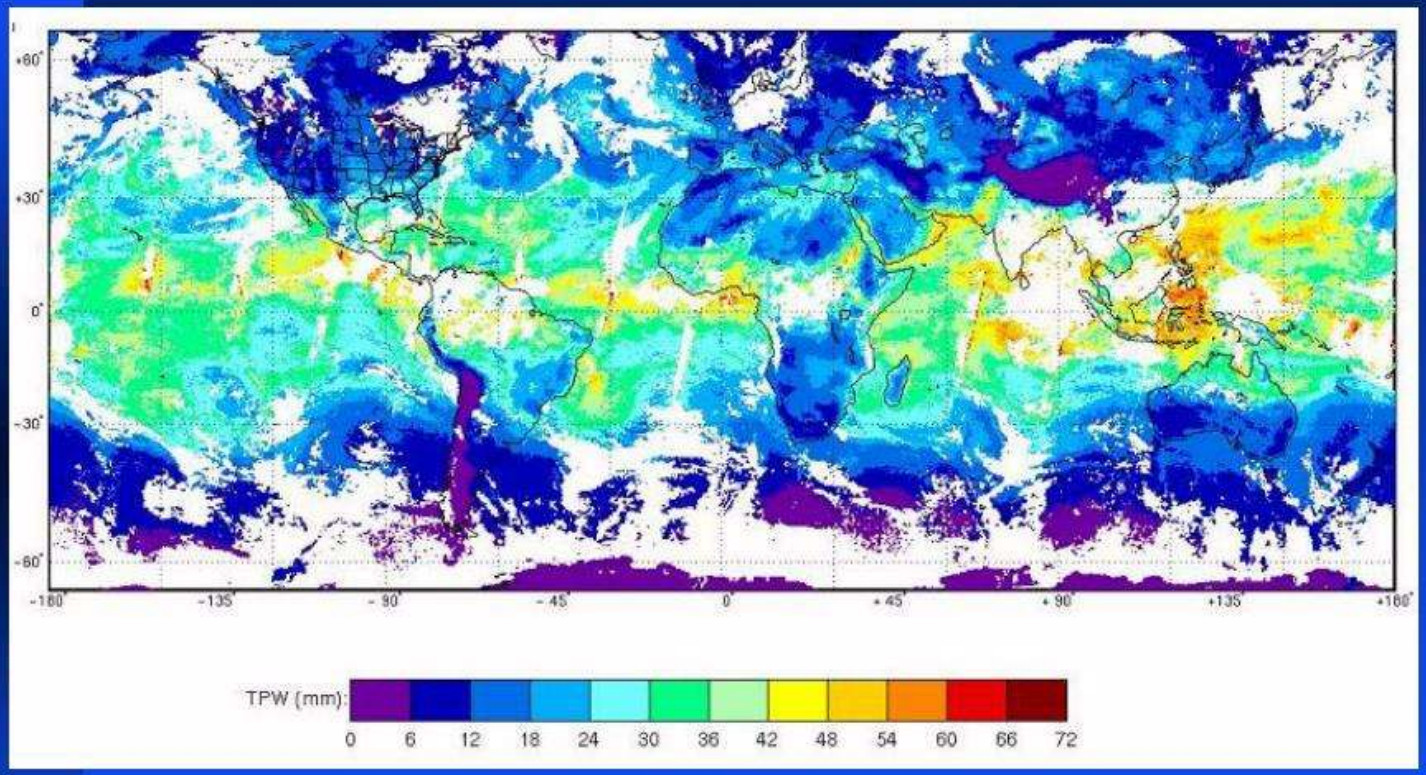
- Vapor or gas to a liquid.
- Clouds
- Fog (a cloud that touches the ground)
- Drops forming on objects or living things

Precipitation

- The vapor that accumulates or freezes on condensation nuclei is acted on by gravity and falls to Earth's surface.



Total Precipitable Water



The total atmospheric water vapor contained in a vertical column of unit cross-sectional area from the Earth's surface to the "top of the atmosphere"

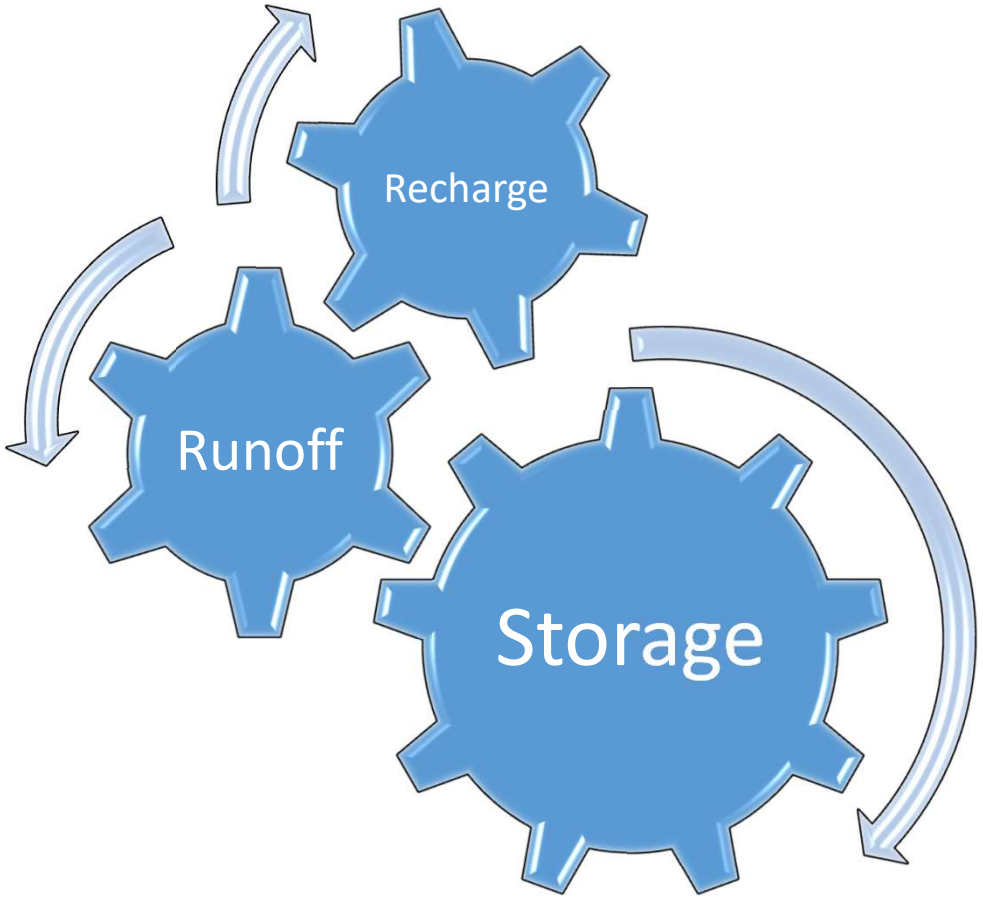
How many gallons of water fall when 1 inch of rain falls on 1 acre of land?

- About 27,154 gallons (102,800 liters)

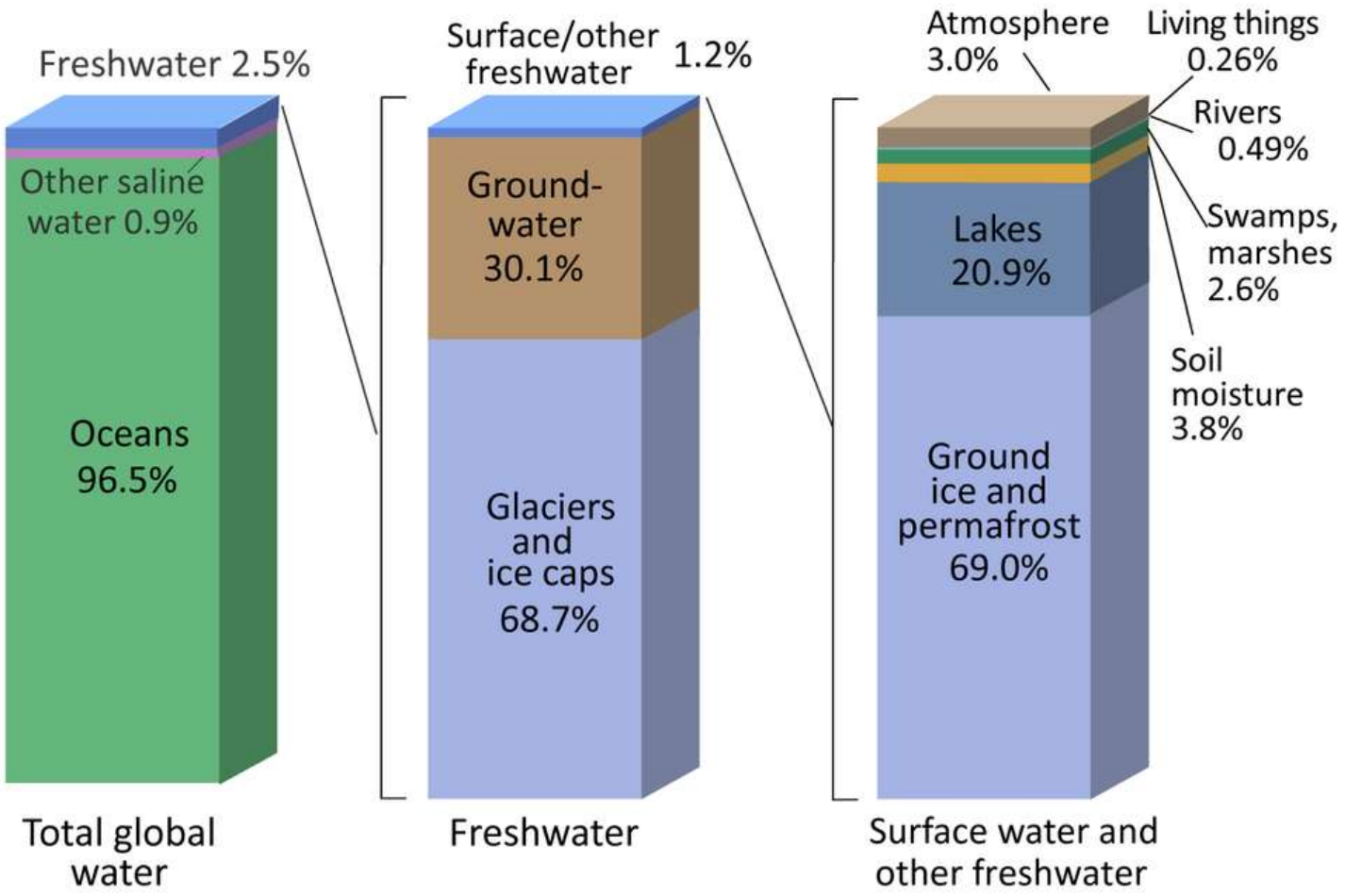
- On average, the 48 continental United States receives enough precipitation in one year to cover the land to a depth of 30 inches.

Three options once water hits the Earth:

- Recharge – Water moving through the Earth's crust
- Runoff – Water moving over the surface
- Storage – Non-moving water



Where is Earth's Water?



Credit: U.S. Geological Survey, Water Science School. https://www.usgs.gov/special-topic/water-science-school
Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

Surface Storage

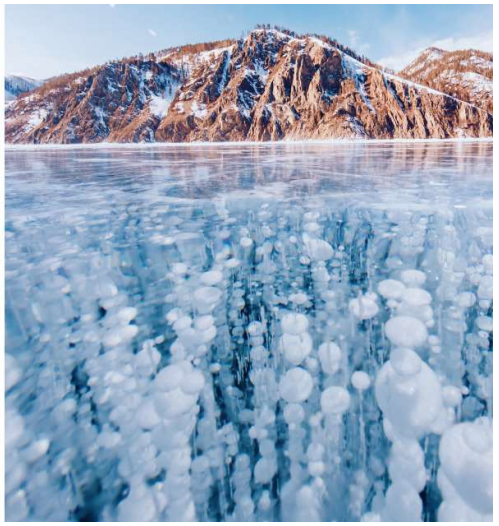
Surface Storage

Oceans (97% of all Stored Water)

Ice, Snow, Glaciers, Lakes

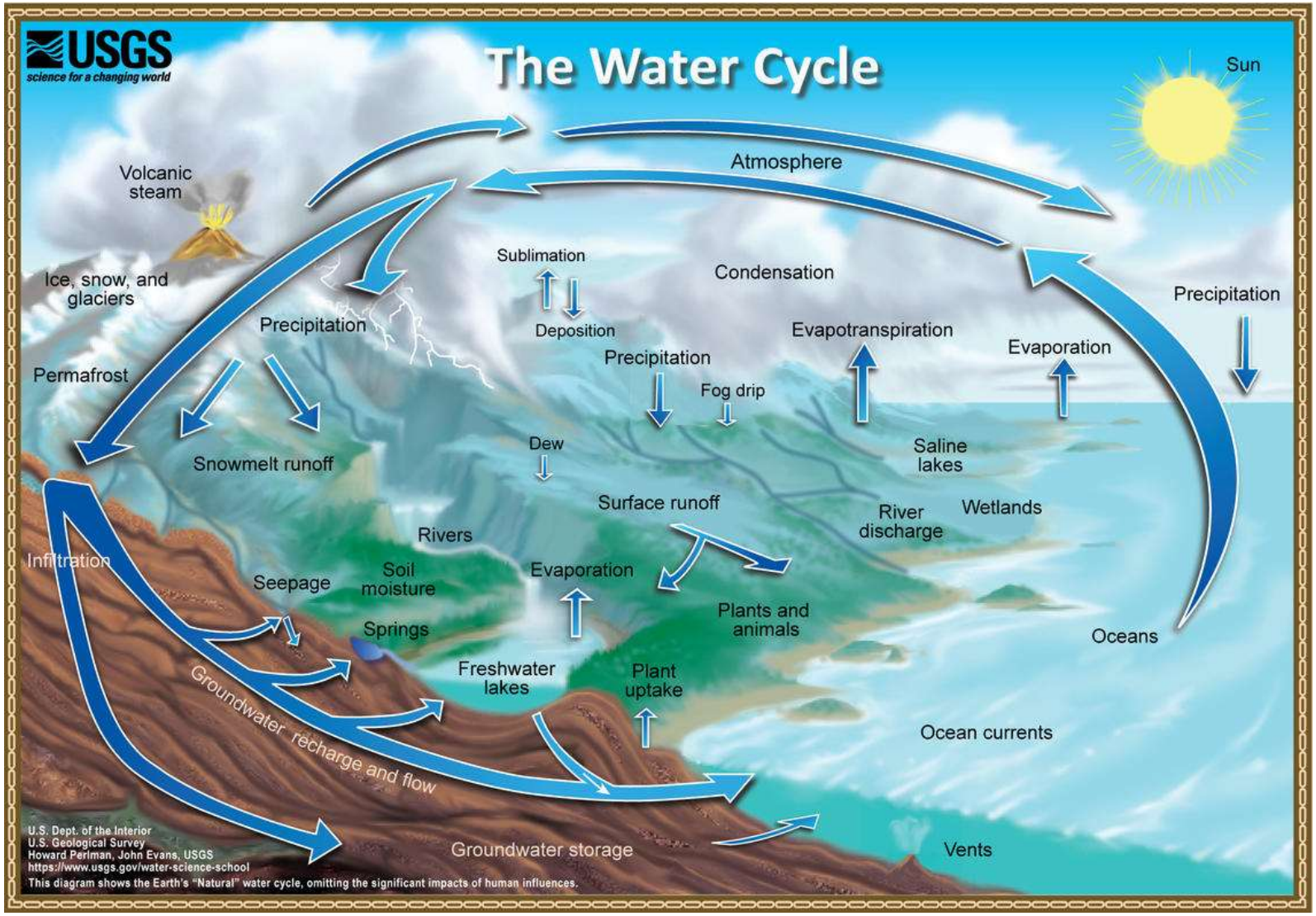
Freshwater – Life-blood

- Freshwater makes up ~3% of all water on Earth and lakes and swamps account for a mere 0.29% of that!
- 20% of all freshwater is in the Great Lakes
- Another 20% is in Lake Baikal in Siberia (Russia)



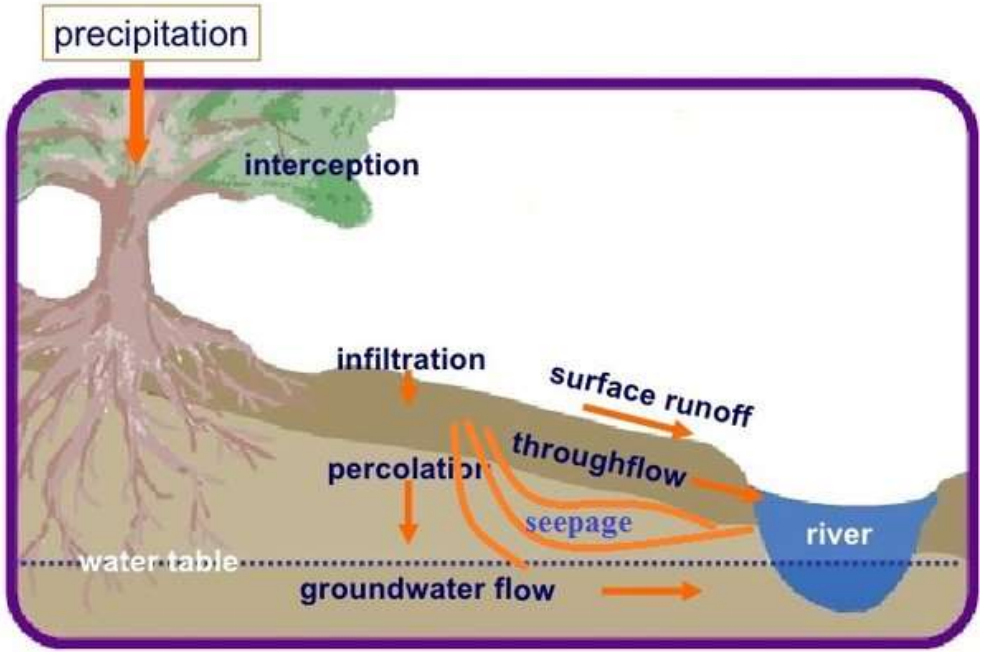
218 Hydrology and Streams

Lecture Day 2


USGS
science for a changing world
The Water Cycle
Sun
Atmosphere
Volcanic steam
Ice, snow, and glaciers
Sublimation
Condensation
Deposition
Precipitation
Precipitation
Evapotranspiration
Evaporation
Precipitation
Permafrost
Precipitation
Fog drip
Dew
Saline lakes
Snowmelt runoff
Surface runoff
River discharge
Wetlands
Rivers
Infiltration
Seepage
Soil moisture
Evaporation
Plants and animals
Springs
Oceans
Freshwater lakes
Plant uptake
Groundwater recharge and flow
Ocean currents
Groundwater storage
Vents
U.S. Dept. of the Interior
U.S. Geological Survey
Howard Perlman, John Evans, USGS
https://www.usgs.gov/water-science-school
This diagram shows the Earth's "Natural" water cycle, omitting the significant impacts of human influences.

Recharge and Groundwater

Recharge

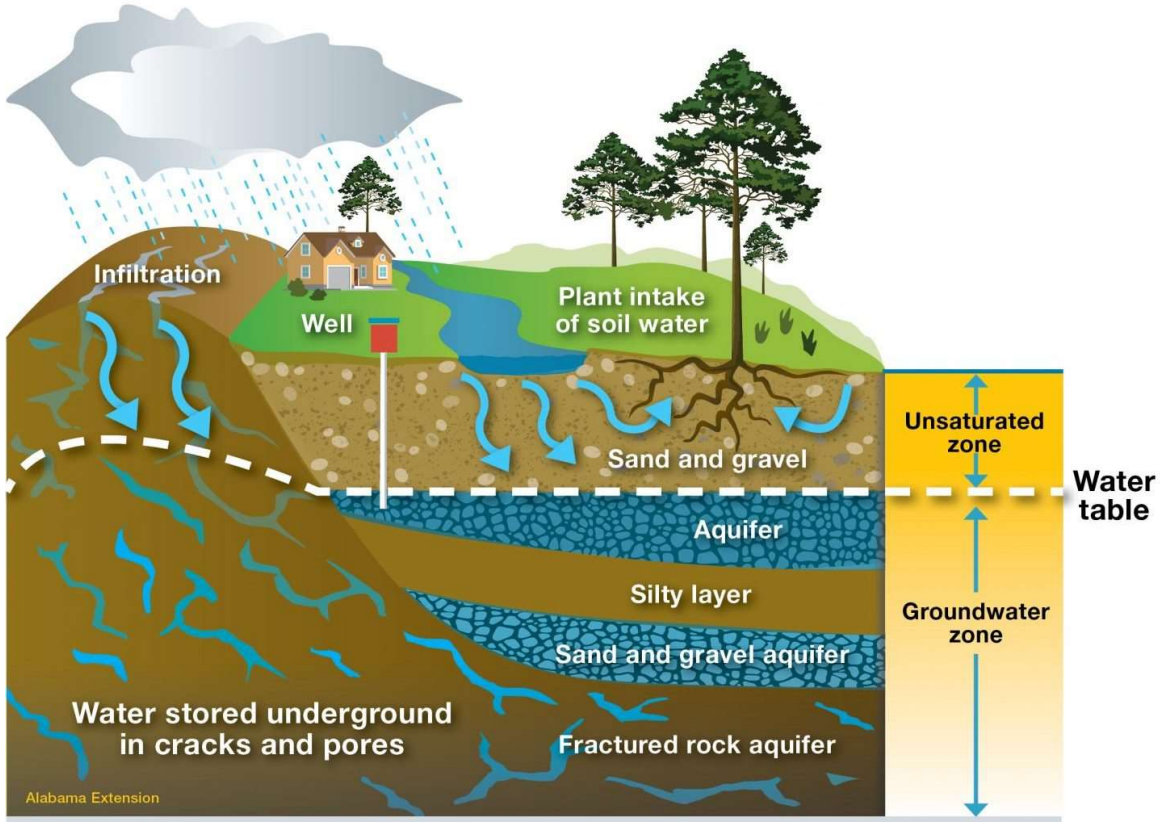


- **Precipitation falls and infiltrates into the subsurface soil and rock**
- Infiltration is the movement of water into the ground from the surface.
- Percolation is movement of water past the soil going deep into the groundwater
- Groundwater is the water that moves through or is stored in the soil and underlying layers of the Earth's crust

Groundwater Storage

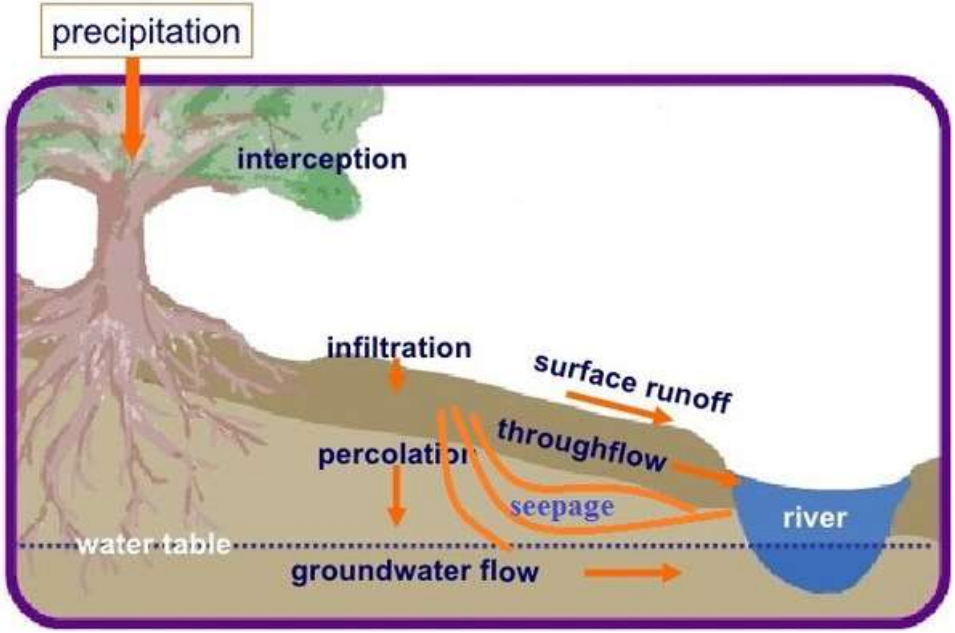
- Aquifer
  - a body of permeable rock which can contain or transmit groundwater

- Permafrost
  - a thick subsurface layer of soil that remains frozen throughout the year, occurring chiefly in polar regions



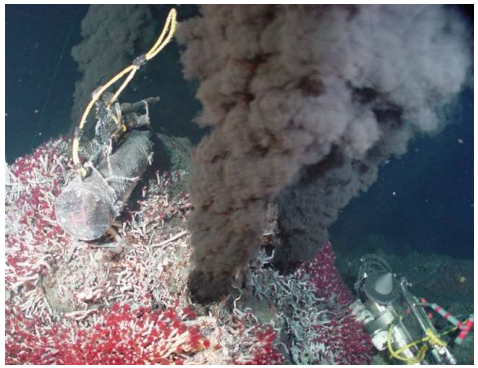
Back to the Surface

- Throughflow. Movement of water through the lower soil towards rivers
- Seepage. Flow from one place to another via small holes or porous material
- Groundwater flow.
- Springs.



Back to the Surface

- Artesion wells
- Human-powered wells
- Plant Uptake
- Vents and Volcanic Steam



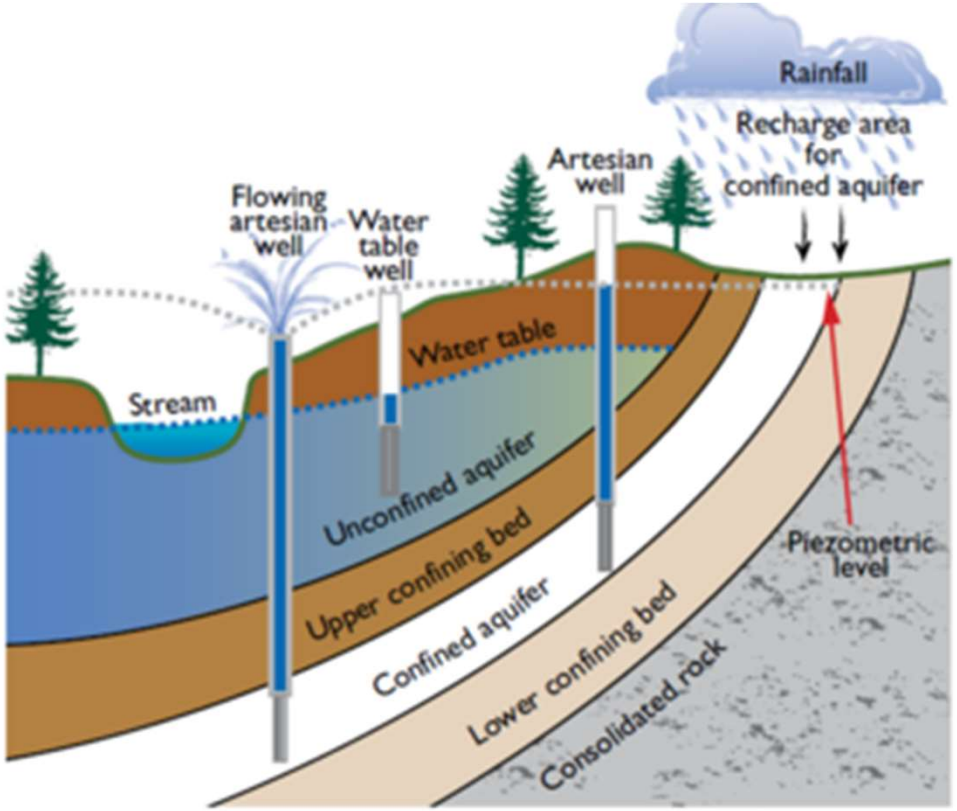


Figure 1. Geological and topographical controls affecting artesian and flowing artesian wells.

Surface Runoff

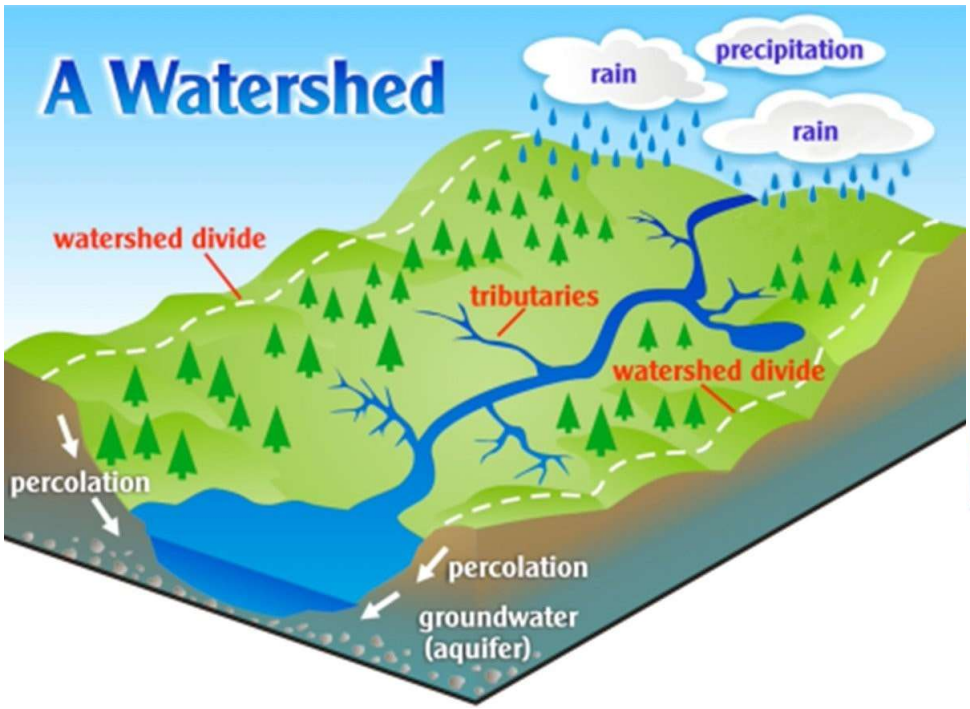
Runoff

Water that moves over Earth's surface when it rains or melts is called **Runoff**.

Snowmelt

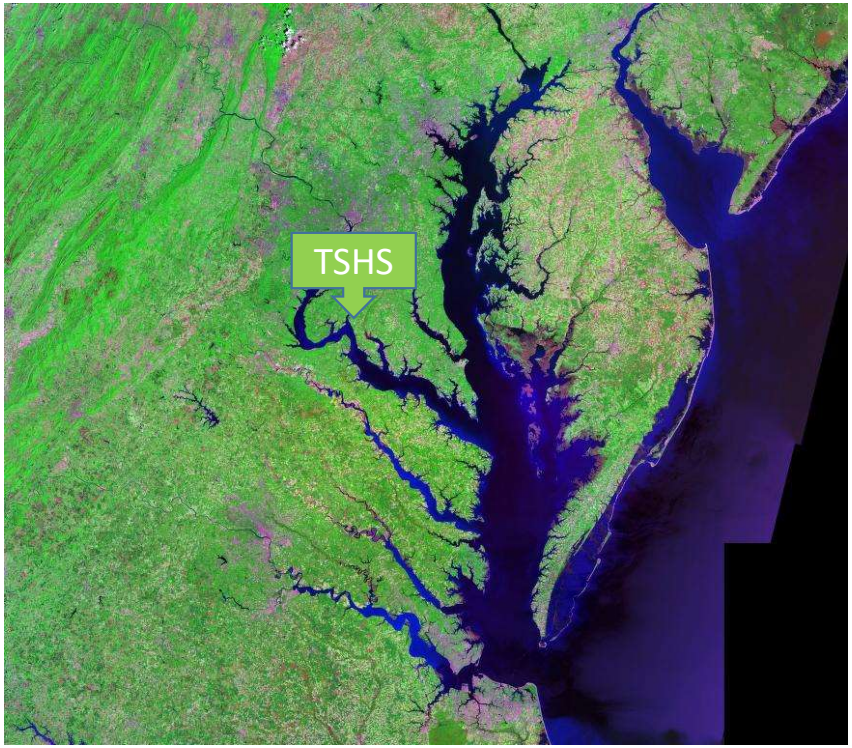
Surface Runoff

General Watershed slide

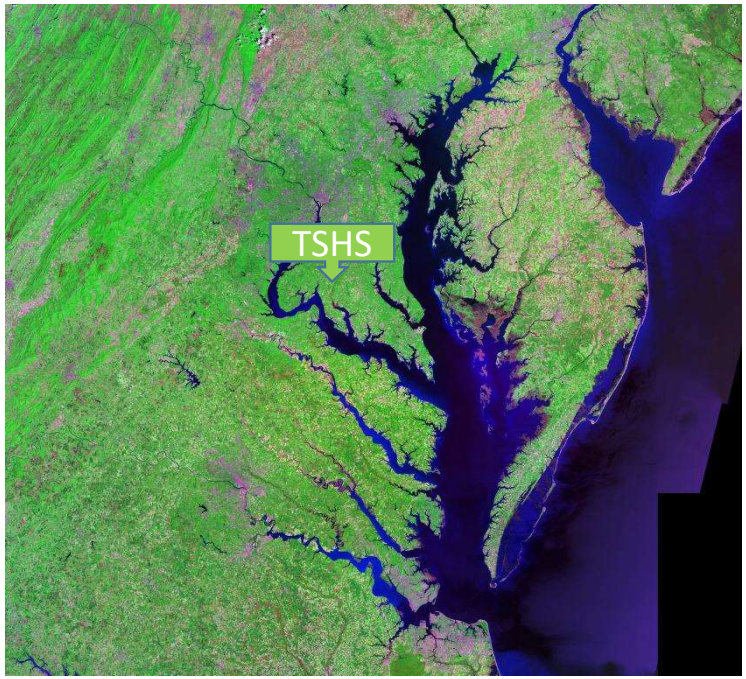


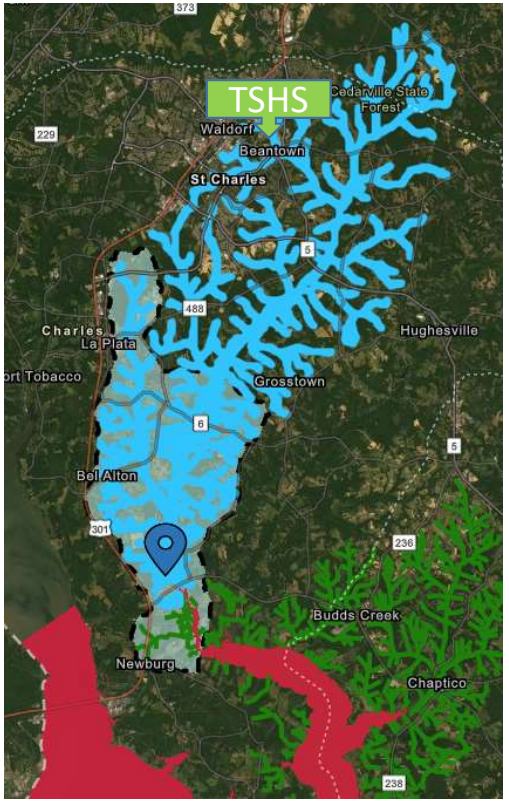
Watershed

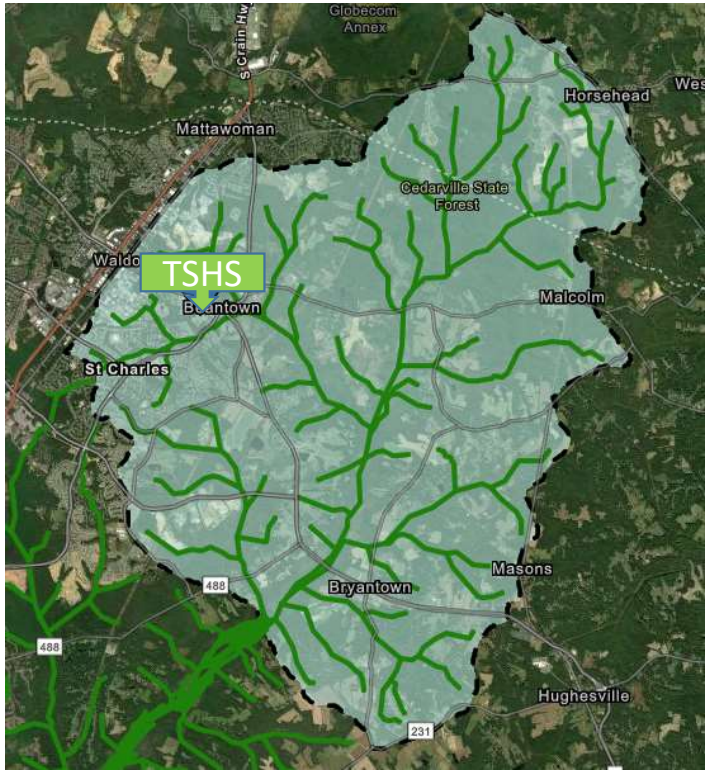
A watershed is an area of land that drains or “sheds” water into a specific waterbody



Watersheds within watersheds



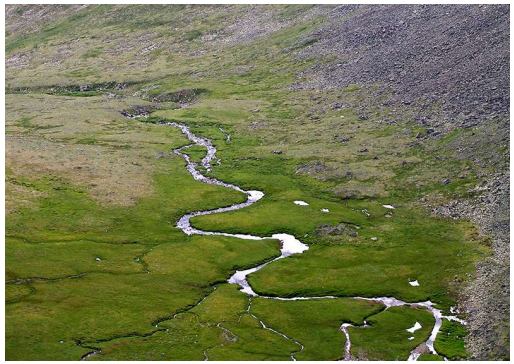


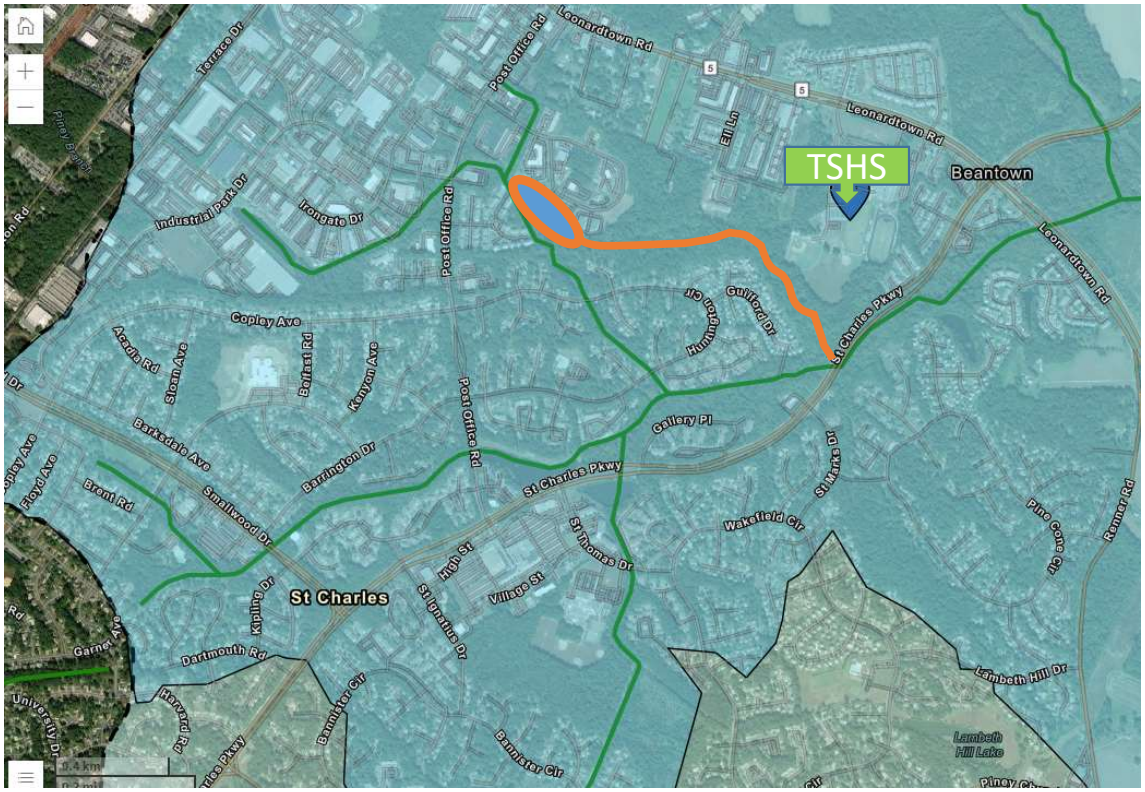


Is this a Watershed?

Tributaries

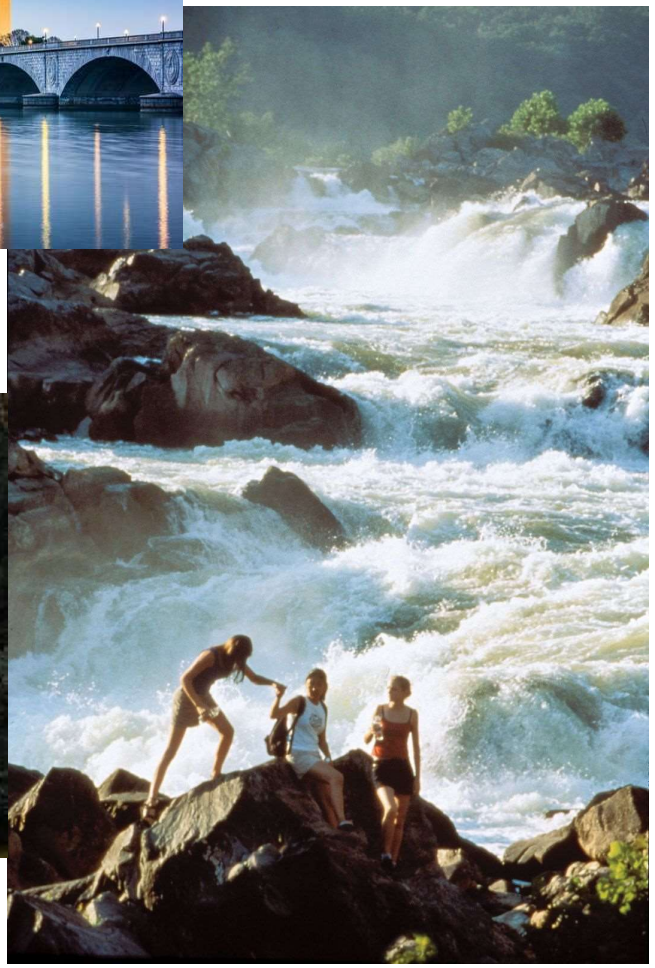
- Watersheds drain rainfall and snowmelt into small streams called **tributaries**
- Small **tributaries** flow into larger streams and rivers
- Gravity guides the water flow



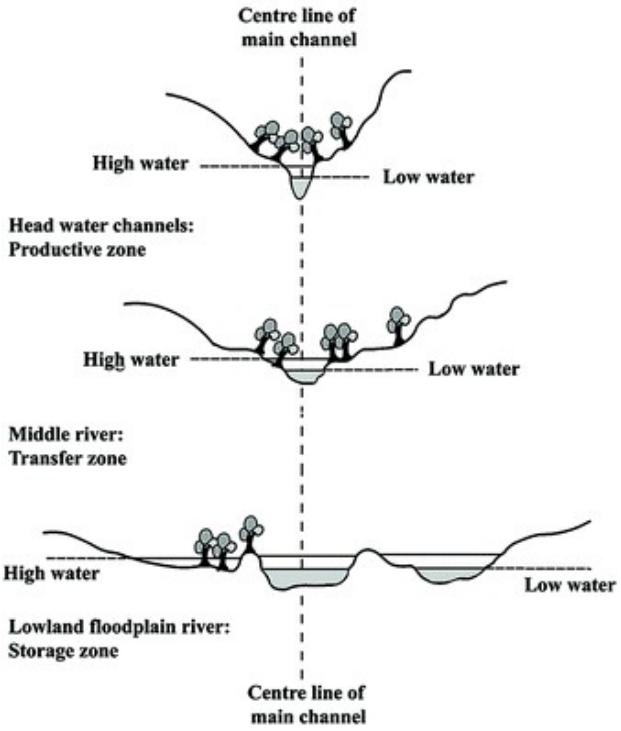


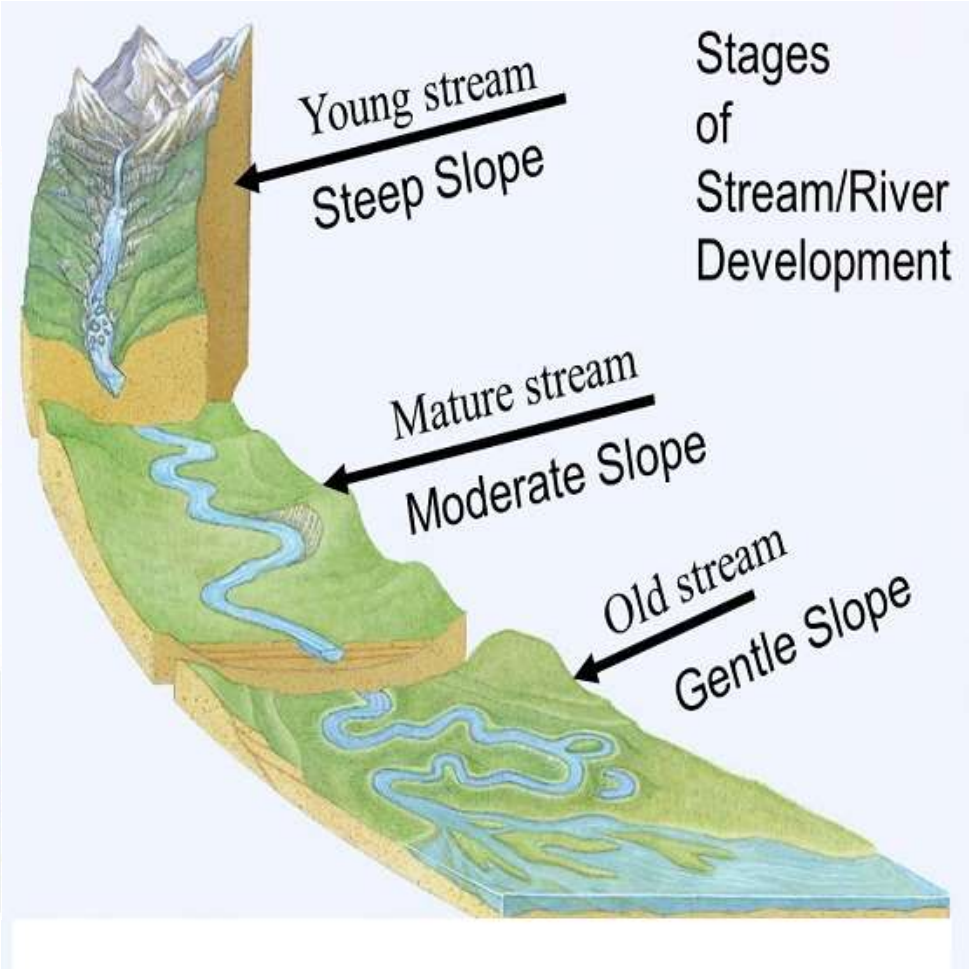
Streams and Rivers

- Once large enough, and fed by many tributaries, seepage and springs, Rivers and Streams form.



Stages of a Stream





Streams Move – Erosion and Deposition

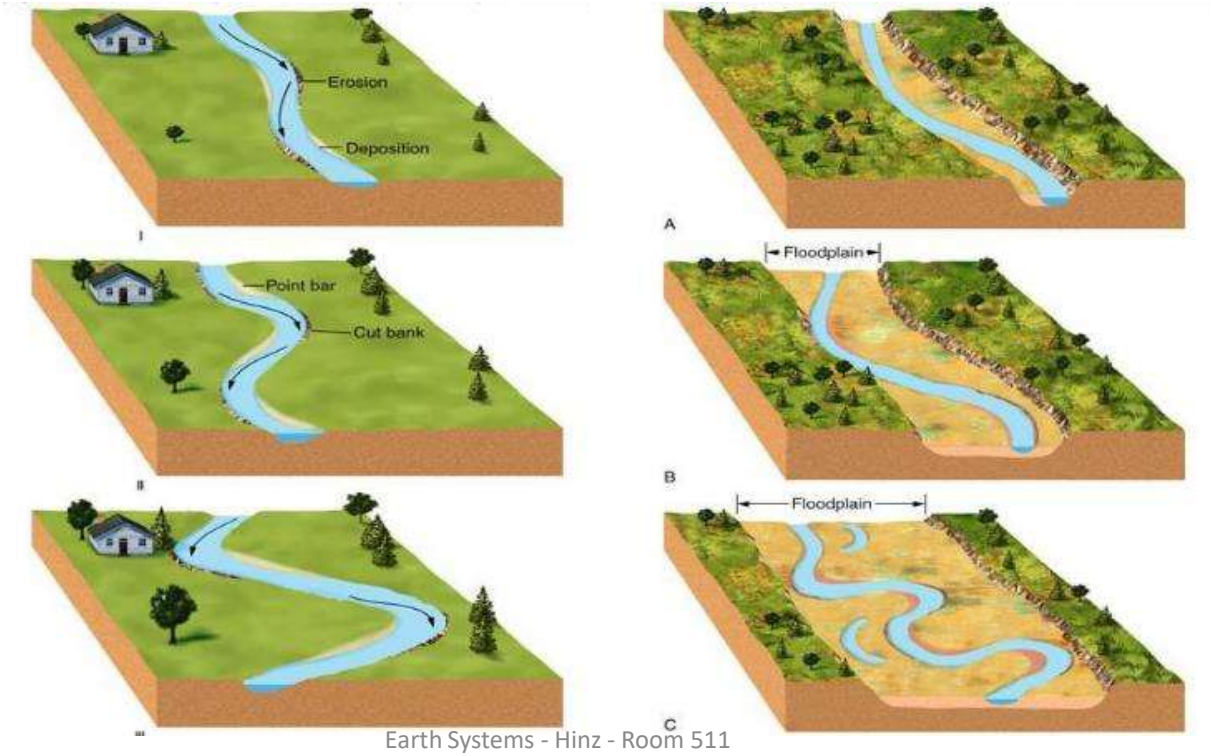
Meanders

- Rivers develop meanders when rivers flow across easily eroded sediment and bend in a u shaped form

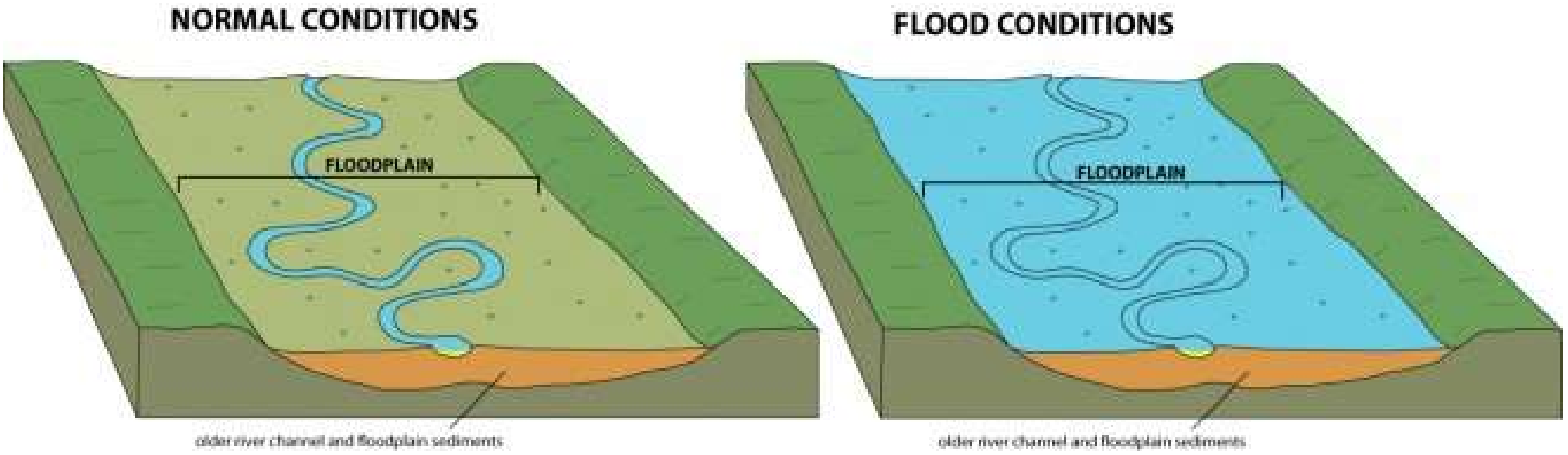
Agents of Erosion

Streams (Running Water)

Water erodes sediment on the outside curves and deposits (drops) sediment on the inside curves.

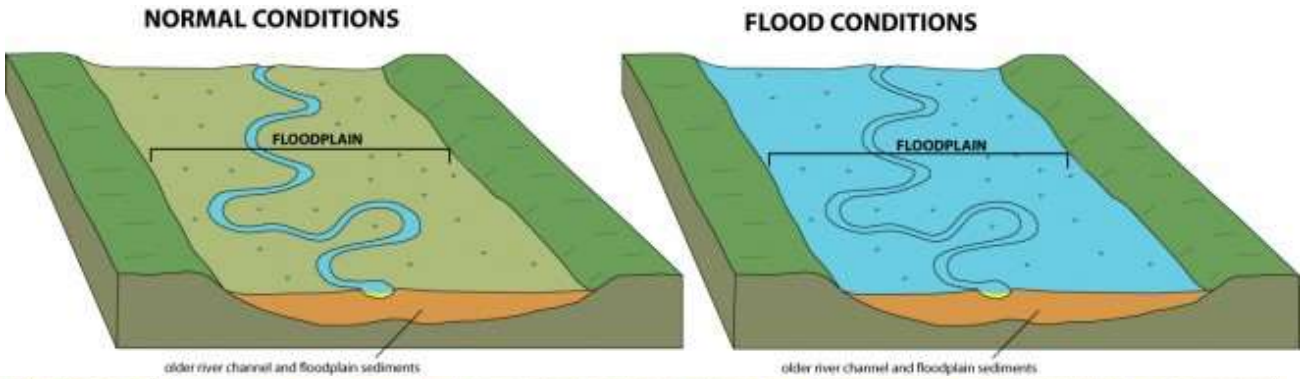


Floodplains



Floodplains

Floodplains



Figures 2.5 + 2.6 High tide flooding along East Potomac Park's perimeter promenade (Flickr, J. Sonder + Along the Gradyent blog)

Why parks are near rivers!

Meanders and Oxbows

- A **meander** that has been cut off from the river is called an **oxbow lake**.

meander

oxbow lake

119 Hydrology and Streams

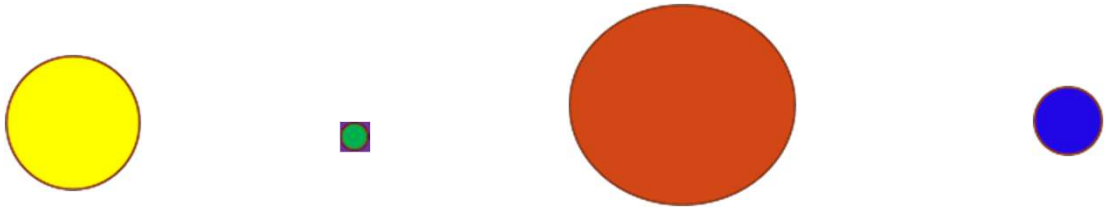
Lecture Day 3

Parts of a Stream

Agents of Erosion

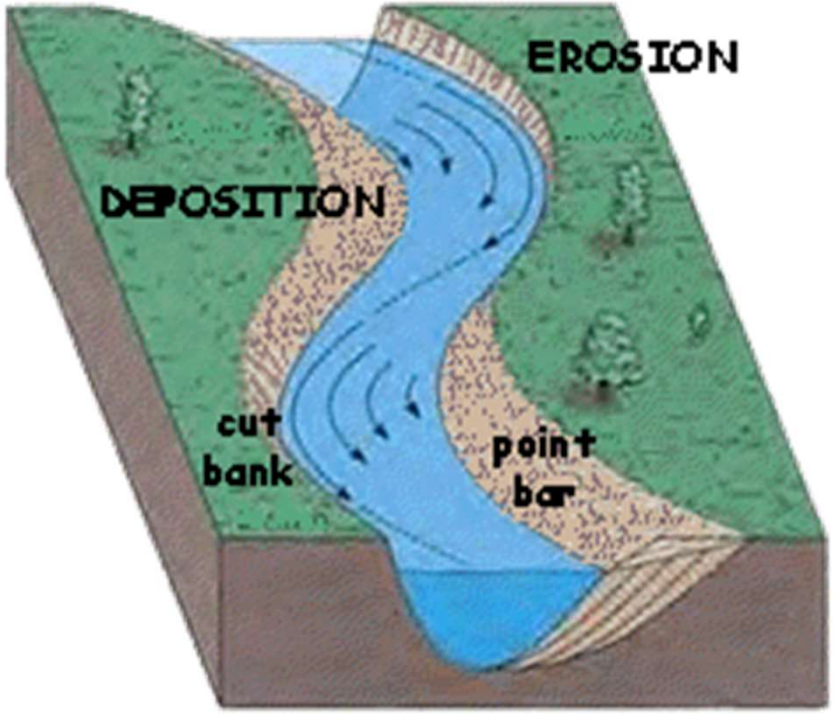
Streams (Running Water)

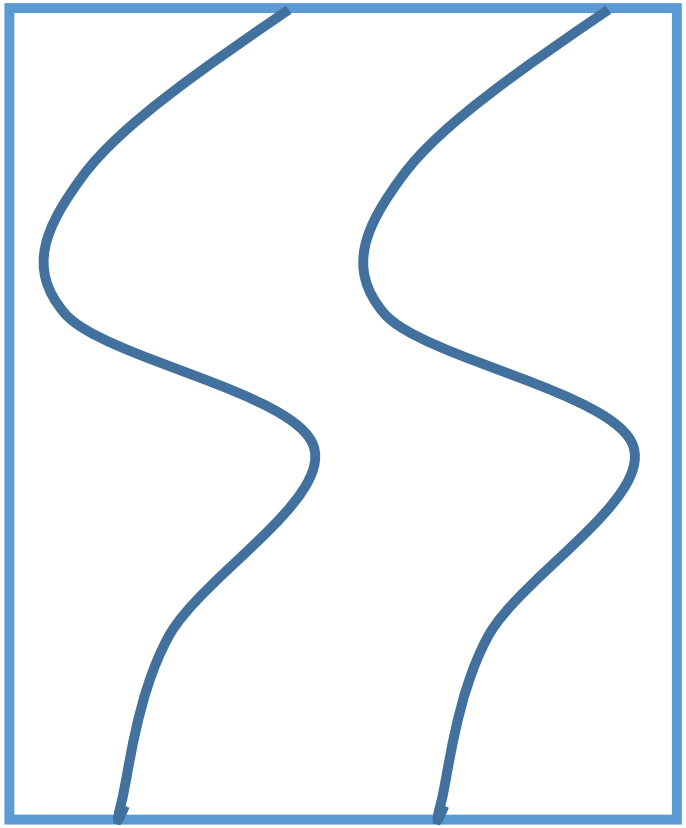
In What Order will These Sediments Settle



C A D

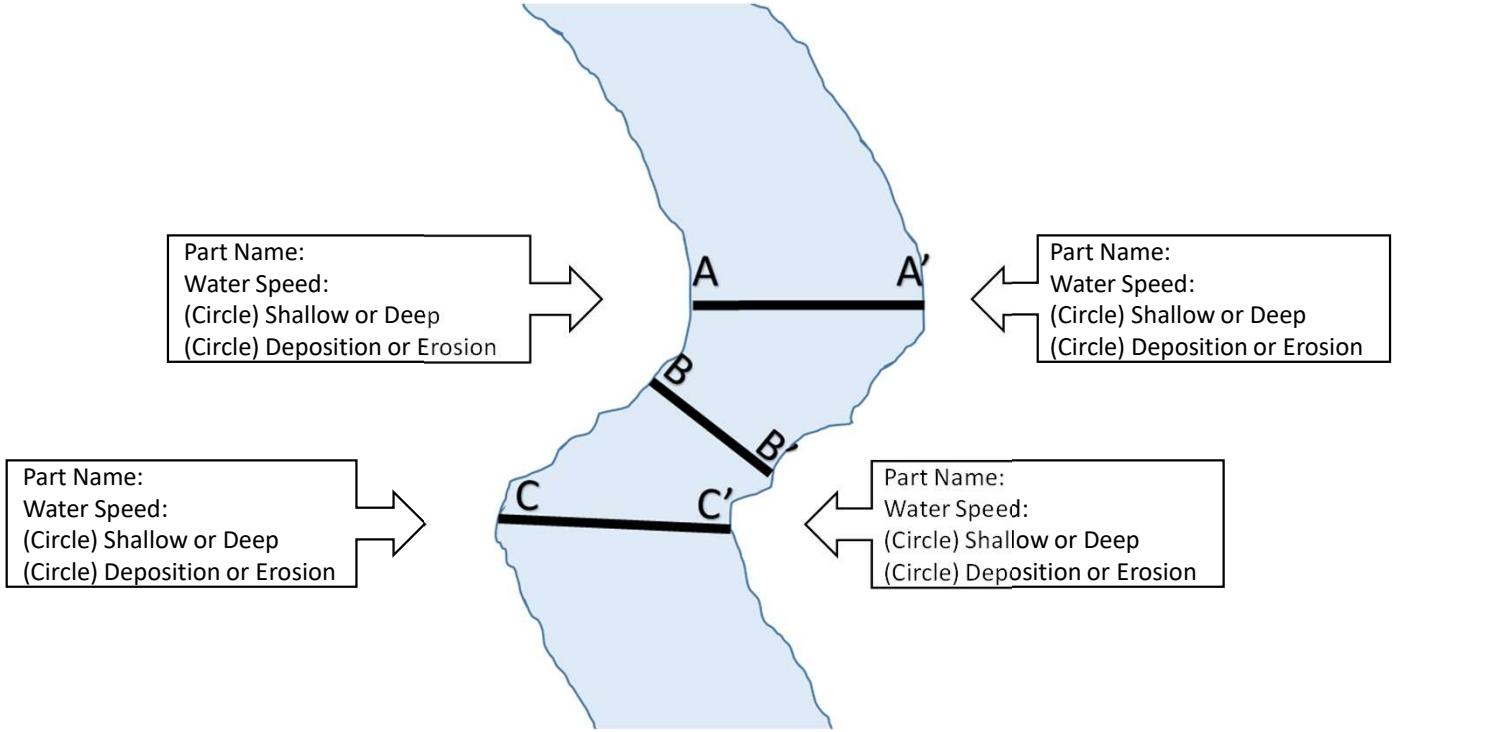
The Parts of a River

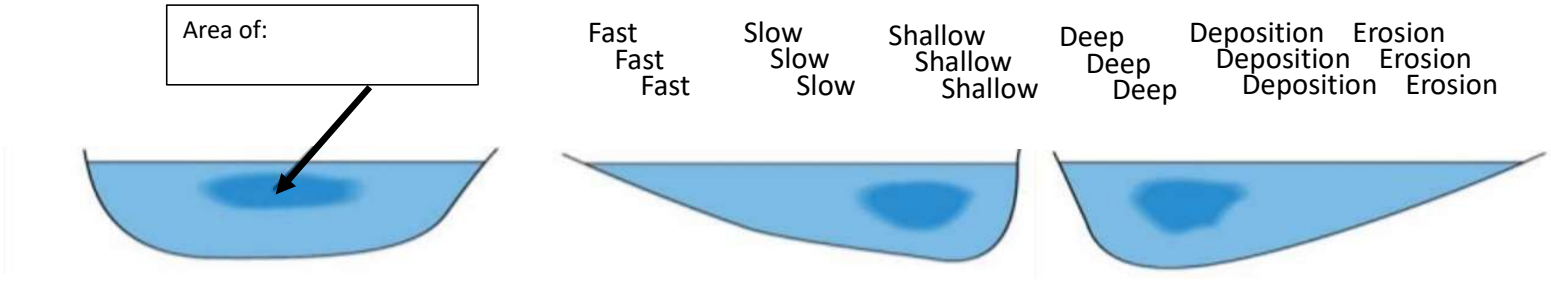




Point bar- where sediments are deposited along a stream due to low stream velocity

Cut bank- where sediments are eroded from along a stream due to high stream velocity


Part Name:
Water Speed:
(Circle) Shallow or Deep
(Circle) Deposition or Erosion
A
A'
Part Name:
Water Speed:
(Circle) Shallow or Deep
(Circle) Deposition or Erosion
B
B'
Part Name:
Water Speed:
(Circle) Shallow or Deep
(Circle) Deposition or Erosion
C
C'
Part Name:
Water Speed:
(Circle) Shallow or Deep
(Circle) Deposition or Erosion


Area of:
Fast
Fast
Fast
Slow
Slow
Slow
Shallow
Shallow
Shallow
Deep
Deep
Deep
Deposition
Deposition
Deposition
Erosion
Erosion
Erosion