

## Slide 1

### **WATER: ESSENTIAL FOR LIFE**

- Unique properties allow life to exist on Earth: capillarity, adhesion & cohesion.
- Universal biological solvent - medium for chemical reactions.
- All organisms depend on water for movement of materials, and is necessary for maintenance, growth & reproduction.
- Plants need water for photosynthesis, animals need plants for food.

### **LIMITED SUPPLY**

- 70% of Earth covered with water.
- Amount of fresh water is only about 1% of total
- Freshwater contains less than .01% of salt.
- Freshwater is unevenly distributed, much is in polar ice.
- The distribution of civilizations are affected by the availability of freshwater.
- Water is a sustainable resource because of natural recycling.
- Sea water is salty because rivers carry small amounts of salt to the oceans where the water evaporates, leaving the salt behind.

### **PHYSICAL PROPERTIES**

- Maximum density at 4 deg. C (37 deg. F) allows for ice to float, bodies of water do not freeze solid. Adhesion (molecules stick to sides of container) and cohesion (molecules stick to each other) are responsible for capillarity which allows water in fine diameter tubes to flow upward, resisting gravity. Transpiration would not be possible without capillarity and evaporation.
- Freezing occurs at 0 deg. C (32 deg. F) - changes phase from liquid to a solid, low kinetic energy of molecules, molecules packed closely together, heat energy has been removed.
- Boiling occurs at 100 deg. C (212 deg. F) - changes phase from liquid to a gas (water vapor), highest kinetic energy of molecules, molecules are spaced farthest apart, heat energy has been added, boiling is rapid evaporation.
- Liquid phase, water, has lower kinetic energy than water vapor but higher than ice. Molecules are spaced closer together than water vapor but farther apart than ice.

- Melting and evaporation occur with the addition of heat.
- Evaporation can occur without boiling, but occurs at a slower rate) changes from water to water vapor.
- Freezing and condensation occur by taking away heat.
- Condensation is a collection of droplets that form when water vapor cools in changing phase to liquid water.
- Forms of condensation:

Fog or mist - droplets condense on atmospheric dust. Clouds - masses of fog or mist as seen from a distance. Dew - drops condensing on cool surfaces or plants. Frost - dew freezing.

Snow - condensation in the atmosphere with temperatures below freezing.

Precipitation - water in a liquid or solid form as it returns to the earth - rain, snow, sleet, or hail.

## **THE WATER CYCLE**

- Consists of evaporation, condensation, and precipitation.

### Slide 3

- Surface Waters - oceans, lakes, ponds, rivers, streams, etc. on earth's surface.
- Groundwater - accumulated water below the earth's surface, completely filling all spaces above an impervious layer.
- Water table - upper surface of ground water.
- Aquifers - layers of porous materials through which groundwater moves.
- Recharge area - where water enters an aquifer.
- Spring- an opening in the surface, groundwater enters surface waters at a point of significant flow.
- Seep - an opening in the surface, ground water enters surface waters at a lower rate of flow but over a wide area.
- Artesian aquifers - the water is under very high pressure because the recharge area is much higher in elevation than the elevation where it leaves.
- Evapotranspiration - combined total of water evaporated from soils and surface waters, and from the transpiration process of plants.

PATHWAYS for precipitation hitting the ground:

- 1) Infiltration - soaking into ground.
- 2) Runoff- entering surface waters.

NOTE: some water evaporates from plant surfaces before hitting the ground. (interception)

ALTERNATIVES for infiltrate water:

- 1) Capillary water - held in soil - can return to atmosphere by evapotranspiration
- 2) Gravitational water - not held in soil - will percolate by gravity to an impervious layer.

**LOOPS of the WATER CYCLE:**

- 1) surface runoff loop - precipitation runs off the surface to surface waters where it evaporates.
- 2) groundwater loop - precipitation enters groundwater from surface, and enters surface waters where it evaporates.
- 3) Evapotranspiration loop - precipitation in soil evaporates or will evaporate as being used by plants.

**WATER PURIFICATION AND FILTRATION:**

- 1) As water evaporates, pure water enters the atmosphere, leaving salt and impurities behind.
- 2) Aquifers can usually filter out organisms and insoluble particles, if the wells, springs, or seeps are sufficiently far enough from the recharge areas. Dissolved contaminants will not be filtered out.

NOTE: The low water flow of rivers and streams (in summer) is not greatly affected for a period of time by recent precipitation. These rivers and streams represent the top of the water tables in those areas.

**PENNSYLVANIA WATER CYCLE**

Annual Water balance: Based on 40" annual precipitation  
Evapotranspiration 23" (60%)  
Direct runoff 6" (15%)  
Enters groundwater 11" (25%)

In forested watersheds, 75% of annual precipitation is lost in evapotranspiration, very little enters groundwater.

Most of recharge occurs in spring and fall.

**CATEGORIES of IMPACTS:**

- 1) Quantitative - concerns for having enough water for needs, impact of diverting one place to another,
- 2) Qualitative - concerns of water purity & effects on human/environmental health.

**CATEGORIES for USES:** (water is used & reused many times)

- 1) Nonconsumptive - water will remain available for the same or other uses if its quality is adequate or can be treated to remove undesirable materials. Example - residential & industrial use.
- 2) Consumptive - applied water is lost to further use, will eventually return to the cycle but at a different part of the cycle. Example -irrigation or evapotranspiration.

**MAJOR PROBLEMS:**

- Increasingly more dependence upon groundwater, overdraft - using faster than recharge, also causes land subsidence and saltwater intrusion. Some is "fossil" water & can't be recharged.
- Allocating more water from rivers than is available at low flow periods or during droughts.
- Sedimentation is the biggest water pollution problem
- Changing of infiltration/runoff ratios, development and construction will divert water that would normally infiltrate into groundwater into overloaded surface water runoff systems.
- Lack of conservation programs.
- Inadequate enforcement of pollution regulations.

**WATERSHEDS:**

- Defined as all the land area from which water drains into a particular stream or river.
- Size can vary, one may be concerned with a watershed for a small stream or the entire Allegheny River drainage.
- On average, it can take from 6 to 12 months in a forested watershed for precipitation to make it to a stream.

**PENNSYLVANIA, a water rich state**

- 83,000+ miles of streams & rivers
- 3956 lakes & reservoirs
- 47 trillion gallons of groundwater
- over one million wells
- average of 42" of precipitation per year

**SIX WAYS TO THE SEA IN PENNSYLVANIA (Six major watershed drainage systems)**

The drainage figures are for PA. Drainage also occurs from other states.

- 1) Susquehanna River - 20,928 sq. miles, largest
- 2) Ohio River (includes Allegheny, Monongahela & Youghiogheny Rivers) - 15,600+ sq. miles
- 3) Delaware River - 6470 sq. miles. Borders with New York and New Jersey
- 4) Potomac River - 1582 sq. miles
- 5) Lake Erie - 509 sq. miles, flows north
- 6) Lake Ontario/Genesee River - 94 sq. miles, flows north, only a small part of Potter County