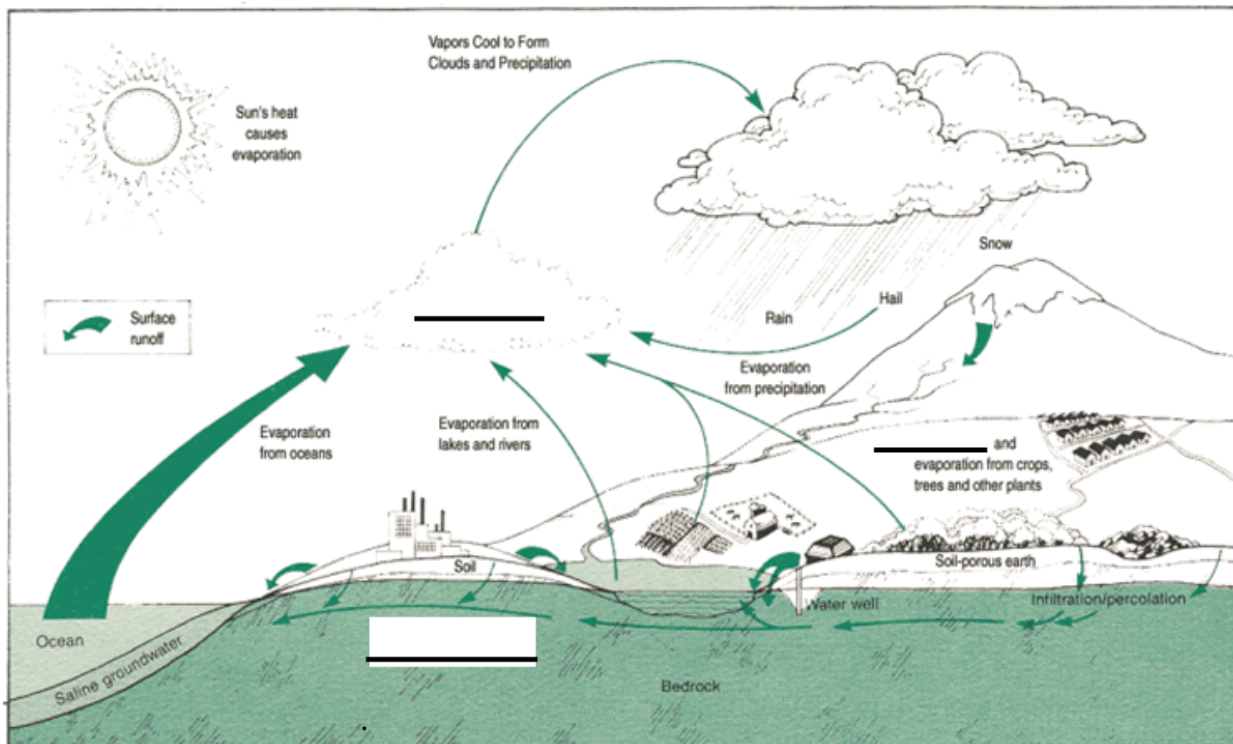


DW Module 2:  
Groundwater Sources of Supply and Protection  
**Answer Key**

**Exercise:** Take a minute and fill in the blanks in the hydrologic cycle graphic. There are three blanks.



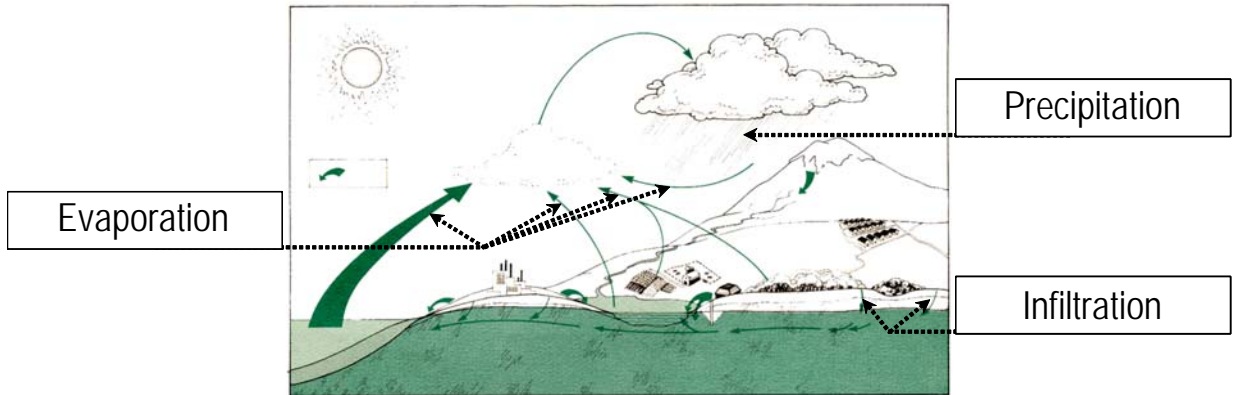
*[From the left side, the answers are: water vapor, groundwater, and transpiration. Ask participants for their answers before you tell them the correct ones.]*



**UNIT 1 EXERCISE: 10 minutes**

- On the diagram below, label the following parts of the Hydrologic Cycle: Precipitation, Evaporation and Infiltration.

**Ans:**



2. In addition to surface water, name two other types of water below and briefly describe each.

- A. Groundwater – found beneath earth’s surface

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- B. Atmospheric water – found in air surrounding the earth – clouds, fog, and precipitation

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3. Match the word with its definition:

Word Pool		
Evapotranspiration	Transpiration	Groundwater
Evaporation	Water Table	

Evaporation	1. When water turns into a vapor and returns to the atmosphere
Transpiration	2. When water travels through a plant and some evaporates directly from plant to air
Evapotranspiration	3. Loss of water by evaporation from the soil and transpiration from plants
Groundwater	4. Water found beneath earth’s surface (can be fresh or salt water). This is our largest source of fresh water
Water Table	5. The boundary below which all of the spaces and cracks in the soil and rock are filled with water



**UNIT 2 EXERCISE: 10 minutes**

1. List the three types of groundwater sources.

**Ans:** Wells, springs, infiltration galleries and radial collectors

2. On the map below, label the map's key to indicate the geological types of groundwater aquifers found in Pennsylvania.

Ans: Student responses should be as listed in the legend: Sand and Gravel, Sandstone and Shale, Carbonate Rock, and Crystalline Rock Aquifers.

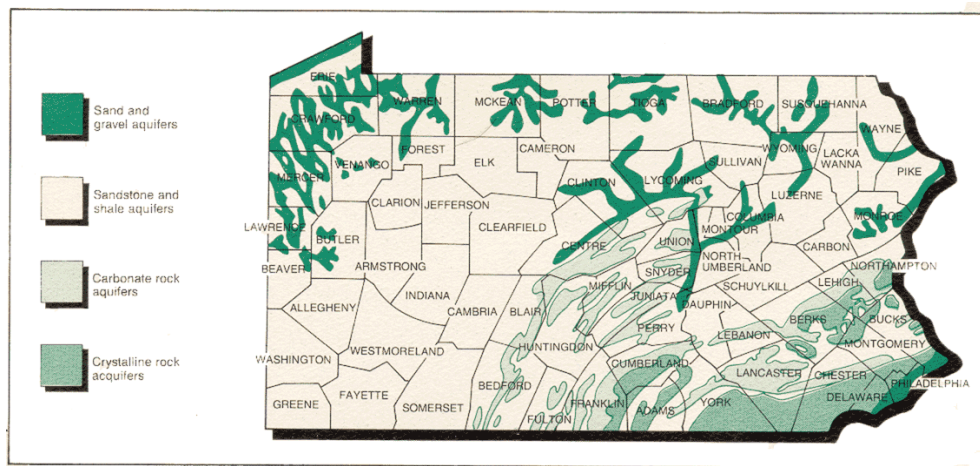
3. True or False: A stratum is a layer of earth

Ans: True

4. Which one of the following best defines the term *aquifer*?

- a. A low lying area where water pools
- b. Water-bearing stratum of rock, sand, or gravel
- c. Impervious stratum near the ground surface
- d. Treated water leaving the water system

Ans: B



5. List the three types of aquifers.

Ans: Unconfined Aquifer, Confined Aquifer, Perched Aquifer or Perched Water Table

6. Based *solely* on **quality** of water and **yield**, which of the four aquifer formations would provide the largest amount of fresh water? Why?

Ans: Sand and Gravel Aquifers

**Yield:** Contain large quantities of water, easily withdrawn, Well yields of 100 – 800 gallons per minute (gpm), Yield in excess of 1000gpm are common.

**Quality:** is variable, but generally good to excellent

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 **Application of Protective Casing Depths.**

1. What is the recommended protective casing depth when the water bearing formation is gravel, overlying material is a mixture of sand and gravel, and the pumping level is 28 feet?

**Ans:** 38 feet. (The depth of casing will be governed by the pumping level. For pumping levels 30 feet or less, the casing shall extend 10 feet below pumping level. For pumping levels greater than 30 feet the casing shall extend five feet below pumping level.)

2. What is the recommended protective casing depth when the water bearing formation is limestone and the overlying material is mantle to a depth of 52 feet for a radius greater than a mile?

**Ans:** The casing shall be firmly seated in the rock formation. (See Section 3.3.6.3)

3. What is the recommended protective casing depth when the water bearing formation is sandstone and the overlying material is limestone at variable depths?

**Ans:** The casing pipe shall be extended 15 feet into firm sandstone.

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**UNIT 3 EXERCISE:**

1. In the space below, define Safe Yield and explain why it is important to groundwater supply sources.

**Ans:** Safe Yield is the amount of water that can be taken out of the ground in a year's time without having an adverse impact on the groundwater system.

This is important because with the time energy and money put into developing the water supply we want to make sure that the capacity of the source will remain constant indefinitely.

2. In the space below, explain the importance of proper installation of the well casing.

**Ans:** The proper installation of well casings helps to ensure that the water will be protected from possible contaminants which could be introduced by surface water entering the well.

3. What is the recommended protective casing depth when the water bearing formation is quartzite and the overlying material is 48 feet for a radius of one mile?

**Ans:** The casing shall extend 10 feet into uncreviced rock below 40 feet.

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#### UNIT 4 EXERCISE:

1. Two plans that need to be in place to address Source Water Protection. Write the names of each plan below.

**Ans:** Source Water Protection Plan or Wellhead Protection Plan, and Drought Contingency Plan.

2. **True or False:** A local steering committee is recommended, but not a required component of a source water protection program.

**Ans:** False, it is actually required.

3. **Fill-in-the-blank:** The \_\_\_\_\_ is a list of all the contaminants and where they are found in a source water protection area.

**Ans:** Contaminant Source Inventory

4. List three examples of source water protection public education methods.

**Possible Answers:** Websites, floats, flyers, or newspaper articles

5. List the three drought stages:

**Ans:** Watch, Warning, and Emergency