



Learn, Protect, and Promote Water: A Water Quality and Pesticide Stewardship Outreach Lesson Plan

Learning Objective: The hydrologic cycle, or water cycle, includes precipitation, evaporation, and transpiration, with precipitation recharging groundwater and becoming surface water. Point and nonpoint source pollution from pesticides and other sources can contaminate water. Best management practices can be used to help protect water from pollution.

Suggested Audience: 6th – 8th Grade

Suggested Time: Thirty to forty-five minutes

Pennsylvania Academic Standards:

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| Environment and Ecology 4.2.8.A. | Describe factors that affect the quality of ground and surface waters. |
| Environment and Ecology 4.5.8.A. | Explain how Best Management Practices (BMP) can be used to mitigate environmental problems. |
| Environment and Ecology 4.5.8.C. | Describe how humans can reduce pollution. |
| Environment and Ecology 4.5.7.C. | Explain how human actions affect the health of the environment. Identify residential and industrial sources of pollution and their effects on environmental health. |

Vocabulary:

Groundwater – Precipitation that has infiltrated through soil, rock, and gravel in the ground.

Point Source Pollution – Pollution from a specific and identifiable source.

Nonpoint Source Pollution – Pollution from several areas with a less identifiable origin.

Best Management Practices – Methods that can improve efficiency, optimize resources, and prevent or help reduce pollution.

Lesson Instructions:

Section 1: Water Uses and Water Sources

The hydrologic cycle, more commonly known as the water cycle, is a process where water is continually moving around the earth, consisting of precipitation, evaporation, and transpiration.

Precipitation is water in any form that falls from the sky. Evaporation is when water changes from a liquid to a gas from being heated by the sun. Transpiration is when water changes from a liquid to a gas from being absorbed through plant roots and going out through leaves.

Groundwater is water found underground in the cracks and spaces in soil and rock. Precipitation can help to increase groundwater levels if the precipitation is able to infiltrate deep enough through soil, rock, and gravel in the ground.

Groundwater reaches aquifers, which is the saturated zone of the soil, rock, and gravel in the ground. Wells need to be drilled into aquifers to access water. The top of the aquifer, where the saturated zone meets the unsaturated zone, is called the water table.

Groundwater aquifers also serve to supply water to streams and other surface water. If not for groundwater, streams would dry up during the driest part of summer when it may not rain for weeks. In urban areas, groundwater recharge is reduced due to pavement, roofs, and other impervious surfaces.

On Earth, only 1 percent of water can be used for drinking. In Pennsylvania, about 50 percent of the population gets at least some of their drinking water directly from groundwater. Additionally, groundwater is used for industry, mining, and agricultural purposes.

Discussion: *Have students form small groups. Ask them to each take a turn sharing a response to the following questions. Encourage students to think of a response that has not already been shared in their group. If everyone in the group answers, see if the each group as a team can think of even more responses for a second round of sharing.*

1. *How do I use water in my daily life?*

2. *Who or what needs water?*

Another way to facilitate this activity is to have students write down responses as a group in a certain amount of time, such as sixty seconds. Have students share and compare responses. For a friendly competition, see which group comes up with the most unique responses.

Section 2: Water Pollution

Water can become contaminated by both point source pollution, which is pollution from a specific and identifiable source, and nonpoint source pollution, which is pollution from a less identifiable source, often spread over several areas, and can mobilized by rainfall or snowmelt.

Point source pollution examples include:

- Factory waste from a pipe
- Discharge from manufacturing plant
- Waste water treatment facility outfall

Nonpoint source pollution examples include:

- Fertilizer in garden
- Dog waste in yard
- Motor oil residue on roads

In addition to other pollutants, pesticides, if not used appropriately, can contaminate both surface water and groundwater. The contamination can be effected by the weather, environment, soil conditions, and human activities. For example, sandy soil has larger soil particles and is more prone to pesticide leaching, which occurs when a pesticide moves through the soil to reach groundwater. Certain characteristics that make a pesticide more prone to leaching include:

- High solubility, meaning the pesticide can easily move in water

- Low adsorption, meaning the pesticide does not easily bind to the soil particles
- Persistent, meaning the pesticide does not easily break down in the environment

Point source pollution examples from pesticides include:

- Improper disposal of pesticide containers and pesticides, such as dumping excess pesticides down storm sewers and other locations.
- Pesticide use in vulnerable areas such as sandy soil, sinkholes, and shallow groundwater.
- Pesticides spills at mixing, loading, and equipment clean-up sites.
- Pesticide use around wells or other known water sources.
- Back-siphoning of pesticides into water sources.
- Any way that pesticides are not mixed, used, stored, and disposed of according to label directions.

Nonpoint source pollution from pesticides includes pesticides moving from large areas into water or groundwater, like what might occur after a rainfall, such as if pesticides are applied to fields and lawns prior to rainfall.

Activity: Groundwater Recharge, Pollution, and Protection

Activity Prep:

1) Print and cut Water Pollution - Scenario Cards.

2) Print Groundwater Mini Posters or prepare 8" x 11.5" handwritten signs that display the following terms: Clouds, Plants, Ground, Stream, Aquifer, Point Source Pollution (2 signs), Non-Point Source Pollution (2 signs). Additional pictures and/or props for the activity could be used as desired.

3) Hang or place the Clouds sign at the front of the room or learning space. In the following order, display the Plants, Ground, and Stream signs several feet away from each other and several feet down from the Clouds sign, such as in the middle of the room. The Aquifer sign should be placed on the opposite end of the room or space from the Clouds sign, several feet down from the Plants, Ground, and Stream signs.

Activity Facilitation: Groundwater is a very important resource. The following activity can demonstrate the hydrologic cycle and groundwater recharge for the Pennsylvania. Students will serve as the water that moves through the hydrologic cycle and provides nutrients to plants, recharges groundwater, and supplies aquifers.

1. Explain to learners that Pennsylvania gets 41 inches of precipitation, on average. Of that precipitation, approximately 50 percent will evaporate or transpire from plants, 30 percent will go to will infiltrate through the soil and recharge groundwater, and 20 percent will land on the ground and runoff into streams.
2. Students are going to serve as precipitation, demonstrating the hydrologic cycle and groundwater recharge. Ask for 20 volunteers. Before the students come to the cloud, assign the following number of students in respective roles: 10 students will be the evaporation and transpiration, 6 students will be the groundwater recharge, and 4 students will be the runoff into stream. Once roles are assigned, have the 20 students come to the front of the room and stand by the Clouds sign.
3. Remind students that approximately 50 percent of the precipitation will evaporate or transpire from plants in Pennsylvania. Have 10 students leave the Clouds sign, representing precipitation, and move to the Plants sign.
4. Remind students that 30 percent of the precipitation will infiltrate through the soil and recharge groundwater in Pennsylvania. Have 6 students leave the Clouds sign, representing precipitation, and move to the Ground sign. Have the students step over the Ground sign, representing how precipitation infiltrates into the ground. Have half (3 of the 6) students move and stand next to the Aquifer sign, demonstrating how groundwater fills aquifers. Have the other 3 move

towards the Stream sign, still below the Ground sign, but forming a horizontal line to replicate how the groundwater feeds surface water like the stream.

5. Remind students that 20 percent of the precipitation will land on the ground and runoff into streams in Pennsylvania. Have the 4 students leave the Clouds sign, representing precipitation, and move towards the Ground sign. Once they reach the Ground sign, the students should not step over the sign, but should move horizontally across to the Stream sign, demonstrating how the precipitation becomes runoff and feeds into surface water, such as streams and lakes.

6. Instruct the group of 10 students standing at the Plants sign to move back to the Clouds sign, demonstrating how water will evaporate (change from a liquid to a gas from being heated by the sun) or transpire (change from a liquid to a gas from being absorbed through plant roots and going out through leaves) as part of the hydrologic cycle.

Explain to learners that groundwater recharge happens primarily in the spring and fall. In the winter, soil is often frozen. In the summer, plants are growing.

A Step Further: Instead of assigning students to groups, ask for volunteers and then have the students determine the numbers for evaporation and transpiration, the groundwater recharge, and the runoff into streams using the given percentages. Or, have the students represent certain inches of precipitation and allow them to determine where the water will move. Example: Each student represents 4 inches of precipitation. To replicate the movement of 40 inches of precipitation, 5 students would move to the Plants sign, 3 to the Ground sign for groundwater recharge, and 2 would be the runoff for streams.

7. Have the students remain in the same positions near the Stream, Groundwater, Aquifer and Clouds signs. Select an additional 4 students or select 4 students standing near the Clouds. These students will now be representing Point Source Pollution or Nonpoint Source Pollution. Distribute one Water Pollution - Scenario Card to each student. Distribute handwritten signs or, if using Groundwater Mini Posters, distribute posters to corresponding pollutant listed on top of Scenario Card. *Optional: Tape a bright colored piece of paper or use another indicator in addition to the signs for the students representing pollution.*

8. Tell students to read the instructions on their scenario card. Instruct the rest of the group to remain in current position unless prompted. (Note: The scenario card instructions tell participant to read the instructions, perform the action when prompted by the instructor, and then share the talking points when prompted by the instructor.)

9. Instruct Person #1 and Person #2 to perform the action listed on their scenario card.

10. Instruct Person #3 and Person #4 to perform the action listed on their scenario card. Once Person #3 is positioned near the Plants sign and Person #4 is positioned near the Ground sign, say "It's Raining." Instruct the students near the Cloud sign, who are serving as precipitation, to move, encouraging some to move towards the Plants sign and others to move towards the Ground sign. Person #3 and Person #4 have an additional action step on their scenario card to move once the precipitation reaches them. Instruct the precipitation students to either stop once they have reached the signs or, take it a step further, with having the students at the Ground sign to either infiltrate towards the Aquifer sign or runoff to the Stream sign.

11. Ask the students about their observation of the pollution and which was point source or nonpoint source pollution. Have Person #1, Person #2, Person #3, and Person #4 read the Talking Points on their scenario cards. Have students propose solutions to protect water sources, such as avoiding applying fertilizer or chemicals near expected rainfall events and ensuring that oil in motor vehicles is not leaking. More water protection solutions will be discussed in the next section.

Alternate Approach: The "Groundwater Recharge and Groundwater Pollution" Poster Activity uses a poster and plastic chips to demonstrate the same concepts of recharge and pollution.

Section 3: Water Protection

Best management practices (BMPs) are methods that can improve efficiency, optimize resources, and can prevent or help reduce pollution. If applying pesticides, BMPs should be used, which promote environmental stewardship and help prevent pesticide contamination of water. Best management practices with pesticides around water include:

- Determine need to even use pesticide products and perform spot treatments when possible.
- Apply pesticides according to the label directions.
- Identify vulnerable areas such as sandy soil, sinkholes, wells, and shallow groundwater.
- Secure storage areas to prevent unintentional chemical exposure.
- Ensure chemicals are tightly closed and monitor for tears to prevent spills or leaks.
- Maintain a 100 foot buffer zone around wells, streams, rivers, and other known water sources when mixing, loading, and applying pesticides.
- Avoid back-siphoning of pesticides.
- Incorporate pesticides into the soil to reduce runoff.
- Have buffer strips to catch sediment and help slow runoff movement.
- Monitor weather to properly time pesticide applications.
- Regularly calibrate equipment.
- Handle pesticides and equipment safely.
- Seek assistance with any questions from Extension Educators and Department of Agriculture affiliates.

Other best management practices to help prevent water contamination include:

- Reduce or eliminate fertilizer use.
- Prevent chemicals from leaking.
- Pick up trash and animal waste.
- Be aware of oil residues from vehicles.

Discussion: Reference the pollutants in the Groundwater Recharge and Groundwater Protection activity and have students research and explore best management practices to help prevent water contamination. Examples:

Pollutant – Pesticide Backpack Sprayer Spill

Best Management Practice (BMP) – Handle equipment safely.

Pollutant – Fertilizer or Chemical Application

Best Management Practice (BMP) – Determine need to even use pesticide products and perform spot treatments when possible. Monitor weather to properly time applications.

Pollutant – Oil Residue on Road

Best Management Practice (BMP) – Prevent leaking. Be aware of oil residues from vehicles.

Discussion: Encourage students to identify areas around their home which are near or connected to water, such as storm sewers, well heads, streams, and others. Ask students about potential contaminants near these areas and if there are best management practices to reduce pollution.

A Step Further: Students can research specific examples and news article that share about water contamination and the effects on the society. Allow students to share findings with the group.

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Water Pollution - Scenario Cards

Person #1 - Point Source Pollution Scenario – Pesticide Backpack Sprayer Spill

Instructions: You are representing Point Source Pollution. Read the Action listed below silently to yourself. When the instructor tells you, perform the steps listed as Action. When the instructor tells you, read the Talking Points out loud.

Action: Stand near the Stream sign. After several seconds, move closer and stand directly by the Stream sign.

Talking Points: I am Point Source Pollution. Point Source Pollution is from a specific, identifiable place or location, such as a pesticide spill near a stream or storm drain.

Person #2 - Point Source Pollution Scenario – Factory Waste from Pipe

Instructions: You are representing Point Source Pollution. Read the Action listed below silently to yourself. When the instructor tells you, perform the steps listed as Action. When the instructor tells you, read the Talking Points out loud.

Action: Stand near the Stream sign. After several seconds, walk over the Stream sign and move towards individuals serving as groundwater and towards the aquifer.

Talking Points: I am Point Source Pollution. Point source pollution, such as factory waste from a pipe, can begin in the surface water (stream), but contaminated surface streams can interact with shallow groundwater.

Person #3 - Nonpoint Source Pollution Scenario – Fertilizer or Chemical Application

Instructions: You are representing Nonpoint Source Pollution. Read the Action listed below silently to yourself. When the instructor tells you, perform the steps listed as Action. When the instructor tells you, read the Talking Points out loud.

Action: Stand near the Plants sign. The teacher will say “It’s Raining” and the students acting as precipitation will come towards you. Several seconds after they reach the Plants sign, move towards the Aquifer. (You are representing groundwater contamination.)

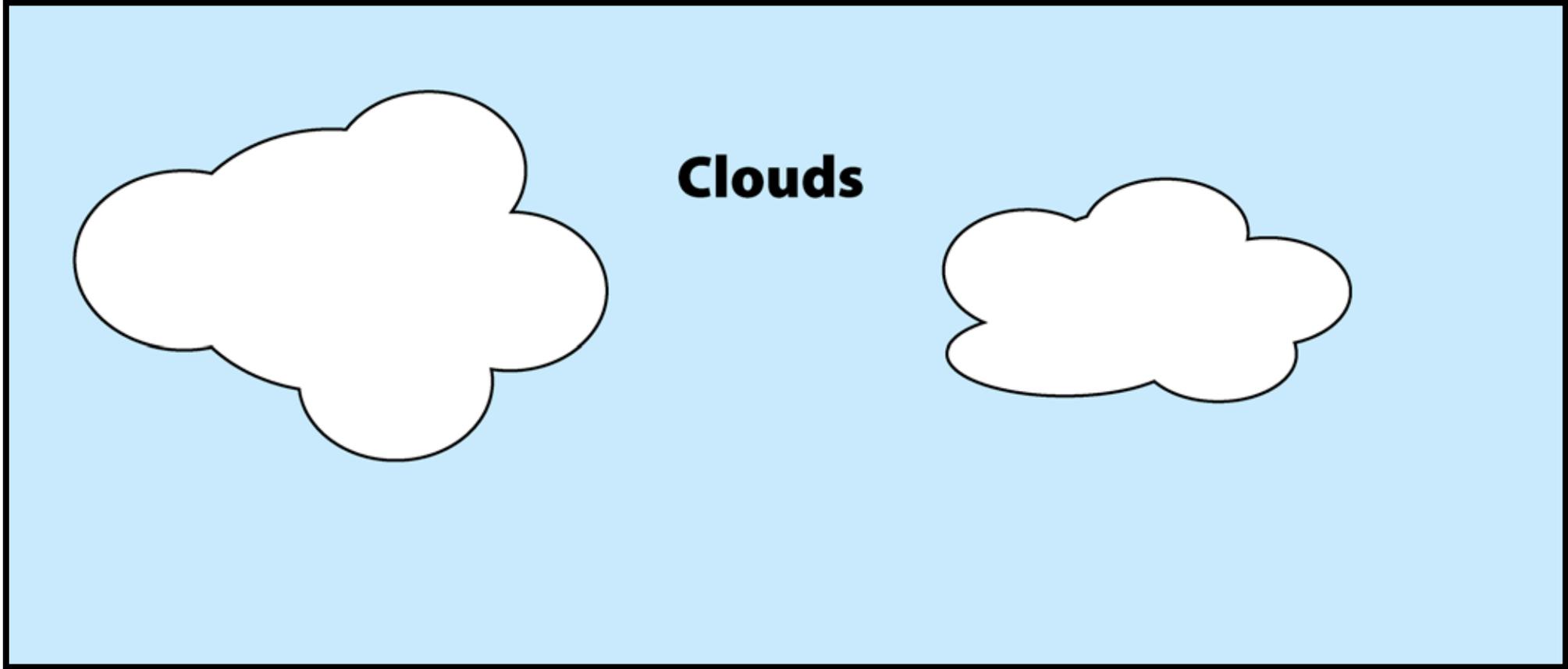
Talking Points: I am Nonpoint Source Pollution. Nonpoint source pollution is from several areas with a less identifiable origin. I might have been excess fertilizer or chemicals that were then mobilized (moved) after a sudden rainfall.

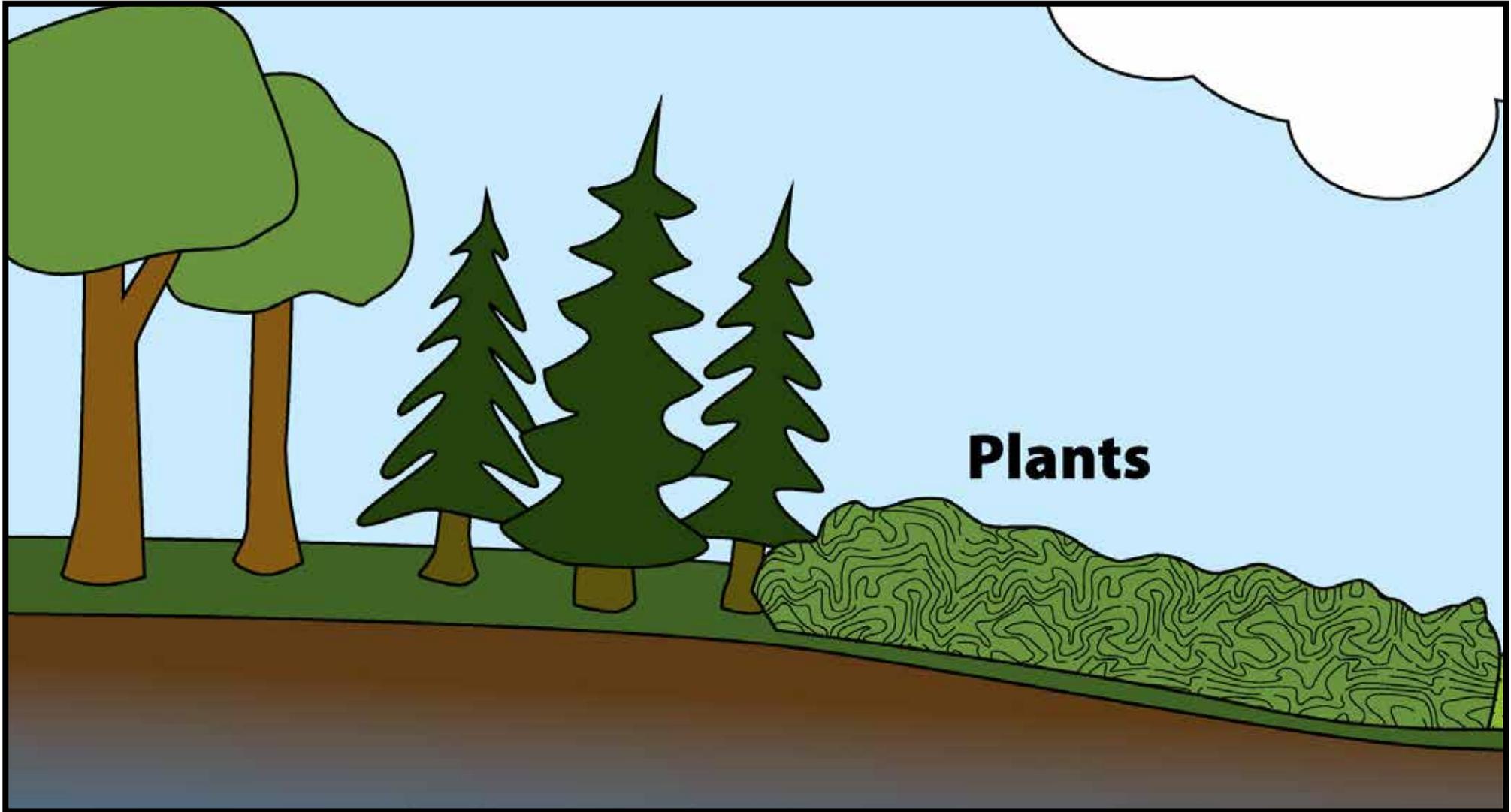
Person #4 - Nonpoint Source Pollution Scenario – Oil Residue on Road

Instructions: You are representing Nonpoint Source Pollution. Read the Action listed below silently to yourself. When the instructor tells you, perform the steps listed as Action. When the instructor tells you, read the Talking Points out loud.

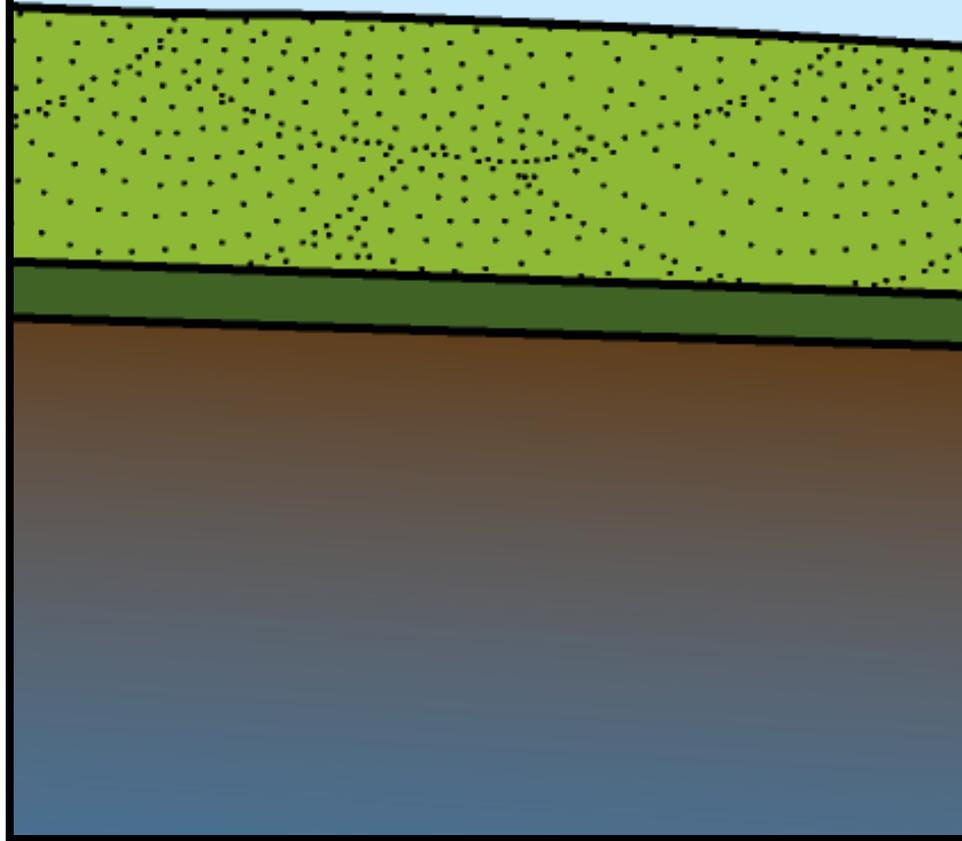
Action: Stand near the Ground sign. The teacher will say “It’s Raining” and the students acting as precipitation will come towards you. Several seconds after they reach the Ground sign, move towards the Aquifer. (You are representing groundwater contamination.)

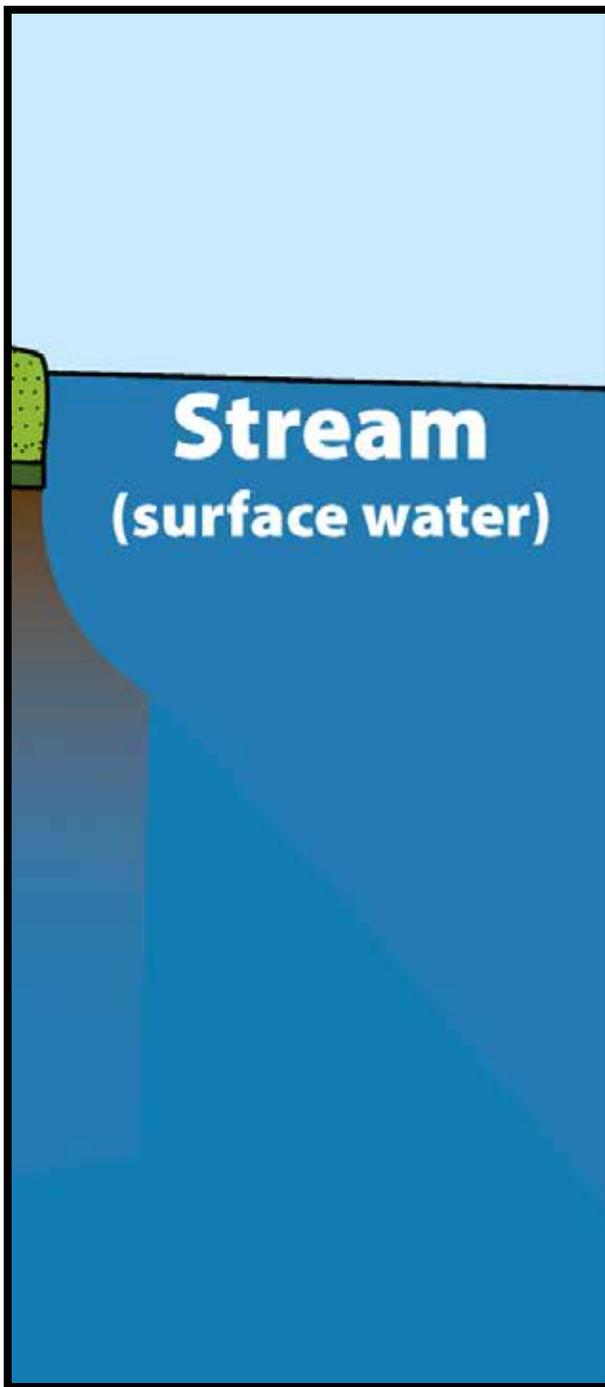
Talking Points: I am Nonpoint Source Pollution. Nonpoint source pollution is from several areas with a less identifiable origin. I might have been excess fertilizer or chemicals from a lawn, dog waste in the yard, or motor oil residue from a vehicle oil change.





Ground





Groundwater

Aquifer
(unconfined)

Point Source Pollution



Point Source Pollution





Non-Point Source Pollution





Non-Point Source Pollution