4-H Water Project Helper's Guide

Unit 3: Water Quality Matters!
Welcome to the 4-H Water project curriculum. As a helper and mentor, you are in a key position to support the positive growth and development of youth. This curriculum provides opportunities for you and youth to develop caring relationships as well as life-long appreciation for water conservation and quality.

Your Role
- Become familiar with the information in this guide and the Water Quality Matters, Unit 3 Project Book.
- Support youth in their efforts to set goals and complete the activities
- Help youth know themselves, including their strengths and weaknesses
- Incorporate the experiential learning cycle in all learning experiences
- Evaluate the impact

Helper’s Guide
This 4-H Water Project Helper’s Guide is designed to help an adult leader assist club members complete their project and to facilitate group activities for the Water Quality Matters, Unit 3 Project Book.

Water Project Outcomes
Through participation in this project youth will
- better appreciate the importance of water quality, and how it is measured.
- increase environmental understanding and stewardship of water.

The 4-H Water Project Books

These 3 project books focus on water with an emphasis on the following themes: Water Use, Water Consumption, Water Conservation, Properties of Water, Forms of Water, Water Cycle, Water Quality, and the Physical, Chemical and Biological Properties of Water.

They have been developed to be interactive and experiential. Youth will acquire life skills and water resource knowledge through each “learning-by-doing” activity. Each project book is designed to be developmentally appropriate for ages 8-16. Many activities can be used effectively as group activities.

Unit 1: Water Conservation with the Water Lion (D0670A)
The “Water Lion” gives an overview of the importance and distribution of water on earth and the need to use and conserve water wisely.

Unit 2: Incredible Water with the Water Lion (D0675A)
The “Water Lion” gives an overview of the fascinating physical and chemical properties of water. The water cycle and the importance of water to all of life is stressed.

Unit 3: Water Quality Matters! (D0680A)
This project book follows Leah and Jason as they learn how water quality is measured in Pennsylvania. You’ll learn about different water standards, participate in water quality tests, and use this criteria to determine the health of a stream.

Revised 4-04-2011
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## Ages and Stages of Youth Development

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<tr>
<th>GRADES 3-5: Characteristics</th>
<th>GRADES 3-5: Helper’s Tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learn best when physically active</td>
<td>Allow youth to participate in activities where they can use physical energy.</td>
</tr>
<tr>
<td>Have a special attachment to older youth</td>
<td>Allow youth to choose an older youth to be their helper and role model.</td>
</tr>
<tr>
<td>Are easily motivated</td>
<td>Use encouragement to keep them motivated.</td>
</tr>
<tr>
<td>Reading becomes an individual experience</td>
<td>Allow time for youth to read on their own and think of activities before working with others.</td>
</tr>
<tr>
<td>Attention span is about 45 minutes</td>
<td>Use varied activities to keep them interested.</td>
</tr>
<tr>
<td>Acceptance by peer group is important</td>
<td>Use the peer group to recognize good work, such as applauding completed activities and avoiding put-down.</td>
</tr>
<tr>
<td>Interests expand from home, to neighborhood to community</td>
<td>Talk to youth about their friends and neighbors and what goes on in their community. Involve them in service learning.</td>
</tr>
<tr>
<td>Enjoy both cooperation and competition</td>
<td>Plan activities so that sometimes youth work together, sometimes compete with each others.</td>
</tr>
<tr>
<td>Show independence by seeking individual attention and sometimes disrupting the group</td>
<td>Involve youth in selecting activities they would like. Give individual attention as needed.</td>
</tr>
<tr>
<td>Feelings of competence enhance self-concept</td>
<td>Provide activities that will let youth feel good about themselves and succeed.</td>
</tr>
<tr>
<td>Show loyalty to members of their own sex and antagonism toward those of the opposite sex</td>
<td>Involve youth in choosing partners.</td>
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<table>
<thead>
<tr>
<th>GRADES 6-8: Characteristics</th>
<th>GRADES 6-8: Helper’s Tips</th>
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</thead>
<tbody>
<tr>
<td>Can take responsibility in planning and evaluating their own work</td>
<td>Give youth responsibility for group activities, including planning, implementing and evaluating.</td>
</tr>
<tr>
<td>Can plan their own social and recreational activities</td>
<td>Provide opportunities for youth to work together. Form committees to plan recreational and social activities.</td>
</tr>
<tr>
<td>Can discuss current events, international affairs and social issues with some help</td>
<td>Use discussion, activities and games that encourage awareness of current events and issues.</td>
</tr>
<tr>
<td>Want to make decisions but still depend on adult guidelines</td>
<td>Establish guidelines that give parameters for youth to follow.</td>
</tr>
<tr>
<td>Gain skills in social relations with peers and adults</td>
<td>Provide activities which foster social interaction with peers and adults.</td>
</tr>
<tr>
<td>Peer pressure mounts, first from same sex, then from the opposite sex</td>
<td>Use peer pressure to influence positive behavior. Have group give encouragement to individuals.</td>
</tr>
<tr>
<td>Can be quite self-conscious</td>
<td>Avoid asking youth to share their work individually until they feel more comfortable with the group.</td>
</tr>
<tr>
<td>Strong emotional attachment to older youth and adults</td>
<td>Encourage youth to participate in activities with older youth and adults.</td>
</tr>
<tr>
<td>Choices are often unrealistic</td>
<td>Assist youth in making realistic choices. Review their plans, discuss alternatives and help them weight options before making decisions.</td>
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<thead>
<tr>
<th>Grades 9-12: Characteristics</th>
<th>Grades 9-12: Helper’s Tips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal philosophy begins to emerge</td>
<td>Use activities where youth search for experiences which will allow them to identify their own philosophies.</td>
</tr>
<tr>
<td>Enjoy discussing world situations as well as personal activities</td>
<td>Encourage discussion of events and feelings.</td>
</tr>
<tr>
<td>Abstract thinking and problem solving reach a higher level</td>
<td>Put youth into real-life problem solving situations.</td>
</tr>
<tr>
<td>Strong desire for status in peer groups</td>
<td>Develop a climate in which youth are encouraged and supported by peers.</td>
</tr>
<tr>
<td>High interest in social activity</td>
<td>Encourage youth to plan and carry out their own social activities.</td>
</tr>
<tr>
<td>Need freedom from parental control to make decisions</td>
<td>Help youth realize that their decisions have consequences.</td>
</tr>
<tr>
<td>Widespread feelings of inferiority and inadequacy</td>
<td>Encourage and help youth see their positive worth.</td>
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**Acknowledgements:** National 4-H Cooperative Curriculum System, Inc. & Colorado State University Cooperative Extension
Teaching and Learning Experientially

Experiential Learning Model

1. Experience (Do): Individual or group experience Involves doing May be unfamiliar Pushes learner to a new level

2. Share (Reflect): Talk about the experience. Share reactions & observations Freely discuss feelings generated by the experience. What did they do? What did they see? Feel? Hear? Taste? What part of the experience was most difficult? Easiest? What part was easiest.

3. Process (Discuss & Reflect): How the experience was carried out. How the themes, problems and issues were brought out. How specific problems were addressed. How did they go about doing this activity? What problems or issues came up as they did the activity? How did they deal with these problems? Why is the life skill they practiced important?

4. Generalize (Identify—Apply): General trends or common truths. Real life principals that surfaced. Key terms that capture the learning. What did they learn from the experience? How does this learning relate to other things they have been learning? What similar experiences have they had (with this life skill or subject matter)?

5. Apply (Discuss how): New learning can be applied to other situations. Issues raised can be useful in the future. Apply: How will you use what you learned? More effective behaviors can develop from new learning. Help participants fee a sense of ownership for their learning. Apply: Ask How can they use what they learned? How could what they learned in this experience relate to other parts of their life? How can they apply (the life skill practiced) in the future?

A skill is a learned ability to do something well. Life skills are abilities individuals can learn that will help them to be successful in living a productive and satisfying life. In the Targeting Life Skills (TLS) Model categories of life skills are identified and divided on the basis of the familiar four H’s from the 4-H Clover that represent Head, Heart, Hands, and Health. Two general categories of skills are included under each of the four headings.

The goal of youth programming is to provide developmentally appropriate opportunities for young people to experience life skills, to practice them until they are learned, and be able to use them as necessary throughout a lifetime. Through the experiential learning process, youth internalize the knowledge and gain the ability to apply the skills appropriately.

Acknowledgements: Targeting Life Skills Model, by Pat Hendricks, Iowa State University
Overview of the Project Unit

Unit 3 of the 4-H Water Project, *Water Quality Matters!*, is intended for youth ages 12 to 16 and can be completed after the completion of Unit 1, *Water Conservation with the Water Lion* and Unit 2, *Incredible Water with the Water Lion*. *Water Quality Matters!* is designed to teach youth about the condition, or degree of cleanliness of water, which is referred to as water quality. Youth will learn about water standards used to set limits for water quality. A few examples of water quality criteria are temperature, turbidity (clarity), the concentration of dissolved oxygen, and pH (measure of how acidic or basic). Youth will investigate what influences water quality and how these substances get into streams and rivers. They will look at the difference between point-source pollution and nonpoint-source pollution. As youth continue in the Project book they will explore where their drinking water comes from, identify different land uses in their watershed and consider possible pollutants based on land use.

With hands on activities youth will use monitoring techniques while learning about the physical, chemical and biological criteria of water. Completing the *Water Quality Matters!* project book will promote interaction of youth in a common effort to increase environmental learning and stewardship of their own watersheds.

Educational Objectives

Water Quality Matters! is divided into 4 chapters intended to meet the following educational objectives:

**Chapter 1: What is Water Quality?**
Examine temperature as a water quality criteria. Learn how water is used. Learn what water pollution is. Learn that chemicals, salts, and detergents can pollute water. Determine where your drinking water comes from. Identify land uses in your watershed and possible pollutants based on these land uses.


**Chapter 2: Physical Criteria**
Learn that turbidity is a physical water quality criteria. Learn what causes turbidity in water. Learn how to reduce turbidity in water. Learn how soil settles out of water. Observe soil in natural waters and practice water filtration. See how vegetation slows erosion and protects against sedimentation.

*PA Ed. Standards: 4.1.10B, 4.1.7-12.C*

**Chapter 3: Chemical Criteria**
Learn that pH is a chemical water quality criteria. Learn the negative effects of acidic water. Learn to measure the pH of common substances and gain an understanding of which are acidic and which are basic. Determine the pH of a nearby stream and how it varies from its source to its mouth, or at other points along the stream.

*PA Ed. Standards: 4.1.12C, 4.3.7.B*

**Chapter 4: Biological Criteria**
Learn what biological water quality criteria is. Learn how to sample a waterway for aquatic macro-invertebrates and observe different kinds of aquatic macro-invertebrates. Learn how aquatic macro-invertebrates can be used as general indicators of water quality.

ACTIVITY 1: CONTAMINATION CENTRAL

Educational Objectives:
Youth will
• Learn that chemicals, salts, and detergents can pollute water.

Background: or Topic Introduction
Water is considered “polluted” when the concentration of one or more substances makes the water unsuitable for its intended or “beneficial” use. When a waterway does not meet its water quality criteria standard the Department of Environmental Protection (DEP) may investigate why. A point-source of pollution comes from a specific identifiable source. Often, no single specific pollution source can be determined, the pollution comes from many sources. This is called nonpoint-source pollution. Many things can be done to improve the water quality of streams.

Procedure:
Label one jar “detergent,” one jar “salt,” and one jar “vinegar.” These are the “pollutants” for this activity. Put about one cup of water into each jar. Add 1 tablespoon of pollutant to each jar, as labeled. Screw the lid onto each jar and shake well. Set each jar down, remove the lid, and answer the reflections.

Reflections:
1. Have the youth describe how the water and the pollutants have mixed.
   The liquid detergent may make the water cloudy and bubbly. Most of the salt will dissolve in the water with mixing, using warm water will help. Vinegar is not likely to be visible in the water.

Have the youth answer the following questions
2. What “real-life” pollutants produce effects similar to each of the test pollutants?
   Laundry detergent—discharge from washing machines, dish washers, or car washes
   Salt—from road salting in winter
   Vinegar—acidic mine drainage, acid rain, acid stone drainage

Materials needed:
• 3 medium (about 2 cups each) clear jars with lids
• Water
• Measuring cup
• Tablespoon
• 1 tablespoon of each:
  liquid detergent
  salt
  vinegar

Key Terms (Vocabulary):
• Point-source pollution
• Nonpoint-source pollution

PA Educational Standards:
• 3.5.7-10.D
• 4.1.7-12.A
• 4.1.7.B
• 4.1.7-12.E
• 4.3.7-12.B
3. How might each real-life pollutant affect aquatic creatures?

Many detergents contain phosphates, which trigger excessive growth of algae. When the algae die, the decomposition consumes oxygen. This can kill fish and other aquatic creatures. Algae may also become so thick that very little light penetrates to the plants that are growing underwater. These can be an important source of food and shelter for fish and other aquatic life. If they die, fish may also die.

Acids can increase the concentration of aluminum and iron in water. High acid levels affect plants, algae and lower level members of the food chain. All are likely to die in these high acid conditions. Metals can also build up on fishes’ gills and impede their breathing.

The use of salt to deice pavement can leave waterways like streams toxic to aquatic life. The winter runoff can potentially have toxic chloride concentrations.

4. Do any of the jars have an odor? Is odor a pollutant? Would you drink water that smelled this way?

Both the vinegar and detergent jars have an odor. Odor is a pollutant. Water should be free of all odors. Water that has an odor is considered polluted and may or may not be harmful to drink. The cause of the odor must be identified to determine whether the water is safe to drink. The vinegar water would be safe to drink because vinegar is a food, but it wouldn’t taste good to most people.

5. Is detergent a pollutant? Is the water draining from your clothes or dishwasher polluted?

Any odor associated with detergent would make the water unsafe. Drinking it might make you sick to your stomach.

6. Taste the water in the salt jar. Does it taste salty? Would you like to drink this water if you were thirsty? Where does salt pollution come from?

The water in the salt jar will taste salty, which is unpleasant to most people. It would not quench your thirst. Salt pollution comes from road salt applied in the winter to melt snow and ice.
**Unit 3: Water Quality Matters!**  
Chapter 1: What is Water Quality

**Activity 1: Contamination Central**

**Assessment Opportunities or Evaluation:**

Have the youth:
1. Discuss point-source and nonpoint-source pollution in their community.
2. Identify “real-life” pollutants that produce effects similar to each of the test pollutants
3. Explain the process of what might happen when detergents containing phosphates enter a waterway.

**Extensions (Related Activities):**

1. Identify different examples of point and nonpoint source pollution.
2. Explain the difference between the two types of pollution.
3. Describe how human actions effect the health of the environment.
4. Explain how human activities may effect local, regional and national environments.

**Levels:**
- Ex: Grades 7-12
- Ex: Ages 12-18

**Time Consideration (Duration):**
Preparation: 15-20 min.
Activity: 45 min.

**Setting:** Indoors

**Materials needed:**
- 3 medium (about 2 cups each) clear jars with lids
- Water
- Measuring cup
- Tablespoon
- 1 tablespoon of each: liquid detergent, salt, vinegar

**Key Terms (Vocabulary):**
- Point-source pollution
- Nonpoint-source pollution

**PA Educational Standards:**
- 3.5.7-10.D
- 4.1.7-12.A
- 4.1.7.B
- 4.1.7-12.E
- 4.3.7-12.B
Activity 2: My Water Source and Land Use List

Educational Objectives:
Youth will
- Find out where their drinking water comes from.
- Identify land uses in their watershed and possible pollutants based on these land uses.

Background: or Topic Introduction
A watershed consists of all the land area which water moves or drains through to reach a particular water body such as a stream, river, or lake. High points of land create natural watershed boundaries. All water, in any form, within the boundaries of a particular watershed drain to a common water body. There is an infinite number of watersheds in any given region of the earth, as even the tiniest rivulets that form after a heavy rain could potentially be considered to be “waterways” and thus having watersheds. It is more useful to consider the major waterways in an area that contribute water and runoff to the major watersheds.

Pennsylvania can be divided into six major watersheds or drainage basins: the Susquehanna River Watershed, the Ohio River Watershed, the Delaware River Watershed, the Potomac River Watershed, the Lake Erie Watershed, and the Genesee River Watershed.

Watersheds are important as the viability of the watershed directly affects the health of the communities within that watershed. Water for human consumption, wildlife, industry and recreation are all impacted by activities that occur within the watershed.

Procedure:
Ask the youth where their drinking water comes from. If they don’t know, have them find out. If they have a private well or spring have them ask their parents or an adult what he or she knows about it. If their city of town supplies the water have them call the town hall or local water department to find out the name of the source. They can check the government pages of the phone book for the number. Make sure the youth find out the name of the source, groundwater or surface water, and where it is located.
Next, and this is an optional activity, ask them to have a trusted adult take them to their water source. Have them observe the watershed of their source.

A watershed is an area of land through which water moves or drains to reach a waterway or water source. A watershed can be thought of as a bowl of land into which all the precipitation that will end up in your water source falls. The water source lies at the bottom of the bowl. Some bowls (watersheds) are very small and some are quite large.

If the youth’ water comes from a large river, the watershed would be very large and may take days to drive from end to end. If their water comes from a small mountain stream, they may be able to stand in one place and view the entire watershed.

The Schuylkill River is a much larger waterway than Trout Run, so the land area of Jason’s watershed is larger then Leah’s

While observing the watershed of their water source have them see if they can tell where some of the borders of their watershed might be. For example, if they see a hill or mountain, water that falls on the side of the mountain facing them would fall in their watershed. Depending on the lay of the land, water that falls on the opposite side might not be in their watershed.

Even if they were not able to travel to their water source have them make a list of ways that land is used in their watershed or around their drinking water source. Uses might include farms, golf courses, athletic fields, factories, parking lots, houses, and lawns.

Once they have identified a number of land uses, have them make a list of materials associated with those land uses that they would not want in their drinking water. For example, this might include fertilizer from lawns, dripping oil from motor vehicles, and runoff from parking lots.
**Activity 2: My Water Source and Land Use List**

Below you will find a list of land uses and possible pollutants:

<table>
<thead>
<tr>
<th>Land Uses</th>
<th>Possible Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Land</td>
<td>sediment, pesticides, fertilizers, bacteria, animal waste</td>
</tr>
<tr>
<td>Houses (residential), Lawns</td>
<td>Sewage from malfunctioning septic systems, motor oil, pet waste, paints, household cleaners, pesticides, fertilizers, detergents</td>
</tr>
<tr>
<td>Parking Lots / Roads</td>
<td>oil and grease, radiator coolant, gasoline, sediment</td>
</tr>
<tr>
<td>Industrial / Commercial</td>
<td>toxic chemicals, oil, solvents, cleaners, solid wastes</td>
</tr>
<tr>
<td>Development</td>
<td></td>
</tr>
<tr>
<td>Forest Land</td>
<td>sediment</td>
</tr>
</tbody>
</table>

Did your youth think of any other land uses or pollutants not listed above?
ACTIVITY 2: MY WATER SOURCE AND LAND USE LIST

Reflections:

1. Have the youth think of ways they or their family could reduce the use of some of the pollutants named on previous page. Have them try to think of one way for each household related pollutant. With the help of family and friends encourage them to put some of the ideas into practice.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Suggested Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Septic Waste</td>
<td>flush less, avoid putting chemicals down drains</td>
</tr>
<tr>
<td>Motor Oil</td>
<td>recycle used oil, never dump on ground or down drains</td>
</tr>
<tr>
<td>Pet Waste</td>
<td>dispose into septic system or pet waste digesters</td>
</tr>
<tr>
<td>Paints</td>
<td>use up as intended, let excess dry solid before disposal</td>
</tr>
<tr>
<td>Household Cleaners</td>
<td>use up as intended, use natural cleaners</td>
</tr>
<tr>
<td>Pesticides</td>
<td>use up as intended, recycle at hazardous waste center, use natural products</td>
</tr>
<tr>
<td>Lawn Fertilizers</td>
<td>use as intended, use compost and natural fertilizers</td>
</tr>
<tr>
<td>Detergents</td>
<td>use as intended, never dump on ground or down drain</td>
</tr>
<tr>
<td>Ice Melt Salt and Chemicals</td>
<td>use sparingly, use sand and grit when possible, keep away from sensitive plants</td>
</tr>
</tbody>
</table>

Looking Ahead...

The book goes on to teach youth how our water is kept safe through water quality standards. Before moving on be sure and review the difference between water quality criteria and water quality standards. They both can be found in the glossary.

The three basic types of water quality criteria are covered in the upcoming chapters. They include:

- Physical - ex. water temperature and turbidity (clarity or clearness)
- Chemical - ex. the pH of water
- Biological - ex. measures of bacteria and the diversity and kinds of macro-invertebrates (animals without a backbone that are large enough to be easily seen with the naked eye)
Unit 3: Water Quality Matters!
Chapter 1: What is Water Quality

**ACTIVITY 2: MY WATER SOURCE AND LAND USE LIST**

**Assessment Opportunities or Evaluation:**

Have the youth:
1. Explain what a watershed is and list several land uses within their own watershed.
2. Identify at least 3 pollutants that might be associated with those land uses that they would not want in their drinking water.
3. Identify the six major watersheds (drainage basins) in Pennsylvania.

**Extensions (Related Activities):**

Using a topographical map:
1. Outline the boundaries of a watershed in your neighborhood or community.
2. Trace the flow of water from the highest to the lowest point.

**Supplemental Lesson Plan: Riverside Drive**

**Educational Objectives:**

Youth will
- Understand that with alteration or destruction of a river ecosystem in one area, there will be impacts on other areas.
- Understand that individual decisions have an impact on the quality of the environment.

**Background: or Topic Introduction**

A river is an intricate ecosystem. We see the running water, the banks, and the associated animal and plant life. Not so obvious, though, are other important interactions which create a distinct character for each waterway. Variables such as riverbed slope, geology, bottom type, velocity of water flow, amount of sediments the river carries, the river’s water temperature, and the amount and type of riverbank vegetation all contribute to the make-up of a particular river ecosystem.

**Acknowledgements:** Riverside Drive from “Bridges to the Natural World” A Natural History Guide for Teachers (c1992); New Jersey Audubon Society. Authors: Patricia F. Kane, Dale A. Rosselet, Karl Anderson.
Unit 3: Water Quality Matters!
Chapter 1: What is Water Quality

Supplemental Lesson Plan: Riverside Drive (cont.)

Background: or Topic Introduction

Flood lands and marshes adjacent to rivers act like sponges and slow turbulent floodwaters. Any precipitation that seeps into groundwater reservoirs flows through sediments and rock beds which help in the cleaning process.

Human practices influence the effectiveness of these natural processes. Clearing riverbanks of vegetation causes erosion and sediment build-up in the water. These excessive sediments cloud the water, cause the flow of the river to lessen, and increase the temperature of the water. Additionally, channel alteration can interfere with fish migration and may decrease species diversity. To maintain and protect the quality of our drinking water all these processes must be considered in the land use decisions that concern sensitive river ecosystems.

Procedure:

Pre-Activity
1. Tape the individual blank white sheets of paper together into one long strip.
2. On one side of the long strip draw parallel lines simulating a winding river. Leave enough room on either side of the lines for the youth to draw.
3. Number each sheet from 1 to N (n= the number of youth pairs you have in your group).
4. Reserve a wall or floor space long enough to display the entire river.
5. Separate the papers and mix them up in random order.

Activity
1. Ask the group “How do people use rivers?”
   Example answers: transportation, recreation, power generation, for drinking water.
2. Have the group list the kinds of development or facilities they have seen along riverbanks.
   Example answers: marinas, waterparks, canoe rentals, houses, parks, power plants, bridges, beaches.
Unit 3: Water Quality Matters!
Chapter 1: What is Water Quality

Supplemental Lesson Plan: Riverside Drive (cont.)

Procedure:

3. Ask “How do wild animals use rivers and river banks?”
   Example answers: for drinking water, holds food supply, transportation shelters.

4. May want to continue discussion eliciting river and riverbank uses mentioned in the background information.

5. Now pair your group off and give one sheet of paper with a portion of the river drawn on it.

6. Tell the group that each team represents a town that exists along the river. Instruct them to consider the uses mentioned in the discussion and draw on their part of the riverbank what the people of their town would want to have along their riverbank.

7. After the group has drawn all of their ideas, tell them to arrange a linear display of their papers in numerical order.

8. Instruct the youth to examine the length of the river and list the different uses in each frame.

9. Have each pair briefly describe how his or her town land was used.

10. Ask the group “How many of the uses drawn into the plans were duplicated?”

11. Ask the group “How has the collective use of the land affected the wildlife habitat along the river?” Are there places for wildlife to hide, to find food, etc.?

12. Ask the group “If the towns had worked together to plan development along the river, would it look different than it does when each worked individually? Explain?

8. Discuss which is a better approach to development, planned or unplanned? Discuss the pros and cons of each.

Extensions:

- Enact a planning board hearing to debate developments along a river system. Divide your group into special interest groups, e.g., environmentalists, energy company, department of recreation, developers, and citizen group. Use a map of the original river, then have the group draw a revised plan and compare it with the original.
- Repeat the initial procedure using a river that branches in three directions.
- Plan a field trip to a center that has a river or stream habitat.

Levels:
- Ex: Grades 7-12
- Ex: Ages 12-18

Time Consideration (Duration):
Preparation: 15-20 min.
Activity: 40 min.

Setting: Outdoors

Materials needed:
- 1 piece of paper for every 2 youth.
- Pencils/Colored markers or crayons
- tape
- scissors

Key Terms (Vocabulary):
- Ecosystem
- Groundwater
- Erosion
- Sediment

PA Educational Standards:
- 3.5.7.D
- 3.5.10.D.
- 4.1.7-12.A
- 4.1.7.B
- 4.1.7-12.E
- 4.3.7-12.B
**Activity 3: Settling Sediment and Stream Bank Vegetation**

**Educational Objectives:**
Part 1:
Youth will
- Learn how soil settles out of water.

**Background: or Topic Introduction**
Turbidity is an example of a physical criterion. Any reduction in the clarity or clearness of water is called turbidity. Soil particles, bits of leaves, and other materials suspended in water cause turbidity. High turbidity can also be harmful to aquatic organisms such as insects.

To officially measure turbidity, scientists use a *nephelometric turbidity unit*. High turbidity in drinking water can make it difficult to kill disease causing bacteria.

When watersheds are paved over with parking lots, roads, and buildings water does not *infiltrate* into the ground. Instead it runs off carrying dirt and debris with it. Forested watersheds soak up most of the precipitation that falls on them. Water rarely flows overland in an undisturbed forest.

**Procedure:**
1. Pour 1 cup of water into each jar.
2. Add 2 tablespoons of soil to one jar.
3. Put the lid of the jar on and shake well.
4. Set the jar down and have the youth watch what happens.
5. Next, have them shine a flashlight through the jar with soil.
   - Ask them if they can see the light coming through the other side of the jar?
6. Have them do the same for the clear jar without soil.
7. Have them watch the soil slowly settle to the bottom of the jar.
Unit 3: Water Quality Matters!
Chapter 2: Physical Criteria

**Activity 3: Settling Sediment and Stream Bank Vegetation**

**Reflections:**

Part 1: Reflections

1. Have the youth describe how the water looked after they shook the jar of water and soil.
   
   The soil becomes suspended throughout the water and the water turns brown or black with soil.

2. Have the youth describe the brightness of the light passing through the two jars by shining a light through the jar onto a piece of white paper to estimate the percentage of light that is absorbed or blocked by the suspended soil.
   
   Nearly 100 percent of the light from the flashlight will be transmitted through the jar of just water. The percentage of light transmitted through the water and soil depends on the characteristics of the soil used. There may be virtually no light transmitted through the soil and water mixture until the soil starts to settle out.

Have the youth answer the following questions:

3. How might the reduction in light caused by soil in the water affect aquatic life in a stream or other waterway?
   
   If a waterway is clogged with sediment, aquatic plants may not receive as much light as they need to live. Some fish, insects, and other creatures depend on these plants for food, and they need to obtain their oxygen from water too.

4. Would you drink water with soil suspended in it?
   
   Most people expect their drinking water to be crystal clear.

5. How long will it take for the water to become completely clear again in the soil jar? This may take longer than you think! Let the jar sit and see how long.
   
   Times will vary due to soil texture (particle size). Soils with fine particles (such as clay and silt) will take longer than soils with larger particles (silt, sand).

6. What did you observe about how the soil settled out of the water?
   
   Did small or large particles settle out first?
   
   The upper section of water clears first. Large particles of soil settle to the bottom first because they weigh more.
Activity 3: Settling Sediment and Stream Bank Vegetation

Assessment Opportunities or Evaluation:

Have the youth:
1. Explain what turbidity does to the clarity of water.
2. Describe how the reduction in light caused by soil in the water might affect aquatic plants in a stream or other bodies of water?
3. Write their observations on how the soil settled out of the water? Describe what types of particles settle out first.

Extensions (Related Activities):

- Name some of the impacts of sediment on Pennsylvania’s water resources.
- Name some of the agencies that manage aquatic resources in Pennsylvania and describe what they do.
- List three ways sediment can get into water bodies and how this might be avoided.
- Discuss why even natural things like sediment can be considered pollution.

Levels:
- Ex: Grades 7-12
- Ex: Ages 12-18

Time Consideration (Duration):
Preparation: 30 min.
Activity: 45 min.

Setting: Indoors or Outdoors

Materials needed:
- 2 medium (about 2 cups) clear jars with lids
- Tablespoon
- 2 tablespoons of soil,
- Measuring cup
- about 2 cups of water
- Flashlight
- Sheet of white paper

Key Terms (Vocabulary):
- Turbidity
- Infiltrating
- Flocculants
- Porous
- Buffer Strips

PA Educational Standards:
- 4.1.10B
- 4.1.7-12.C
Unit 3: Water Quality Matters!
Chapter 2: Physical Criteria

ACTIVITY 3: SETTLING SEDIMENT AND STREAM BANK VEGETATION

Educational Objectives:

Part 2:
Youth will
• Observe soil in natural waters and practice water filtration.

Background: or Topic Introduction

Turbidity is caused by solid particles suspended in water. Given enough time, most particles will settle out. That’s why turbidity can be treated by allowing water to stand still in a pool or a tank and then siphoning the clear water off the top. The settling of solid particles can be sped up by adding chemicals called floculants to the water. Floculants cause particles to join together. These larger particles are heavier and settle our faster. Floculants are very important in treating drinking water. Turbidity can also be removed by filtering water through a porous membrane or bed of sand. All particles larger than the pores in the filter or sand bed get stuck there. Sand filters are often used to remove turbidity from drinking water.

In this activity (Part 2) you will be demonstrating how the sediment suspended in stream water (turbidity) is removed by filtration.

Procedure:

1. With proper permission, have the youth collect water from a stream after a rainstorm. Be sure to stress that they collect from a safe place on the bank where there is no danger of falling into the water. Stress that they do not stand in the stream.
2. Once collected have them put the lid on the jar and shake it.
   • Have them note whether the water is clear or cloudy.
3. Have the youth filter the water by placing the coffee filter inside the funnel and then slowly pouring the water through the funnel into a clean jar.
   • Have the youth look at the sediment and other material collected on the filter. (a magnifying glass may be helpful)
   • This is visible evidence of sediment suspended in stream water, even when you can’t see the sediment.
4. Ask if the filtered water is clearer than when first collected?
   • This demonstrates turbidity removed by filtration.
ACTIVITY 3: SETTLING SEDIMENT AND STREAM BANK VEGETATION

Assessment Opportunities or Evaluation:

Have the youth:
1. Explain 3 ways sediment becomes suspended in stream water.
2. Demonstrate the process of filtration.
3. Explain what a porous membrane is and how it is used to filter sediments out of water.

Supplemental Lesson Plan: Building a Watershed

Educational Objectives:

Youth will
• discover what a watershed is and how it can cause pollution and erosion when it is disturbed.

Background: or Topic Introduction

A watershed is the land area that drains into a particular body of water. The land area of a watershed is often defined by elevated lands, such as hills and mountains. Elevated lands separate watersheds from one another by causing precipitation run-off to move in different directions—down one side or the other. All watersheds eventually empty their waters into larger bodies of water, such as a stream or river. Eventually the water is then transported to a pond, lake sea or ocean.

Supplemental Lesson Plan: Building a Watershed

Procedure:

1. Find a nice level spot outside that can get wet or is easily cleaned up.
2. Fill spray bottles with water. Use at least two or more.
3. Crumple newspaper sheets and form a pile. Use at least six sheets or more to make a larger watershed.
4. Cover the pile of newspaper sheets with a large plastic bag.
5. This is your watershed!
6. Spray bottles on a mist setting to simulate precipitation by spraying over the watershed.
7. Ask the youth what happened as they sprayed the water?
   **The water gathers and flows, due to gravity, to the lower end of the watershed. Notice the path the run-off takes. This is simulating the flow of streams and rivers.**
8. Have the youth observe how small streams gather and collect other streams and how these larger streams gather to form “rivers”.
9. Now have youth make changes in the watershed, such as adding more paper or lowering the elevation by flattening the “hill”.
10. Have one youth fill one of the spray bottles with the colored powdered drink mix and simulate human disturbances such as pollution or erosion.
11. Ask the youth what happened when a polluting substance was introduced? **The water downstream of this spill became polluted.**
12. Discuss how disturbances upstream in the watershed can effect downstream habitats.

Discussion Questions:

- What happened when the rate of water flow was increased by using more spray bottles?
- What changes can be made in a watershed to change the flow of water?
- What other materials could be used to build a watershed?
- What are some possible ways that a watershed can be polluted?
- What is meant by the saying “we all live downstream”?
- How can you have a positive influence on the environment?
Activity 3: Settling Sediment and Stream Bank Vegetation

**Educational Objectives:**

Part 3:
Youth will
- Observe how vegetation slows soil erosion and protects against sedimentation (the transport of soil into water).

**Background: or Topic Introduction**

Turbidity can be reduced before it gets into a waterway by planting grass, trees, and other plants along the waterway’s bank. This slows the flow of surface water and filters out soil particles before they cause turbidity in the waterway. Wide borders or strips of vegetation planted or left along waterways are called buffer strips because they protect or buffer the water from the effects of pollutants that cause turbidity.

In this activity (Part 3) you will see turbidity and practice filtration for yourself.

**Procedure:**

1. Cut a V-shaped notch in one end of each box so the point of the V reaches just to the bottom of the box.
2. Line each box with a plastic bag that extends over the sides of the box and over the V.
3. Place the sod, grass-side up, in one box.
4. Place the soil in the other box in a gently packed down layer about as thick as the sod. The soil should have no grass or other vegetation growing in it.
5. Set the boxes on the table and place a block of wood or other object under the uncut end of each box so that they are tilted slightly down toward the end of the box with the notch.
6. Place each box so that the end with the notch is slightly over the edge of the table.
7. Place a jar under each notch to catch water (see illustration p. 23).
8. Have the youth fill the watering can with 3 cups of water and pour near the back of one box (farthest from the V).
9. Have them time how long it takes for this water to reach the jar.
**Unit 3: Water Quality Matters!**
*Chapter 2: Physical Criteria*

**Activity 3: Settling Sediment and Stream Bank Vegetation**

**Procedure Cont’d:**

10. Have them repeat the process with the next box and jar.
11. Be sure they pour from the same height and at approximately the same rate.
12. Have the youth observe what happens to the water in each box and note the appearance of the water collected in the jars.

**Reflections:**

1. Have the youth use the measuring cup to determine how much water came out of each box; bare soil versus the soil with grass. *Your answer will depend on how much water you poured on the boxes. In general, more water will be recovered from the bare soil box, but some water will be absorbed into the soil as well.*

2. Have the youth determine if the water exited each box at the same rate, which was faster and explain why. *Water will pass through the soil box faster. Some water will soak into the soil and some will flow over the top of the soil, but it will almost all soak into the sod.*

3. Have the youth compare the water in each jar and decide which is clearer and why. *If any is collected, water from the sod box is clearer because it slowly infiltrates the soil. Some water flows across the surface of the soil in the soil box and picks up soil particles.*

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**Key Terms**
*(Vocabulary):*
- Turbidity
- Infiltrating
- Flocculants
- Porous
- Buffer Strips

**PA Educational Standards:**
- 4.1.10B
- 4.1.7-12.C
Activity 3: Settling Sediment and Stream Bank Vegetation

Reflections Cont’d:

4. Have the youth determine in which box less soil was lost to the forces of water. **Less soil was lost to the forces of water in the sod box.**

5. Ask the youth what materials might be used to reduce the erosion of the bare soil. Have them think about construction sites you have seen. **Straw mulch or stone, etc.**

What kinds of materials are used to control soil movement? **Straw, various mulches, seeding, silt fence, hay bales, stone, sediment basins, landscape fabrics, mulch nets, etc.**

Have the youth empty any water in the catch jar for the grassy soil box. Have them place that jar to catch water coming out of the bare soil box. Next, have them place straw, leaves, or grass clippings on the bare soil and repeat the experiment to see if the water coming out of the bare soil box with the added materials is clearer. Have them record their observations. **By placing straw, leaves or grass clippings over the bare soil less erosion will take place. The bare soil is protected, the water is slowed and more tends to infiltrate into the soil rather than run off taking soil particles with it. The water collected in the jar should be clearer than from the bare soil alone.**
Activity 3: Settling Sediment and Stream Bank Vegetation

Reflections Cont’d:

6. Have the youth write a short paragraph about how the results of their experiments relate to scraping soil bare to build roads and buildings. Ask them if they were a fish, would they rather live in a stream where the watershed was covered with grass and other vegetation or where the soil was bare? Have them explain why?

The box with bare soil is meant to simulate the effects of rainfall on bare disturbed soil such as construction sites. Laws are in place to prevent erosion and sedimentation from reaching our streams, protecting water quality. Construction sites with exposed soil need to have protective measures in place to prevent soil from moving off site and need to be re-vegetated as soon as possible.

A fish would rather live in a watershed that was covered with grass and other vegetation. In a vegetated watershed less soil would wash into the waterway. Soil in the stream causes turbidity. Fish eggs may not hatch successfully in streams with high turbidity. High turbidity is also harmful to aquatic insects that many fish need for food.

Assessment Opportunities or Evaluation:

1. Compare results from both the bare soil test box verses the sod test box and explain why water ran faster out of one box than the other and which box had less soil loss.
2. List at least 4 types of materials you might use to reduce erosion of soil. From the bare soil text box.

**ACTIVITY 4: pH EXPLORATION**

**Educational Objectives:**

Part 1:
Youth will
- Learn to measure the pH of common substances.
- Understand which common substances are acidic and which are basic.

**Background: or Topic Introduction**

Chemical criteria deal with the actual makeup of stream water, including all the things that are in water besides good old H2O. **pH** is an example of a chemical water quality criterion; pH is the measure of the concentration of hydrogen ions in a solution. A solution rich in hydrogen ions is *acidic*, a solution poor in hydrogen ions is *basic* (alkaline). The pH scale measures how acidic or basic a substance is. The pH scale ranges from 0 to 14. A pH of 7 is *neutral* (pure water). A pH less than 7 is acidic. A pH greater than 7 is basic.

The pH scale is logarithmic and as a result, each whole pH value below 7 is ten times more acidic than the next higher value. For example, pH 4 is ten times more acidic than pH 5 and 100 times (10 times 10) more acidic than pH 6. The same holds true for pH values above 7, each of which is ten times more alkaline (another way to say basic) than the next lower whole value. For example, pH 10 is ten times more alkaline than pH 9 and 100 times (10 times 10) more alkaline than pH 8.

When testing the pH on substances using litmus paper, if they turn the paper red then they are acidic. If the test result are blue then the substance is basic.
**ACTIVITY 4: pH EXPLORATION**

**Procedure:**
1. Measure 1 tbsp of each substance listed below into a separate cup.
2. Have the youth test the pH of each substance with the pool test kit, litmus paper, or pH meter. Be sure they follow the directions provided with each test material.
3. Record your results in the table below.

### pH of Common Substances

<table>
<thead>
<tr>
<th>Substance</th>
<th>pH*</th>
</tr>
</thead>
<tbody>
<tr>
<td>lemon juice</td>
<td>2.4</td>
</tr>
<tr>
<td>vinegar</td>
<td>3.0</td>
</tr>
<tr>
<td>orange juice</td>
<td>3.5</td>
</tr>
<tr>
<td>Cola</td>
<td>4.0</td>
</tr>
<tr>
<td>rainwater</td>
<td>5.0</td>
</tr>
<tr>
<td>milk</td>
<td>6.5</td>
</tr>
<tr>
<td>tap water</td>
<td>~7</td>
</tr>
<tr>
<td>bottled distilled water</td>
<td>7</td>
</tr>
</tbody>
</table>

* There are some variability in the pH of these household substance. Approximate values are given here.

You could also try testing the pH of tap water from several nearby towns and several sources of bottled water.

**Reflections:**
1. How much variability in pH do you see?
   - The pH ranges from a low of 2 for the lemon juice to a high of 12-13 for the bleach.
2. Which substances are acidic and which are basic?

### ACIDIC

<table>
<thead>
<tr>
<th>lemon juice</th>
<th>Cola</th>
</tr>
</thead>
<tbody>
<tr>
<td>vinegar</td>
<td>milk</td>
</tr>
<tr>
<td>orange juice</td>
<td>rainwater</td>
</tr>
</tbody>
</table>

### BASIC

<table>
<thead>
<tr>
<th>egg whites</th>
<th>Milk of Magnesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>baking soda solution</td>
<td>ammonia</td>
</tr>
<tr>
<td>Tums® antacid</td>
<td>bleach</td>
</tr>
</tbody>
</table>

---

**Materials needed continued:**

- If a pH meter is easily available and you are working with someone who knows how to use it, you could use that instead for these tests. (If you use a pH meter, you’ll need enough of each of the liquids to fill a cup about 3 inches deep.

- You might want to try some measurements with the pH meter and litmus paper or the pool test kit to see how they compare.)

**Key Terms (Vocabulary):**

- pH
- Acidic
- Basic (Alkaline)
- Neutral

**PA Educational Standards:**

- 4.1.12C
- 4.3.7.B
**Activity 4: pH Exploration**

**Assessment Opportunities or Evaluation:**
1. Identify where basic (alkaline) solutions are located on the pH scale and name 3 basic solutions.
2. Identify where acidic solutions are located on the pH scale and name 3 acidic solutions.
3. What pH number represents neutral?

**Extensions (Related Activities):**
1. Have youth collect rain water and test the pH. Have them determine if the rain is acidic, neutral or basic.
2. Have youth research the average pH level of Pennsylvania’s rainfall.
3. Identify where the main pollutants that cause acid rain, sulfur dioxide and nitrogen oxide, are produced.
4. Investigate what soil types have the capabilities to neutralize or buffer acid rain.
5. Have youth investigate the effects of acid rain on agriculture, forests, fresh water streams, and lakes.

**Levels:**
- Ex: Grades 7-12
- Ex: Ages 12-18

**Time Consideration (Duration):**
- Preparation: 30-45 min.
- Activity: 30-45 min.

**Setting:** Indoors

**Key Terms (Vocabulary):**
- pH
- Acidic
- Basic (Alkaline)
- Neutral

**PA Educational Standards:**
- 4.1.12C
- 4.3.7.B
Levels:
- Ex: Grades 7-12
- Ex: Ages 12-18

Time Consideration (Duration):
Preparation: 30-45 min.
Activity: 1 hour

Setting: Outdoors

Materials needed:
- Detailed map of your area showing streams (a topographic map or the Pennsylvania Gazetteer works well)
- Water test kit, litmus paper, or portable pH meter
- Several small cups.

Key Terms (Vocabulary):
- Cold water fisheries
- Warm water fisheries

PA Educational Standards:
- 4.1.12C
- 4.3.7.B

**Educational Objectives:**

**Part 2:**
Youth will
- Determine the pH of the stream nearest them and how it varies from its source to its mouth, or at other points along the stream.

**Background: or Topic Introduction**

Acidic water can have several negative effects. It could contain high amounts of metals that make the water taste metallic. Acidic water flowing through lead drinking water pipes will dissolve lead into the water, potentially causing a lead poisoning hazard. Certain metals, such as aluminum, become soluble in acidic water and can be harmful to fish. Dissolved aluminum can kill fish by damaging their gills and decreasing the level of sodium in their blood. Fish eggs and young fish are also very susceptible to acidity and toxic metals.

The pH of water can be changed. Acidity can be reduced by adding a basic substance such as baking soda or crushed limestone. Acidity can be increased by adding an acid.

The water standard for cold- and warm-water fisheries states that the pH should be between 6 and 9.

**Procedure:**

1. Have the youth select a stream in their area they wish to study and note public access points. Do not trespass on private property.

2. In the company of a trusted adult, have the youth collect a water sample from free-flowing water in the stream, rather than stagnant water. Remind them to be careful and to stay away from dangerously high water levels.

3. Have them take the pH measurement of this sample and repeat on 2 or 3 other sections of the stream. Be sure they use a new, clean cup each time.

4. The youth could also measure the pH of several streams nearby to see how they compare.
Activity 4: pH Exploration

Reflections:

1. Have the youth describe their observations. Have them determine how the pH of their study stream compare with that of some of the common substances they measured earlier. Some fish are more tolerant than others of low-pH water. However, very few can survive at pH less than about 4.5. This is because the acidity changes the flow of elements into and out of a fish’s blood and makes the blood more acidic.

Have the youth answer the following questions after their water sampling:

2. Does the pH fall within the pH standard for warm- and cold-water fisheries (6–9)?

3. Based on pH alone, do you think this stream provides good habitat for fish?

Assessment Opportunities or Evaluation:

1. Describe how your stream’s pH compares to some of the solutions tested earlier.

2. If you tested several streams, where there any differences in their pH levels and explain a reason why there were differences.

Extensions (Related Activities):

1. Help youth explore how pH and water temperature can impact animal diversity.

2. Sample streams above and below your local waste water treatment plant.

3. Measure and record the dissolved oxygen for the streams your group visited. Look at the relationships to the values for water temperature and pH.

4. Have youth contact local wildlife, environmental and conservation groups to find out what their concerns are regarding water quality. Determine what can be done as an individual and as a community to improve or maintain local water quality.
ACTIVITY 5: AQUATIC MACRO-INVERTEBRATES AS INDICATORS OF WATER QUALITY

Educational Objectives:
Youth will
- Learn how to sample a waterway for aquatic macro-invertebrates.
- Observe different kinds of aquatic macro-invertebrates.
- Learn how aquatic macro-invertebrates can be used as general indicators of water quality.

Background: or Topic Introduction
Biological water quality criteria deal with the presence of living organisms in water. Many kinds of bacteria and other tiny organisms live in water. These organisms are so small that they can only be seen with a microscope. Most are completely harmless to other aquatic organisms and humans, but there are some that can cause very serious diseases, or even death, in people who drink water that contains them. Checking a water sample for all of the many different kinds of tiny, or microscopic, organisms is difficult. That’s why scientists often rely on testing for a single kind of bacteria, called fecal coliform which is fairly widespread and can cause disease.

Another biological indicator of water quality is the diversity and kinds of aquatic macro-invertebrates (animals without a backbone that are large enough to be easily seen with the naked eye) in a waterway. Insects, clams, worms, crayfish, and snails that live in water are collectively called aquatic macro-invertebrates. There is a greater variety and number of aquatic macro-invertebrates in relatively clean water than in dirty water.

Rules for Aquatic Invertebrate Collectors
You do not need a permit to sample for aquatic organisms in Pennsylvania as long as the state’s rules are followed. These are:
1. You may have no more than 50 organisms in your possession at one time.
2. If you use a net to catch insects, it may be no larger than 4 feet by 4 feet.
3. Anyone old enough to require a fishing license must have one during sampling, as well as a second form of identification.
ACTIVITY 5: AQUATIC MACRO-INVERTEBRATES AS INDICATORS OF WATER QUALITY

Procedure:

1. Have the youth approach the stream they have been studying at a public access point or where they have the landowner’s permission.

2. Have them work with at least one other person, one of whom should be a trusted adult. For safety, make sure they do not attempt to sample large streams or rivers and have them sample only when water levels are low.

3. Have them use one or more of the following methods to locate aquatic macro-invertebrates in the stream.
   - Rock-rubbing method
   - Stick-picking method
   - Leaf pack-sorting method

The best method for gathering organisms from their study stream will depend on the characteristics of the stream bottom. Be sure they read through each method (found on page 21-22 in Members Water Quality Matters! Project Book) and choose the best one(s) for their stream.

4. The youth will use the pictures on pages 24–26 of their project book to determine what kinds of organisms they’ve collected. They do not need to precisely identify every organism they find. The pictures will give them a good idea of what they’re looking at.

5. Have them note the kinds and classes of organisms they find on the “Notes” page in the back of their project book. Youth may need to use a magnifying glass to observe the organisms so they can clearly see the legs, gills, and tails.

6. Be sure the youth carefully return the organisms they find to the stream when they’re done. Stress that they keep them in water and handle them gently.
Activity 5: Aquatic Macro-invertebrates as Indicators of Water Quality

Reflections:

1. Give the youth several different numbers of aquatic macro-invertebrate diversity they might find in several imaginary streams. Based on these, ask them to rate the stream’s water quality?

   Rate the streams as polluted, moderately polluted, not polluted based upon the variety of macro-invertebrates collected. Also, based on the numbers, what classes do they fall into?

2. Have them think back to Inquiry Time Activity 2 in which they identified some of the land uses in the watershed of their drinking water supply. Based on what they learned in that activity, ask them if the water quality classification made using aquatic macro-invertebrates as indicators suggests that some land uses are impacting their study stream?

   Keep in mind that forested watersheds provide the highest quality water.

Assessment Opportunities or Evaluation:

1. Demonstrate macro-invertebrate sampling techniques
2. Relate watershed and stream characteristics to organisms found in the stream.
3. Identify at least 3 aquatic macro-invertebrates

Extensions (Related Activities):

- Investigate the macro-invertebrates of a shallow pond or lake and compare them to stream macro-invertebrates. Discuss differences in habitat, food, adaptations and environmental stressors.
- Arrange for a water quality specialist from county conservation district or another agency to speak with your club.

Levels:
- Ex: Grades 7-12
- Ex: Ages 12-18

Time Consideration (Duration):
Preparation: 30-45 min.
Activity: 1 hour +

Setting: Outdoors

Key Terms (Vocabulary):
- Aquatic Macroinvertebrates

PA Educational Standards:
- 4.1.4.C
- 4.1.10.C
- 4.1.12.C


Some Class I Organisms (Pollution Sensitive)

Sizes of illustrations not proportional. Bar lines indicate relative size.

Illustration Credits, pages 34-36:
Illustrations whose captions are marked with an asterisk (*) are provided by the University of Wisconsin-Extension in cooperation with the Wisconsin Department of Natural Resources (except for the snail on the far left, page 36). They are based on a key developed by Riveredge nature Center, Newburg, WI. All other illustrations are by Patti Estheimer and are provided courtesy of the Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks.
Some Class II Organisms (Moderately Pollution Tolerant)

Sizes of illustrations not proportional. Bar lines indicate relative size.

Aquatic sowbug or isopod

Damselfly nymph

Damselfly nymph

Dragonfly nymph

Helgrammite

Dragonfly nymph

Scud

Water penny
Some Class III Organisms (Pollution Tolerant)

Sizes of illustrations not proportional. Bar lines indicate relative size.
Acidic: being or containing an acid; of a solution having an excess of hydrogen atoms (having a pH of less than 7)

Acidic precipitation: rain, snow, and fog that is more acidic than pure water because of interactions with atmospheric pollutants. Occurs when air pollutants, primarily sulfur and nitrogen oxides, mix with moisture and are exposed to sunlight. Sulfuric and nitric acids are formed and fall to earth in various precipitation forms. The pH of the “Acid Rain” is 5.6 or lower.

Aquatic Macro-invertebrates: animals without a backbone that are large enough to be easily seen with the naked eye in a waterway. Insects, clams, worms, crayfish, and snails that live in water are collectively called aquatic macro-invertebrates.

Aquifer: underground sediment, sand, or rock deposits that hold significant quantities of water

Bacterial contamination: is a situation which occurs when bacteria end up in a location where they are not supposed to be. Bacterial contamination is usually measured by the fecal coliform levels in the water. Fecal coliform is an indicator (bacteria) organism; it is easily measured and can signal the presence of other harmful bacteria in water.

Basic (Alkaline): refers to an aqueous solution having a pH greater than 7

Biodiversity: the range and diversity of organisms present in a particular ecological community or system.

Buffer strips: borders or strips of vegetation planted or left along waterways to protect the water from the effects of pollutants

Cold water fisheries: A designation given to waters whose temperatures rarely reach 70 degrees Fahrenheit. Cold water fish prefer water temperatures lower than 70 degrees, in most cases closer to 60 degrees as a maximum. These waters support trout and salmon. Cold water species such as trout and salmon require more oxygen to survive than fish classified as warm water.

Ecosystem: A stable and self-perpetuating ecological unit in nature created by the interaction between living organisms and the non-living physical environment.

Erosion: The gradual wearing away of soil or rock; in this case water is the agent that causes the wearing away.

Flocculant: material that causes the solid particles in water to join together, making them heavier and faster to settle out

Groundwater: water that has moved down through the soil and is held in porous rock and in cracks in nonporous rock

Infiltrate: to pass into; in this case referring to water slowly seeping into soil

Microorganisms: an organism that is microscopic (too small to be seen by the naked human eye). Microorganisms are very tiny one-celled organisms, viruses, fungi, and bacteria.

Neutral: refers to 7 on the pH scale
Nonpoint-source pollution: water pollution that enters a body of water through diffuse sources, rather than through a pipe or distinct source (example: pollution from lawn fertilizer)

pH (potential hydrogen): the negative logarithm of the hydrogen ion concentration; On a scale, 7 is considered neutral, above is considered alkaline (basic) and below is considered acidic for water testing

Potable: fit to drink, drinkable

Point-source pollution: water pollution that enters a body of water from a distinct source, such as pipe, leaking tank, or accidental spill.

Pollution: The contamination of soil, water or the atmosphere by the discharge of noxious substances

Porous: having many tiny pores or holes

Precipitation: all forms of water that fall from the sky—rain, snow, and sleet

Runoff: is a term used to describe the water from rain, snowmelt or irrigation that flows over the land surface and is not absorbed into the ground, instead flowing into streams or other surface waters or land depressions. Often pesticides and fertilizers are washed into waterways from lawn and garden runoff

Sediment: a term associated with silt, this silt settles out to the bottom of a water source, producing damaging sediment deposits

Silt: a sedimentary material consisting of fine mineral particles intermediate in size between sand and clay

Turbidity: any reduction in the clarity or clearness of water

Warm water fisheries: A designation given to waters whose temperatures are higher than 70 degrees Fahrenheit, perhaps even in the 80’s. Warm water fish would include such fish as the large-mouth bass and the catfishes.

Water quality criteria: those conditions or parameters such as pH, temperature, and turbidity to which standards (numeric concentrations or levels) are applied to assess quality

Water quality standards: numeric concentrations, levels, or conditions of water quality criteria for which governments monitor; laws or regulations that states adopt to maintain and improve water quality and to protect people’s health and that of aquatic creatures

Watershed: the land area through which water moves or drains to reach a waterway or body of water
4-H Science Interest and Abilities Evaluation:
Be sure to evaluate the impact on youth by asking them to answer the following questions both BEFORE and AFTER they complete the 4-H Water Project:

Science Interest:
Indicate the extent to which you agree or disagree with the following statements.
(Select ONE in each row.)

<table>
<thead>
<tr>
<th></th>
<th>I don’t know</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I like science.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Science is boring.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Science is useful for solving everyday problems.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>When I graduate from high school, I would like to have a job related to science.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I do science-related activities that are not for schoolwork.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Science Abilities:
Please let us know how often each of these statements is true for you.
(Select ONE in each row.)

<table>
<thead>
<tr>
<th></th>
<th>I don’t know</th>
<th>Never</th>
<th>Sometimes</th>
<th>Usually</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can use specific science knowledge to form a question.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I can ask a question that can be answered by collecting data.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I can design a scientific procedure/experiment to answer a question.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I can record data accurately.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>I can analyze the results of a scientific investigation.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Skills for Everyday Living Survey:
This evaluation system will help 4-H Youth Development professionals share the value of local youth development programs with legislators, parents, other agencies as well as internal stakeholders. Penn State Cooperative Extension makes every effort to provide valid documentation to show the difference that the programs are making in the lives of youth we work with everyday. Skills evaluated are decision making, critical thinking, communication, goal setting and solving problems.

This survey is both a Pre-test and Post-test. The pre-test should be conducted at the start of the program year or the beginning of the program. The survey is completed by the youth individually. It is important to emphasize there are no right or wrong answers. The post-test should be administered at the last program meeting of each year or at the end of the program. The program must meet at least five times for the survey to be valid.

You may access a downloadable copy of The Skills for Everyday Living Survey by going to http://www.humanserviceresearch.com/youthlifeskillsevaluation/

For further information on either of these evaluations contact your County 4-H Youth Development Educator.
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RESOURCES

- Project WET Foundation (© 1995) Project WET Curriculum and Activity Guide, Project WET Foundation, 1001 W. Oak Street, Suite 210, Bozeman, MT 59715. 1866-337-5486; E-mail: info@projectwet.org; Web Site: www.ProjectWet.org

RESOURCES (continued)

Storybooks which Compliment the 4-H Water Project Curriculum

Use this children's literature to expand youth understanding and appreciation.

This fun rhyming story explores the potential interconnectedness between a small pond and the many other different bodies of water on earth. While Marco dreams of catching fish which find their way into the pool where he is waiting, readers are reminded of the importance of treating our waterways with care.

This scientific fact based story is written in rhyme. Readers follow little Droplet as he travels around the world through the water cycle, in its 3 forms – liquid, solid and vapor. Readers will come to appreciate the vital role water plays in life.

This supplement offers activities that extend the exploration of unique properties of water and water geography. It includes a section for applied knowledge.

This carefully illustrated true story follows the historical changes and influence of the Nashua River in Massachusetts. Readers will come to appreciate the role the river had in the history of the area. They will also appreciate the effect people had on the river and role Marion Stoddart and the Nashua River Cleanup Committee had on restoring the river after decades of industrial and residential pollution.

This picture book portrays the water cycle against in all its forms against the backdrop natural landscapes. It includes accurate scientific explanations of each painting for educational purposes.

This picture book helps children understand the vital role water plays in human lives. They also learn about global water sources. Each photograph is accompanied by an explanation of location and significance.
4-H MOTTO
“To Make the Best Better”

THE 4-H PLEDGE
I pledge my Head to clearer thinking,

my Heart to greater loyalty,

my Hands to larger service,

and my Health to better living,

For my club, my community, my country, and my world.

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Visit Penn State Extension on the web: extension.psu.edu

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