

Water Pollution: Problems & Solutions

TO NONPOINT SOURCE POLLUTION



- **Teacher's Guide**
- **Lesson Plans**
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Teacher's Guide/Answer Key

Page 4 Answers

Connections:

1. What is nonpoint source pollution?

Non-point source pollution is pollution that comes from a variety of sources and is caused when rain or snowmelt runs over the ground – washing pollutants into our streams or groundwater.

2. List three potential types of human-made nonpoint pollution.

Answers will vary, but could include three of the following:

Urban generated runoff:

trash, motor oil, detergent, pet waste, lawn fertilizer, etc. washing into our storm drains and then into our lakes, streams, rivers, wetlands, and water systems

Soil erosion:

construction of new homes, buildings, and roads

Rural generated runoff:

septic systems, agriculture including fertilizer, manure, and crop residues

Forest and recreation runoff:

timber harvesting, fire control, weed control, road construction, and off-road vehicles

Runoff from abandoned mines:

tailings piles and acid drainage

Hydrologic modification:

Diverting water, straightening the stream bed, and building dams

3. Give an example of sediment that would not be considered pollution.

Sediments carried by a river on an ordinary basis, or salts washed off undisturbed lands

Page 6 Answers

Connections:

1. What types of activities does your family engage in that can cause nonpoint source pollution?

Answers will vary, but could include some of the following:

oil and gas drips, pet waste, soap and detergent, fertilizer, landscape waste, herbicides and pesticides, exposed soil, paint and chemicals, winter salt, downspout to pavement, overwatering, runoff to lakes and streams

2. What can you do to reduce these activities?

Answers will vary, but could include stopping any of the above behaviors or water conservation.

Page 13 Answers

Connections:

1. Have you seen places where the environment has been negatively affected by recreational use?

Answers will vary.

Turning a Question into an Writing Prompt

Use the following question from page 13 as a prompt for your students to write 2-3 paragraphs.

Question: As we march through the twenty-first century, we are writing our own chapter in history. One of the headings in our chapter is about water resources. What can we do to make ourselves proud of what our chapter says?

Page 14 Answers

Connections:

1. Have you ever seen tainted water from abandoned or current mining operations?

Answers will vary.

If a student has seen this type of nonpoint source pollution, ask them to describe its appearance and where it was.

2. What impact does tainted water have on aquatic life (fish and plants)?

Answers will vary, but may include:

The toxic materials produced can poison a section of a stream killing fish and plant life.

Lesson Plan: Water Quantity/Quality Research Trip & Labs

Adapted from Central Colorado Water Conservancy District Educational Materials

Brief Description: The purpose of this activity is to provide experience through investigative research to establish the current condition of water at a specific site and to create a composite water quantity, water quality, and nonpoint source water pollution report for a selected river/stream system.

Level/Subject Area: High School Science

Skills: Group work, listening, written and oral communication skills, water quantity and quality skills development, calculating skills

Objectives:

The learner will be able to:

1. Identify and research selected life zone for water quantity, water quality, and nonpoint source pollution
2. Collect, organize, and analyze data using an integrated systems approach
3. Discuss the analysis of water quantity, quality and nonpoint source pollution and prepare a report or presentation

Teaching Time: *This lesson is flexible and can be broken into modules that can be done individually or you can divide your class into 11 different groups and have each group perform the specific sampling, testing and calculations for water quantity and quality. In addition to prep time for a field trip, a nearby site must be determined, permission must be obtained, transportation lined up, safety issues addressed with students, etc. Depending on the proximity of the site, the field trip could be a half-day or full day activity. Be sure to have students take photographs (if a camera is available) of the site for aesthetic evaluation as well.*

Materials: Module 1-12 cards, outdoor clothing, drinking water, boxed lunches if you will be at the site during lunch, camera, water quality test kits (see each test module below to determine specific requirements. Note: Some test kits may need to be ordered in advance), pencils, and field logs for recording data on site

Procedures:

1. Check your final list of materials and equipment prior to loading and transportation to the research site
2. Travel to the river/stream site and off-load the materials and equipment
3. Collect and record data relative to aesthetics, water quantity, quality, and nonpoint source pollution issues and/or problems.
Be sure to take pictures as well
4. Return to school and discuss your personal feelings and attitudes, commitment and implementation of stewardship, scientific investigation, and historical development of your site
5. Finish lab work and assist students in calculating and finalizing the report for each test and preparing an integrated presentation

Extensions:

In addition to preparing a report for the findings of each test, develop an impact statement and improved action plan including discussion of the following:

1. How can you and your group improve the water at your river/stream site now and in the future?
2. How did the Water Quality Index compare with the water quality rating based on the Aquatic Organism Diversity Index?
3. How is the water polluted at your river/stream? Discuss with the class what constitutes a water pollutant. Have the students keep a journal for a week in which they will note all their observations of potential and actual causes of water pollution.
4. What is the history of land use and water use at your river/stream?

The impact statement should take an integrated approach merging aesthetics, stewardship, scientific and historical factors focusing on data collected from the various indexes. As a group, discuss and develop a future use action plan for your river/stream site. Include in your plan a suggested schedule for improvement. Each plan should have solutions for currently identified problems and issues. In addition, the plan should account for future problems and issues affected by population increases. Direct preparation of a multi-media presentation using creativity and thoroughness.

Resources:

1. www.hach.com, 1-800-227-4224, A source of basic, self-contained test kits, such as test strip and titration kits, for analyzing water quality parameters. An affordable and less equipment-intensive way to test for many water quality pollutants and indicators, although not as accurate as many laboratory procedures.
2. STORET – Water Quality Database, www.epa.gov/storet, STORET is EPA's main repository of water quality monitoring data. It contains water quality information from a variety of organizations across the country, from small volunteer watershed groups to State and Federal environmental agencies. This data can be downloaded from the internet and used for classroom discussion in place of data collected and analyzed by students. There is a training exercise that provides a step-by-step guide for first-time users at: www.epa.gov/storet/storet_download.pdf

Lesson Plan:

Stormwater Pollution: Integrating Science and Civics

Adapted from Colorado Department of Public Health and the Environment - Teacher Resources for Introducing Urban Stormwater Quality Concepts in the Classroom

Brief Description: This exercise will expose students to the ways in which stormwater pollution affects different members of our society. Science will be integrated with government policy through the exploration of an environmental problem.

Level/Subject Area: High School Science/Civics

Objectives:

The learner will be able to:

1. Students will be able to state at least 3 types of people, (see roles below) that stormwater pollution can affect.
2. Students will demonstrate knowledge of stormwater pollution issues through small group discussion.
3. Students will be able to write a professional-style letter expressing appropriate interest in stormwater pollution issues.

Materials: index cards

Vocabulary: erosion, fertilizers, runoff, urban stormwater pollution, water quality, watershed

Procedures:

1. Explain the causes and effects of urban stormwater pollution and initiate a classroom discussion about possible local pollution issues.
2. Create a stack of environmental problem playing cards. Each card should have a different environmental problem related to stormwater pollution written on it. The following list provides a few examples of stormwater pollution issues.
 - Mr. Johnson changes the oil in his truck every few months on the street in front of his house and disposes of the oil in the storm drain.
 - Every Sunday Ms. Paige uses industrial strength soap to wash her car on her driveway.
 - Walter uses twice the recommended amount of fertilizer on his lawn just before a big rainstorm.
 - Prairie Flower Development Inc. is building an apartment building on the side of a creek and has no controls in place to keep soil from eroding into the creek.
 - Acme Widgets Company is storing materials in a way that is resulting in oils and metal shavings being washed into a nearby storm drain when it rains.
3. Break class into groups of 4 students. Have one student from each group come and draw one of the environmental playing cards. This card will give each group in the class a different issue.
4. Assign each member of the group one of the following roles:
 - State Stormwater Program Manager
 - Responsible Party (person or company responsible for the stormwater pollution)
 - Biologist/Environmental Scientist
 - Everyday Concerned Citizen
5. Depending on available time, choose one of the following methods for having students learn about their roles.
 - Have each student spend time on the internet researching the role he or she is assigned.
 - Provide students with brief descriptions of the roles that have been assigned.
6. Have students in each group engage in a discussion about the effects their stormwater pollution issue might have on the different roles they are taking.
7. Have students playing the Responsible Party, Scientist, and Citizen write a letter to the Stormwater Program Manager, and have the student playing the Stormwater Program Manager write a letter to the Responsible Party. The letters should address the situation from the letter writer's perspective and propose solutions.

Extensions:

A teacher may expand this activity to include a broader range of roles and role-playing scenarios.

Examples of roles include:

- | | | |
|--------------------------------|---------------------------------|--|
| • Pollutant | • Aquatic organism (e.g., fish) | • Biologist |
| • Environmental group | • Everyday concerned citizen | • Environmental Engineer |
| • Residential developer | • City official | • State Stormwater Program Manager |
| • Congressional Representative | • Federal Judge | • EPA (Federal) Stormwater Program Manager |

The teacher can guide the class through whatever scenario he/she chooses. For example, the role playing might begin with the pollutant(s) telling us who they are, and where they came from. The aquatic organism may respond adversely and be noticed by the biologist or everyday citizen. They bring it to the attention of the city official. Meanwhile, the engineer and developer are also talking to the city official. The city official consults the State Stormwater Program Manager who, subsequently, requires a new best management practice as part of their municipal permit. If this fails to resolve the pollution

problem, the EPA Project Manager may intervene. Other options may include the concerned citizen calling up their favorite environmental group to sue local governments for failure to resolve the situation. If no solution is found, the congressman might have to draft a new bill that will set new policy for the EPA Project Manager to implement through the Executive Branch.

This activity could involve verbal classroom presentations and discussion, or be conducted in a journal passed between classmates. This activity is also a great opportunity to integrate the content areas of science and civics as the early scientific/factual “steps” in the process leading to government policy development and implementation. This activity could also be a lead-in to your school’s mock-trial exercise.

Activity Suggestions:

Poster contest

Ask students to create an educational poster using 3 or 4 household activities that cause nonpoint source pollution. Poster’s goal is to create awareness, educate the public on what activities to avoid and why. Poster should be colorful, easy to read and include website info where public can learn more about ways to reduce these activities.

Ecology project

As an extension activity, each student could choose an ecology project to do at home. Some suggestions would be:

- Keep track of how much water their family uses in a month. Put into place some restrictions, follow for a month, and calculate the amount of water saved.
- Research what happens to water/wastewater after it leaves their houses (or the school.) Do a report on the processes used and time involved.
- Put recycling practices in place at home or at school. Keep track of how much is collected, and figure out how much energy/natural resources are saved.

Plant project

Study the effects of salt on the growth of a bean plant. Salts are part of many products used in urban areas and a cause of nonpoint source pollution.

Acid Rain project

Materials:

- red and blue litmus paper
- cookie sheet
- eyedropper
- distilled water
- pond water
- rainwater (collected in a cup placed on a windowsill or on the lawn)
- tap water (collected from the tap)

Procedure:

1. Lay out the red and blue litmus paper on a cookie sheet.
2. Using the eyedropper, place one drop of rainwater on each piece of litmus paper. Record any color changes you see. Wash out the eyedropper afterward.
3. Repeat this process for the tap water, distilled water, and pond water samples, by placing a drop of each sample on both types of litmus paper.
4. Record any color changes you observe.

Your should notice that the samples will change the color of the litmus paper differently, based on their pH values.

Stormwater project

One engaging and empowering, hands-on conservation activity for students is to spray paint using stencils near storm drains. There are many varieties, but they boil down to the message, “Don’t Dump, Drains to Stream.” See Internet Resources (last listing on page 7) for a company that sells these stencils.

The obvious first step in such a project is to contact the local water authority managing stormwater. This can have several benefits:

- Guest speaker: sharing info about stormwater management
- Maps of stormwater system and where the water leads
- Permission and map of drains needing the stencils

This type of hands-on project educates the students as well as residents in a community.

A possible spin-off could be to have students write up a short brochure explaining their project to the public, and including pictures of local water bodies and their wildlife that will be protected if the community heeds the signs. In addition, information for hazardous waste recycling centers can be included. These brochures can be made available at busy locations throughout the community.

Garbage project

Garbage has an impact on water systems. Any type of garbage could be used instead of cans.

1. Have students collect cans
2. Estimate the weight of the cans collected
3. Weigh them
4. Cash them in
5. Have students figure cost per pound and cost per item
6. Estimate different weights of cans such as: 1,000 pounds or 5,000 pounds, etc.
7. Estimate how many cans it would take to fill the local landfill and the amount of time they think it would take
8. They could then write the process in a complete, well-written paragraph.

Individual Action Checklist

What Can I do...?

Adapted from Colorado Department of Public Health and the Environment - Teacher Resources for Introducing Urban Stormwater Quality Concepts in the Classroom

Pet and Human Waste

- Clean up after pets and other large animals to keep feces from polluting water. Carry and use a pooper scooper and plastic bag to dispose of waste in the trash.
- Keep animals out of lakes and streams.
- Inspect and pump septic systems regularly. Chemicals can damage septic systems, so select them carefully and use care in pouring or flushing them into septic systems. Use a monthly environmentally friendly septic treatment to keep your tank running well.

Yard and Garden

- Landscape with fewer hard-paved surfaces to reduce volume of stormwater runoff.
- Prevent the erosion and runoff of soil by vegetating bare soil. When storing soil, do not store it on or near paved areas where it can easily be carried to storm drains.
- Landscape with vegetation (such as greenbelts, buffer zones or grass filter strips) between hard paved surfaces and storm drains and/or surface waters (e.g., lakes and streams). Design drainage systems to direct stormwater runoff into grassy or well-vegetated areas rather than paved surfaces.
- Minimize soil compaction by core aerating your yard.
- Manually operate sprinklers and use drip/trickle irrigation systems to water only as needed. Keep water off paved surfaces to avoid excessive runoff. If rain is expected, water another day.
- Replace high-maintenance lawns with drought-resistant grass strains and select native plants that require less water, fertilizer, and pesticides.
- Raise lawn mower to its highest level. Grass requires less water when longer and shaded.
- Compost (or leave on your lawn) grass clippings and other lawn waste that will safely decompose. Do not dump such items in storm drains or ditches since they can clog drainage systems and add unwanted nutrients to runoff.
- Reduce pesticide use by planting pest-resistant plant species or those that attract beneficial insects for biological pest control.
- Store all fertilizers and pesticides in proper containers and keep dry.
- Use slow-release or natural fertilizers such as compost and bone meal.
- Follow manufacturer's instructions for application of fertilizers and pesticides to avoid overuse and excessive runoff into storm drains. Sweep excess product from sidewalks and driveway back onto yard so it doesn't wash easily/directly down gutters.
- Never over-water after application of fertilizers and pesticides. If rain is expected, then apply chemicals another day.

Auto and Household Maintenance

- Store all automotive chemicals (such as antifreeze, oil, gas and grease) and household chemicals (such as cleaners, solvents, thinners and paints) in proper containers and keep dry.
- Do not pour these chemicals onto soil.
- To clean up accidental spills, use absorbents (such as kitty litter and sawdust) and then sweep. Don't rinse with water!
- Never use storm drains or gutters to dispose of chemical waste.
- Properly handle and dispose of such wastes by recycling or taking them to a treatment facility. Did you know that 60% of household hazardous wastes can be recycled?
- When washing your car consider: (1) using commercial car washes where wastewater is treated, (2) washing car over lawn, gravel or other permeable surface to reduce runoff, and (3) only using the hose for final rinse.
- Keep your vehicle well-maintained and repair any leaking systems immediately. Watch for drips!

Around Your Neighborhood

- Do not litter. Litter can be carried into local streams and lakes where it can negatively affect wildlife habitat and water quality.
- Report any sources of stormwater pollution that are resulting in discharges into storm drains or surface waters (such as construction sites with unmanaged soil erosion, and businesses or individuals dumping materials into drains) to local government officials.

Share your pollution prevention behaviors and practices with your family, friends, and neighbors.

Internet Resources

Adapted from Colorado Department of Public Health and the Environment - Teacher Resources for Introducing Urban Stormwater Quality Concepts o the Classroom

1. Project WET (Water Education for Teachers)

www.projectwet.org

A non-profit water education program and publisher for educators and young people ages 5- 18. Program development resources, test kits, outreach materials and more. This program is already being implemented in several Colorado school districts.

2. Educating Young People About Water - Water Curricula Database

<http://www.uwex.edu/erc/ey paw>

A searchable database of water curricula that has been reviewed and approved by a national review team. Includes urban stormwater quality curricula, and other curriculum.

3. Colorado Water Protection Project

www.ourwater.org

A public education program (by the League of Women Voters of Colorado) that includes great fact sheets and background information on the causes and effects of urban stormwater pollution; suggestions for citizen action; and many internet links to programs of local municipalities, non-profits, state, and federal government.

RELATED COLORADO PROGRAMS

4. Colorado River Watch

wildlife.state.co.us/riverwatch

Colorado Division of Wildlife program that links environmental protection with education in a meaningful, hands-on project for Colorado residents. Participants currently are made up of middle and high school students, their teachers, watershed management groups, and stakeholders.

5. Colorado Recycles

www.colorado-recycles.org

The whats, wheres, and hows of recycling anything in Colorado.

6. Xeriscape Colorado!, Inc.

www.xeriscape.org

Learn how to landscape with plants that are locally adapted and require less water, fertilizers, and pesticides.

TECHNICAL/PROFESSIONAL RESOURCES

7. National Menu of Best Management Practices

cfpub.epa.gov/hpdes/stormwater/menuofbmps/menu.cfm

EPA's comprehensive menu of stormwater best management practices, including everything from education on topics, such as, pet waste and litter, to technical fact sheets on retention ponds.

8. Center for Watershed Protection

www.cwp.org

A non-profit corporation that provides great multi-disciplinary technical tools for protecting surface waters, including books and online slide shows on stormwater management.

9. The Stormwater Manager's Resource Center

www.stormwatercenter.net

A web page from the Center for Watershed Protection, with technical assistance on stormwater management issues.

STATE AND FEDERAL STORMWATER & NONPOINT SOURCE PROGRAMS

10. Colorado Water Quality Control Division, Water Quality Permitting Program

www.cdph.e.state.co.us/wq/PermitsUnit/wqcdpmt.html

Information about regulation and permitting of stormwater pollution in Colorado.

11. Nonpoint Source Colorado

www.npscolorado.com

Nonpoint source pollution information, news, stories, meetings, and projects in Colorado.

12. U.S. Environmental Protection Agency, Stormwater Program

www.epa.gov/npdes/stormwater

Technical and regulatory information on stormwater pollution in the U.S.

13. U.S. Environmental Protection Agency, Nonpoint Source Program

www.epa.gov/owow/nps

EPA's nonpoint source pollution site provides fact sheets, publications and information for students/educators.

14. U.S. Environmental Protection Agency, Stormwater Month Outreach Materials and Reference Documents

cfpub.epa.gov/npdes/stormwatermonth.cfm

EPA Stormwater Month brochures, posters, door hangers, stickers, bookmarks, games, fact sheets, and other publications.

COMMERCIAL SITES WITH RESOURCES FOR SCHOOLS

15. EnviroScape

www.envirosapes.com

A company that supplies great stormwater models, posters, and other educational program materials.

16. Earthwater Stencils

www.earthwater-stencils.com/foredu.html

Information about and supplier of storm drain stencils as an educational interactive tool to engage people of all ages.