3 What Kind of Pollution Issues Affect Illinois?

OVERVIEW

Earth's Closed System Revisited

It is easy for people to think that what we do does not affect other people or the world around us. However, much of what we do consumes energy or resources, and much of it does or can produce pollution.

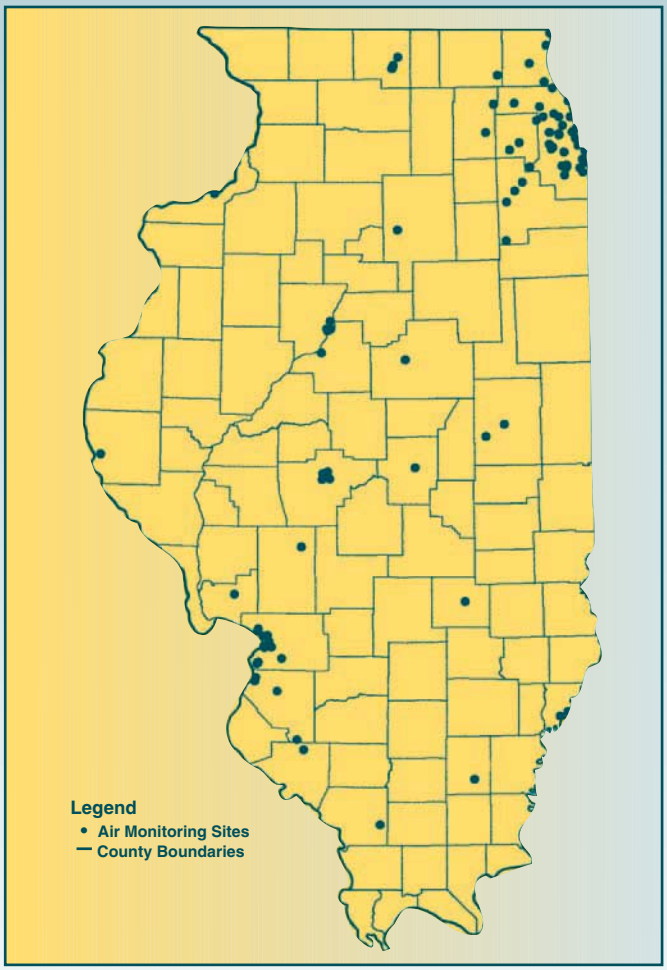
When you are at home and turn on the TV or the computer, or turn up the heat or the air conditioning, you are using energy - electricity, gas, or oil. When you eat a handful of french fries from a fast food restaurant, you benefit from the work of farmers who raised the potatoes, the industries that made the packaging, and the truckers who transported them to your town. The farmers, industries, restaurants and transporters all used energy.

How people use and produce food, energy and other resources that you enjoy can keep your environment safe and clean—or, they can contribute to making it dirty and polluted. The way that you use these resources can also affect the environment. You decide what to buy, what to repair or recycle, and what to throw away. You can help make the environment cleaner or dirtier, depending on your decisions.

BACKGROUND

Air Quality in Illinois

The IEPA uses air quality monitors to take samples of air throughout Illinois and test them for levels of six pollutants. These six pollutants are: ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Other pollutants, such as hydrocarbons, are measured too. Each of these pollutants has a safe level that can be in the air. The IEPA issues pollution advisories when the air quality is expected to be unhealthy. Air monitoring in Illinois shows that the Chicago and East St. Louis metropolitan regions do not meet national air quality standards for gound-level ozone (smog), which is formed when oxygen in the air reacts with sunlight in the presence of hydrocarbons and other emissions from industrial, vehicular and other sources. Also, portions of the southern Chicago and western Cook County areas do not meet national air quality standards for particulate matter.



Particulate matter is small solid particles produced by several types of sources including power plants, wood burning stoves, leaf burning, automobile exhausts, incinerators, rock quarries, coal processing plants, farming and roadways. Particulate matter can bother people with respiratory diseases such as asthma, and may irritate the eyes.

Carbon monoxide is a colorless, odorless, poisonous gas from the incomplete burning of fossil fuels such as coal, oil and gas. Carbon monoxide is produced chiefly by automobiles but also by power plants and other sources. When a person inhales carbon monoxide, the supply of oxygen to the body is reduced; this can cause vision problems and headaches. Exposure to large amounts of carbon monoxide can stress the heart, affect the brain, and even cause death.

Overall, the quality of air in Illinois is improving each year. The IEPA continues to work to change and improve the methods of testing and controlling air pollution in Illinois, so that the air we breathe is clean.

Nitrogen dioxide is released into the air from burning fossil fuels at high temperatures. Some nitrogen dioxide occurs naturally in the soil and atmosphere. High levels of nitrogen dioxide can strain the heart and respiratory system and increase the chances for breathing problems and illness.

Sulfur dioxide is formed when fossil fuels and other substances that contain sulfur are burned. Major sources of sulfur dioxide emissions are factories and power plants that burn coal and other fossil fuels. Many people experience eye, nose and lung problems when they are exposed to high sulfur dioxide levels.

Perhaps the greatest success story in reducing air pollution concerns lead. Lead is classified as a heavy metal. Very small particles of lead can be found in the air we breathe, in the water we drink, in the food we eat, and in some soils. Once taken into the body, it tends to remain there. Lead in the air comes primarily from the burning of leaded gasoline, from iron smelters (places where ore is melted to separate metal) and from car battery manufacturing plants. Health effects related to lead poisoning (especially in young children) include brain damage, muscle cramping, and anemia. Since a law was passed in 1975 that required cars and trucks to use only unleaded fuel, the amount of lead in air has decreased by 85 percent.

Water Quality in Illinois

Illinois is rich in surface water resources with approximately 900 rivers and streams having an estimated total of 87,110 stream miles and 91,400 inland lakes and ponds, 3,256 of which have a surface area of six acres or more. About three-fourths of Illinois inland lakes are man-made. The state is bordered by three major rivers, the Mississippi to the west, and the Ohio and Wabash to the southeast. The other large rivers in Illinois include the Rock, Fox, Des Plaines, Kankakee, Illinois, Sangamon, Kaskaskia and Big Muddy.

Nearly one million acres of Lake Michigan stretch along Illinois' northeastern border. Lake Michigan is the third largest of the Great Lakes and is the largest body of freshwater entirely within the United States (portions of the other four Great Lakes are on the U.S.-Canada border).

The majority of Illinois' lakes are artificial. Illinois lakes serve many purposes such as providing drinking water, flood control, industrial plant cooling water, fish and wildlife habitat, and opportunities for fishing and boating.

River and stream water quality in Illinois has improved considerably since 1972. (In 1972, the **Clean Water Act** was passed to protect the water in the United States.) The number of rivers and streams with poor quality has declined, while the number of rivers and streams with good water quality has increased. Water is tested at more than 3,000 monitoring stations throughout Illinois to determine water quality conditions.

Most of the pollution that enters Illinois rivers and streams comes from nonpoint sources (pollution that cannot be traced to one source). The common nonpoint source pollutants come from:

• habitat change (removing plants such as trees from stream banks or changing the course of a river or stream),
• runoff (oil, chemicals, soil and other pollutants that are washed from streets, parking lots and driveways) and
• resource extraction (removing resources such as coal from the land). The other major causes of pollution in Illinois rivers and streams are point sources. These are pollutants discharged from a pipe such as from a factory or waste-water treatment plant, or some other identifiable source.

Portions of the DesPlaines, Sangamon, Illinois, and Mississippi rivers contain fish whose flesh contains high levels of pollutants. Fish consumption advisories have been issued for parts of these rivers. A fish consumption advisory identifies species of fish within certain bodies of water that contain enough contamination that the public should limit the amounts they eat, or in some cases, not eat them at all.

The IEPA and the city of Chicago monitor (test) Lake Michigan's water quality. Information from Lake Michigan water testing has shown that the water quality of Illinois' portion of Lake Michigan has improved over the last 20 years. For example, the amount of pollutants such as phosphates and ammonia has declined. Phosphates and ammonia are found in sewage, industrial waste, and runoff from agricultural fields. In general, Lake Michigan water quality conditions are good.

Most of the pollution in lakes consists of sediments and nutrients that wash into lakes. Lakes function as traps or sinks for pollutants from watersheds (the area drained by a river or river system). The water in polluted lakes may have bad taste and odor, be overgrown with aquatic plants and/or look dark brown or green. The water quality problems in lakes limit the use of the lake for fishing, boating and swimming, and affect the aquatic life. If the lake is filling in with sediment, its life will be shortened. Those lakes showing improvement are part of special restoration projects to reduce the amount of pollution that reaches them.

Contaminant levels in fish are monitored through a cooperative effort between the Illinois Departments of Agriculture, Natural Resources, Nuclear Safety, Public Health and the Illinois EPA, which is commonly referred to as the "Fish Contaminant Monitoring Program." Meal advisories are issued when fish are found with elevated levels of contaminants, such as chlordane, methylmercury and polychlorinated biphenyls (PCBs). In 2005, the methylmercury advisory applied to predator fish, which includes all species of black bass (largemouth, smallmouth and spotted), striped bass, white bass, hybrid striped bass, walleye, sauger, saugeye, flathead catfish, muskellunge and northern pike – IN ALL ILLINOIS WATERS. Current Illinois fish

Land Cover in Illinois

27.5 million acres	agricultural land (crops, such as corn and soybeans, and rural grassland)
4.1 million acres	forested land (upland, partial canopy and coniferous)
2.3 million acres	urban and built-up land
1.4 million acres	wetlands
0.7 million acres	other (surface water, and barren and exposed land)
36 millions acres	

Source: The Illinois Interagency Landscape Classification Project, Land Cover of Illinois 1999-2000.

advisories can be viewed on IDPH's web site at http://www.idph.state.il.us/envhealth/factsheets/fishadv.htm.

The northeastern portion of Illinois' border is formed by 63 miles of the shoreline of Lake Michigan. The lake provides drinking water for Chicago, as well as many of its suburbs. Fifty miles of Illinois shoreline are suitable for swimming.

There are pollutants which are found attached to sediments in several Illinois harbors on Lake Michigan. These include such pollutants as polychlorinated biphenyls (PCBs). For example, sediments in Waukegan Harbor were found to be contaminated with PCBs. As a result, a cleanup project was done to remove nearly one million pounds of contaminated sediments. Pollutants such as PCBs are also found in Lake Michigan fish. These pollutants bioaccumulate in fish, which means that older and larger fish tend to have higher levels of pollutants.

More than four million people in Illinois use groundwater as a source of drinking water. Approximately 400,000 residents in the state are served by their own private wells. Seventy percent of Community Water Supply (CWS) systems in the state withdraw water from confined aquifers that have natural geologic protection from surface and near-surface activities. This means the remaining 30 percent of the communities withdraw water from unconfined aquifers that are susceptible to pollution from land use and other surface activities.

Groundwater quality is a major concern in Illinois. Water quality degradation or contamination results from point and nonpoint sources throughout the state. In many industrialized areas, including the metropolitan areas of Chicago, Rockford, and St. Louis, groundwater has been degraded by improper storage or disposal of chemicals. In many agricultural areas, the quality of groundwater in shallow aquifers has been reduced by the routine application of agricultural chemicals. Nearly 10 percent of the CWS wells in the state are estimated to have water quality which is either susceptible to pollution, or of poor quality, as a result of impacts by agricultural runoff. Approximately 22 percent of the CWS wells using unconfined aquifers and 2 percent of the CWS wells using confined aquifers have been affected.

Land Quality in Illinois

Illinois contains 56,349 square miles. (just over 36 million acres). This includes land and water surface areas within its boundaries. There are currently 27.5 million acres of rural land. In 1996, 21.6 million of the rural acres were cultivated for agricultural purposes. Forested land makes up about four million acres of land within Illinois. Urban areas and transportation routes (highways and railroads) cover 2.3 million acres of Illinois. The remainder of the land in Illinois is wetlands, rivers and lakes, and barren and exposed land.

Before 1970, pollution control efforts were directed only toward the most extreme violations of the state's public health laws. Since its establishment in 1970, the IEPA has made excellent progress in closing open dumps (not the same as legal landfills) and managing solid and hazardous waste.

One of the biggest problems in rural areas is erosion of soil. About 17 percent of our rural land (roughly four million acres) needs some form of treatment to control soil erosion. Overall, Illinois is losing approximately 57 million tons of soil each year due to erosion. The goal in Illinois is to reduce soil erosion until all agricultural land is at tolerable soil loss levels. Tolerable soil loss is the amount of soil that can be lost while retaining the productive capacity of the soil for an indefinite period of time.

In Illinois, a total of 16.2 million tons of municipal waste was generated and 6 million tons of waste was recycled in 2003. According to the Illinois Recycling Association, the average American will throw away 600 times his or her adult weight in garbage in a lifetime. Thus creating as much as 100,000 pounds of trash for his or her children.

Land quality in Illinois can be affected by many things. Our national throwaway society discarded 231.9 million tons of municipal solid waste, or garbage, in 2000. Homes, industry, businesses, government and schools all contribute to this growing waste problem.

In our state, 1.1 million tons of hazardous waste is generated annually. In 2002, 4,772 drums of hazardous waste were collected from 24,134 Illinois households. These hazardous wastes present a special challenge. To protect the environment and the public's health, cleanups are needed at thousands of properties contaminated with petroleum products (gas, oil, etc.) from leaking underground storage tanks.

Due to stronger state and federal environmental regulations, the number of solid waste landfills in Illinois declined from 146 in 1987 to 58 in 1999, a 60 percent decline. This will result in fewer, larger landfills to handle the disposal of waste. How we manage the waste we generate has a direct effect on our quality of life and the land we depend on.

What's Blowin' in the Air

Subject: Mathematics
Science

Skills:
- Analyzing
- Comparing / Contrasting
- Drawing Conclusions
- Collecting
- Hypothesizing

Concepts: 1. C, J, L, R
2. I
3. A , F

Objectives: Students will:
1) analyze collected particles and draw conclusions about them.

2) identify areas of the school where air pollution might be a problem.

State Standards:
Mathematics: 10.B.2 c
Science: 13.A.2 b,c

Vocabulary:
- parts per million (ppm)

Setting: Indoor & Outdoor

Materials:
- class tally sheet
- graph paper
- scissors
- pencils
- tape
- student air particle worksheet (p. 62)
- hand lenses
- microscope (optional)

Time: Two class periods one week apart

Activity Overview

Students collect particulate matter from the air at different locations around the school and analyze particles collected.

Background

Air pollution is any visible or invisible gas or particle which is not part of the natural composition of air. Natural air pollution, such as pollen, natural fires, and smoke and gases from volcanoes, has existed for millions of years. Since the 1800s, pollution caused by humans has become a concern.

Solid particles of soot and dust are sometimes in the air we breathe. They are called particulate matter. These particles come from burning fuel and leaves, construction projects, harvesting crops such as corn and soybeans, and from natural sources such as volcanoes and forest fires. Eventually, these particles can be inhaled by people and other animals, fall into the water, or settle on the surface of buildings or cars as dust or grime.

Since these particles and gases can be harmful to humans and other animals, many communities have programs in place to monitor air quality. The amount of particulate matter in air (measured in ppm, or **parts per million**) will vary depending on many factors including wind, precipitation, and the amount of fossil fuel being burned. Monitoring consists of examining samples of the air to determine if there is enough pollution in it at any given time to be dangerous. In many areas, monitoring helps officials warn the public prior to the air becoming harmful, and thus is an important public health tool.

What is One Part Per Million?

One part per million is:
- **one second in 12 days of your life;**
- **one penny in $10,000;**
- **one inch in 16 miles.**

Preparation

1. Explain to fellow faculty and staff, in particular janitorial staff, that your class will be conducting a scientific experiment. Ask them please to not disturb the monitoring devices.

2. Prepare a class tally chart, like the one shown below, on a chalkboard or overhead.

Team	Location	Particle Average	Types of Particles

Procedure

1. Explain to the students that they will be conducting an experiment to measure air quality within their school.

2. Focus the students by discussing the following air pollution questions:
   - What is air pollution?
   - What do you know about air pollution?
   - How do we know air pollution exists? Are air pollutants visible or invisible?
   - What is air pollution made of? (Help students understand that there are many kinds of air pollution, including different gases and particulate matter.)
   - What are some sources of air pollution?
   - Where in the school might you find more or less pollution?
   - What ideas do you have about how the class can monitor or look for signs of pollution?

3. Ask students if they think there are particles in the classroom air right now. Do they think those particles are visible or invisible? Both answers are correct, but the class will be focusing on those particles in air that are visible. To demonstrate this, darken the room so no light is seen and turn on a very bright light, like that from a slide projector or a very bright flashlight. Ask students to look through the beam of light and see if they notice dust or lint particles floating though the air.

4. Explain that the students will be monitoring the air around the school for particulate pollution, and that they will be constructing scientific monitoring devices. Ask students for their ideas on where to put pollution monitors so that they won't be disturbed by people or weather for a week. List possible locations on the board.

5. Group students in pairs and give each pair a milk jug cap or similar circular item about an inch in diameter, a piece of graph paper, and a Student Air Particle Worksheet. Pairs should choose a location to place their monitor. Have them fill out the Hypothesis portion of the worksheet, explaining what kinds of particles they expect to find at the location they have chosen, and why. The teacher should make a model in front of the class, explaining each step.

6. Have the students fold the graph paper lengthwise with the lines on the inside of the fold. Have them draw three circles on one of the outside surfaces of the paper using the milk cap, being sure that they leave at least one inch between circles and an inch on each side. Have them unfold the paper and cut out the three circles. Have them fold the paper back; on the side that has not been cut, have the students write their names, the date, and the location they have chosen for their monitoring device, being as specific as possible.

7. On the front side where the circles are cut, have them write **"Scientific Experiment-Do Not Remove"**.

8. Next, have them trace around the inside of the circles they have cut, so that drawn circles appear on the inside flap. Have them open the paper, like a greeting card, and lay it flat.

Distribute clear cellophane tape to each pair. Have them rip off pieces of tape longer than the drawn circles (they may need two strips per circle). Instruct them to have one student hold the strip, adhesive side up, at the edges without touching the tape in the middle of the circle. The other person is to tear off strips of tape and tape the first piece down at the edges, again making sure not to touch or tape over the adhesive in the circle. Repeat for all three circles.

9. Have them tape or staple the card closed. Make sure that the grids of the graph paper are visible through the tape on the circles.

10. The teacher should record the locations that the students have chosen. Allow students to hang or place their monitors in the locations they have chosen. Some may need to tape their monitors to walls or other items; others may need to attach them to coat hangers so that they can hang from pipes or branches without being damaged.

11. Have the students turn in their worksheets to the instructor.

12. The instructor's monitor is not to be placed for monitoring, but is to be kept as a control. Place it in an envelope, box, or other container where it will not be exposed to ambient air.

13. After one week have the students collect their air monitoring devices and bring them to class. As a class, decide what unit of measure to use so that everyone's data can be compared. Discuss why it is important to analyze and report data in common measures.

14. Distribute a hand lens to each pair. Have them count the total number of particles in each square (or whatever unit has been selected). Ask them to list and describe the different types of particles they observe on their graph paper. Particles should differ in shape, color, and size. (You may choose to have students use microscopes instead of or in addition to hand lenses.)

15. Have the students take readings from each of the three circles. Instruct them to draw an average of the number of particles they find, using the Student Air Particle Worksheet. One student will then record their average on the class chart.

As students are working on their worksheets, the instructor should complete one for the control strip as these results will be compared in step 16.

16. Have the pairs complete the last portion of the worksheet, where they compare their results to their hypotheses. Discuss as a class.

17. Discuss the results:
- Were you surprised at your results?
- Did you expect more or less particulate pollution?
- How did your results compare with the control strip?
- What did the particles look like?
- Where do you suppose the particles came from?
- Are there any differences in particles based on where the strips were placed?
- Where were the dirtiest places? Where were the cleanest?
- Why do you think you got the results you did? Was wind a factor? Was there something close by that affected the results?
- Do you think you would have received the same results at different times of the year? Why or why not?

Wrap Up

Assessment

Have students brainstorm a list of possible sources of the air pollution they found. Divide the list into natural and man-made sources. Ask them if they think any of the pollutants are preventable.

Have each student pick a pollution source and develop a way of preventing or reducing the pollution that comes from it. Their results can be in the form of a model or a written paper.

Extensions

Community

• Do the experiment a second time, and have the students take the strips home or to places within the community. Have them do a comparison to the results they had at the school.

Multidisciplinary

• Allow students to design posters to show the steps they took to acquire the data. Create a bulletin board where students can display their posters and monitoring strips so that the class can compare all results.

Technology

• *Daily Air Quality Report*
An air quality index is available online for major air pollutants that are monitored throughout the state.
www.epa.state.il.us/air/aqi.

The Illinois Annual Air Quality Report is also available online at www.epa.state.il.us/air/air-quality-report.

Resources

• *Air Facts - Air Quality Monitoring*
Information on levels of air pollution in Illinois and how they are monitored.
IEPA (see order form in appendix)

• *Air Facts - Criteria Pollutants*
A fact sheet on the six criteria air pollutants and how they are regulated and controlled.
IEPA (see order form in appendix)

• *Air Facts - Nonattainment: Falling Short of Air Quality Standards*
A fact sheet on the steps being taken to improve air quality in regions in Illinois that fall below national standards.
IEPA (see order form in appendix)

• *Project A.I.R.E. - Air Pollution Background Information* (PDF Version)
Fact sheet on air pollution and ways to detect and prevent it. www.epa.gov/region01/students/pdfs/rd_airpol.pdf

• *The No Waste Anthology - A Teacher's Guide to Environmental Activities K-12,*
Department of Toxic Substance Control Public Education and Information, 1991.

To order, contact: Environmental Education Coordinator D.T.S.C., 1001 I Street, P.O. Box 806, Sacramento, CA 95812-0806. To download online, visit www.dtsc.ca.gov/Education/upload/OEA_FLY_NWA.pdf.

• *Indoor Air Quality (IAQ) Tools for Schools Kit*
This kit is available free of charge. To order call 1-800-483-4318 (document number 402-K-95-001), or visit www.epa.gov/iaq/schools/toolkit.html.

Adapted From: "Air Strips," Environmental Resource Guide. Air Quality Air & Waste Management Association. Pittsburgh, PA. 1991.

Student Air Particle Worksheet

Names: _____ **Location:** _____

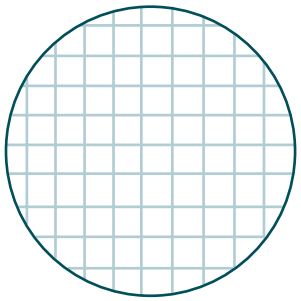
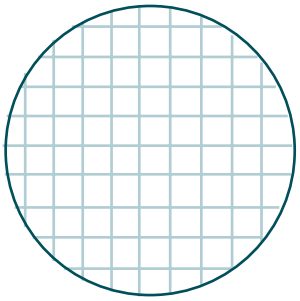
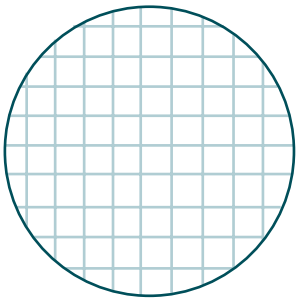
_____ _____

Hypothesis - What types of particles do you think you will collect with your air monitor? Why? _____

_____

_____

_____

Draw the Particles	Number of Particles Found in One Grid Square	Describe the Particles
	☐	_____ _____ _____ _____
	☐	_____ _____ _____ _____
	☐	_____ _____ _____ _____

Add the numbers in the boxes. _____
Divide the total by 3. _____
This is the average number of particles you found.

Conclusion - Was your hypothesis correct? Why or why not?

_____

_____

It's Warm in Here, or Is It?

Subject: Language Arts
Science
Social Studies

Skills:
- Analyzing
- Comparing / Contrasting
- Drawing Conclusions

Concepts: 1. C, F, J,
2. C, F, E, G
3. A, E
4. B

Objectives: Students will:
1) judge the strengths and weaknesses of information.

2) discuss the causes and possible effects of global climate change.

State Standards:
Language Arts: 2.B.2 a
5.B.2 a
Science: 13.B.2 b,c
Social Studies: 17.C.2 b, c

Vocabulary:
- chlorofluorocarbons
- greenhouse gas
- ozone

Setting: Indoor

Materials:
- copies of the scientist position papers for each student (pp. 66 & 67)

Time: One class period

Activity Overview

Students read two differing articles on the concept of global climate change and determine how or if air pollutants may be affecting our climate.

Background

Chlorofluorocarbons (CFCs) or freons were discovered in the 1930s. They are chemical compounds made of chlorine, fluorine and carbon. They are nonreactive, nontoxic, non-caustic, noncorrosive and nonflammable. These properties make CFCs perfect for use as coolants in refrigerators and air conditioners, propellants in aerosol sprays, plastic foam blowing agents (used in making some types of styrofoam) and cleaning solvents used in the electronics industry. But in 1974, scientists discovered that the same stable qualities that make CFCs useful can result in major environmental problems when these gases drift (without breaking down) into the stratosphere.

The stratosphere contains a thin layer of a gas called **ozone**, and forms what we know as the ozone layer. Ozone gas forms when oxygen molecules interact with ultraviolet rays from the sun. Under normal circumstances, the ozone layer varies in thickness since it is continuously being lost and regenerated. The ozone layer is an important protective screen for life on earth, filtering out more than 99 percent of the ultraviolet rays (the ones that can cause skin cancer, immune deficiencies and cataracts) before they can reach the ground.

Environmental problems at a global level may also be caused by so-called **greenhouse gases**, most notably carbon dioxide (CO_2) and methane. The levels of both of these gases in the atmosphere have increased since the beginning of the industrial revolution. These gases absorb and reradiate heat from the earth which would otherwise escape into space. In so doing they perform the functions of a greenhouse. Many scientists believe that their increased presence in the atmosphere is already disrupting climate and weather patterns worldwide. The 1995 Kyoto Protocols attempted to address this concern on an international level. However, some scientists disagree with the predictions of global warming and see recent fluctuations as part of a

natural cycle. Many people feel more research must be done before taking any action.

Preparation

1. Make copies of the student worksheet (p. 68) and the scientists' statements (pp. 66 and 67).
2. Review background material.

Procedure

1. Ask the class what they know about global climate change, often referred to as "global warming." Discuss with them the greenhouse effect and greenhouse gases, such as carbon dioxide and CFCs.

2. Explain that most scientists agree that the increasing amounts of carbon dioxide, CFCs, methane, and other greenhouse gases in the atmosphere will affect the world's climate. However, there is some disagreement about whether these changes have already begun and how serious the effects will be. Scientists also disagree on how we should react to global climate change.

Wrap Up

Assessment

Give each student a worksheet and both of the scientists' statements. Give them time to read the articles and answer the questions on the worksheet. Discuss their answers.

Ask students the following questions:

1) What are the main points brought up by each scientist?
2) What are the advantages and disadvantages of the alternative presented by Scientist 1?
3) What are the advantages and disadvantages of the alternative presented by Scientist 2?
4) Can you think of a course of action that is a compromise between the two plans presented by the scientists?
5) What do you think the best course of action is? Why do you feel this is the best thing to do?
6) Do you think it's important to stay informed about scientific issues? Why or why not?

Potential Answers:

1) Scientist 1 thinks that global warming is already happening and we need to cut carbon dioxide and CFC emissions now to slow it. Scientist 2 believes that we can't be sure yet if the world's climate is warming as a result of increased CFC and carbon dioxide levels and that we need to do more research before we take any drastic action.
2) ADVANTAGES: Would help cut down on the possibility of causing further global warming; would cut down on pollution in general due to decreasing use of fossil fuels; would increase energy efficiency, and the use of alternative energy sources; would save money due to use of more energy-efficient appliances.
   DISADVANTAGES: Would cost more in the short term to develop more energy-efficient cars, factories, and appliances; might eliminate some jobs or cut profits; could reduce crop production or industrial efficiency; may focus resources and talents toward the wrong problem.
3) ADVANTAGES: Would result in more knowledge about our atmosphere; would cost less in the short term; would not inflict economic hardships on U.S. businesses and people in developing countries.
   DISADVANTAGES: Would not reduce pollution; would cost more in the long run; would increase the possibility that, later on, it might be too late to stop the warming trend.

4) A possible compromise might include making some of the changes suggested by Scientist 1 to help increase energy conservation, while continuing to do research as Scientist 2 suggested.
5) Opinions will vary. Note that decisions about climate change, like decisions about many complicated environmental issues, are often based on information that may not be as complete as people would like. Values that people have also influence their decisions.
6) It's important to stay informed about scientific issues so that you can better understand problems and can change your daily behaviors to help solve problems.

Extensions

Community

• Have students contact local auto dealers, appliance showrooms, and heating/cooling repair services and determine if their products still contain CFCs. Find out what steps are being taken or have been taken to phase out CFC use in their community. Alternatively, the instructor could locate these individuals in the community and invite them into the classroom for a presentation/discussion.

Multidisciplinary

• Have students research the topic further, exploring different people's points of view. With this expanded information, hold either a debate or a town hall meeting and have students take on the point of view they researched.

Technology

• Have students locate a scientist via the internet and research the methods that he/she used or could use to study the effect(s) of CFCs.

Resources

• *Air Facts - Air Quality Monitoring*
Information on levels of air pollution in Illinois and how they are monitored.
IEPA (see form in appendix)

• *Benefits of the CFC Phaseout*
The CFC phaseout is already producing benefits for the environment, businesses, and individuals.
http://www.epa.gov/ozone/geninfo/benefits.html

• *Cycles of the Earth and Atmosphere, A Website for Teachers*
On-line teaching module for middle school science teachers. The content focus is climate change and issues related to both stratospheric and tropospheric ozone.
http://www.ucar.edu/learn

• *Global Warming: Early Warning Signs*
A science-based world map depicting the local and regional consequences of global climate change.
http://www.climatehotmap.org/index.html

• *Illinois Annual Air Quality Report*
This report highlights information obtained from the Bureau of Air's statewide air monitoring network.
http://www.epa.state.il.us/air/air-quality-report

• *Ozone Depletion: Myth vs. Measurement*
A series of responses to the most common misunderstandings about ozone depletion
http://www.epa.gov/ozone/science/myths.html

• *Project A.I.R.E - Air Pollution Background Information* (PDF Version)
Fact sheet on air pollution and ways to detect and prevent it.
http://www.epa.gov/region01/students/pdfs/rd_airpol.pdf

Adapted From: "A Heated Controversy," Environmental Education in the Schools. North American Association for Environmental Education/Peace Corps. Washington D.C. 1993.

Scientist 1—It's Warm in Here or is It?

One Point of View on
Global Climate Change
by Scientist 1

It's time to face the facts—the increasing amounts of carbon dioxide and CFCs in the atmosphere are making our planet's climate warm up. We see the warning signs in our increasing world temperatures. The 1990s was the hottest decade in recorded history. While this isn't proof that global warming has begun, it certainly should warn us that something is happening to our climate.

Over the past 100 years, average world temperatures have risen by about 1°F. That may not seem like much of an increase, but keep in mind that temperatures today are only about 9°F warmer than they were during the last ice age. It takes only a small change in temperature to cause big changes in our world. If we continue to put as much carbon dioxide into the atmosphere as we do now, the world's average temperature may increase by 3° to 10°F within 50 years. If temperatures do rise, we can expect some drastic changes to take place. As temperatures go up, polar ice caps will melt, sea levels will rise and many coastal areas will become flooded. The warming could make droughts occur more often in certain areas. Some places, like the Midwest, could become so hot and dry that many crops couldn't grow there anymore. All over the world, plants and animals may not be able to adapt quickly enough to the sudden changes in their habitats. Some species could even become extinct.

Some people claim that we should wait until we're absolutely sure of global warming before we do anything to control it. I disagree. If we wait too long, it may be too late to prevent damage from the warming trend. Besides, many adaptation policies make good sense even without climate change. They preserve resources, diversify our sources of fuel, and increase our general quality of life.

We should cut carbon dioxide production by at least 20 percent and phase out CFCs now. Since people in the United States produce a lot of the carbon dioxide and CFCs that go into the air, we have to set an example for the rest of the world. We must develop safer chemicals to replace CFCs. We have to switch to solar power and other alternative energy sources. Until we make that switch, we have to use less fossil fuels. Industries that continue to use coal and other fossil fuels must become more energy efficient. These industries should be taxed for the excessive carbon dioxide they release. A higher tax should also be placed on gasoline to encourage people to drive less. Car makers should be required by law to make cars that get better gas mileage. Agriculture and waste disposal processes must change so that we release less methane into the atmosphere.

Individuals must do their part, too, by using cars less and public transportation more, and by buying more energy-efficient appliances and cars. The burning of the tropical rainforest must stop as well. By preserving these forests, we can reduce carbon dioxide emissions caused by the burning and save the trees and other vegetation that help absorb carbon dioxide.

It will cost money to make some of these changes. But it's better to pay the price now—not later, when the effects of global warming can't be reversed.

Scientist 2—It's Warm in Here or is It?

Another Point of View on Global Climate Change by Scientist 2

There's been a lot of concern lately that the world's climate is warming up. Some scientists say that the increased amounts of carbon dioxide and CFCs in the atmosphere are causing this global warming. According to them, the only way to avoid global disaster is to cut carbon dioxide emissions by at least 90 percent—a move that would affect people all over the world.

I say there's not enough scientific evidence to back up this call for drastic action. Let's consider the facts. It's true that there's more carbon dioxide in our atmosphere than there used to be and that we have added gases, such as CFCs, that were never part of our atmosphere before. But there's just not enough evidence to prove that these gases are making the world warm up. In the past 100 years, average world temperatures have risen by only 1°F. This hasn't been a constant rise. Between 1940 and 1970, world temperatures actually dropped, and some scientists suggested that another ice age might be on the way. This latest rise could be just another small change in a natural climate cycle.

There is also some evidence that the temperature differences that are being documented are not as widespread as first believed. For example, although ground temperatures have risen slightly, there does not appear to be a corresponding rise in temperatures in the upper atmosphere, according to satellite data. This could mean that the weather patterns we are seeing are caused by changes on earth, rather than by greenhouse gases.

It's very important to keep in mind that many of the predictions about the effects of global warming are based on various theories. Scientists have come up with these predictions by plugging information about our atmosphere into computer models. The models make predictions about what will happen if we add certain amounts of carbon dioxide and other gases. The problem is, different computer models can give you different answers! Some models have predicted that the increase in carbon dioxide will cause more clouds to form. These clouds would block sunlight and cancel out much of the warming. And according to other models, it's possible that the earth's huge oceans will absorb any extra heat. We just don't know enough yet about how our atmosphere works.

Because of this uncertainty about what is really happening in our atmosphere, I believe we need to do more research before we make any big changes. To significantly cut the amount of carbon dioxide we put into the atmosphere would make life harder for many people—especially those living in less developed countries. How can we ask them to cut back on releasing carbon dioxide when they're just now getting cars and factories that people in more developed countries have had for so long? In the United States, cutting carbon dioxide production would cost billions of dollars each year. Forcing industries to stop using fossil fuels might drive smaller firms out of business and hurt people in regions where coal mining provides many jobs. We must do more research before we make any changes that, in the end, may cause more harm than good.

Name: _____

It's Warm in Here or is It? - Student Worksheet

After reading the statements of the two scientists, answer the following questions:

1) What are the main points brought up by each scientist?

The main point of scientist 1 is _____

_____

The main point of scientist 2 is _____

_____

2) What are the advantages and disadvantages of the alternative presented by Scientist 1?

Advantages:_____

_____

Disadvantages: _____

_____

3) What are the advantages and disadvantages of the alternative presented by Scientist 2?

Advantages:_____

_____

Disadvantages: _____

_____

4) Can you think of a course of action that is a compromise between the two plans presented by the scientists? _____

_____

_____

5) What do you think the best course of action is? Why do you feel this is the best thing to do?

_____

_____

6) Do you think it's important to stay informed about scientific issues? Why or why not?

_____

_____

Where Water Wanders

Subject: Language Arts
Science

Skills:
- Creative Thinking
- Reporting/ Presenting
- Researching
- Collaborating
- Evaluating

Concepts: 3. M, P, R

Objectives: Students will:
1) understand where their domestic water originates, how it reaches them and where it goes after use.

2) be able to explain the movement and management of water in their own words.

State Standards:
Language Arts: 4.B.2 b
5.C.2 b
Science: 11.A.2 c, d, e

Vocabulary:
- aerobic bacteria
- aquifers
- coagulation
- floc
- groundwater
- surface water

Setting: Indoor & Outdoor

Materials:
- access to informational resources

Time: One week or more

Activity Overview

Students will research, create and develop a presentation in which they explain how water gets to them and where it goes after being used.

Background

Safe drinking water is something most people take for granted. It's easy to see why. What could be more simple than turning on the tap and getting a drink of water? But behind each gallon, behind each drop, are the efforts of scientists, engineers, legislators, water plant operators and regulatory officials. It is their job to keep the water clear, clean, abundant and safe.

Our drinking water supply comes from two sources—**groundwater** and surface water. Groundwater comes from the reserves of water hidden underneath the earth in **aquifers**. **Surface water** is the water in rivers, streams and lakes.

Where Does Our Drinking Water Come From?
In Illinois and many other states, many early settlements were near surface water sources. As communities grew, people were forced to move farther away from rivers and lakes. Those people who lived some distance from lakes and rivers also needed a good, clean and easily obtainable supply of water. To get a steady supply of water, people dug wells. Most wells today are dug with powerful drills, but for hundreds of years they were dug by hand. Wells continue to provide water for many communities and individuals.

What Happens to Water Before It Comes Out of the Faucet?
The answer to this question depends on where you live. Of those people who live in rural areas, many get their water from a private well drilled on their own property. These wells may range from 40 to several hundred feet deep to reach suitable water, depending upon the local geology. People with private wells generally have a water treatment unit in their home, such as a water softener or a filtration system.

About 1,800 community public water supply systems deliver more than 1.77 billion gallons of safe, clean drinking water to Illinois water consumers each day. The majority of public water suppliers (water companies) pump water from wells

for treatment and distribution to customers. People living in the Chicago area receive treated drinking water from Lake Michigan.

The Drinking Water Treatment Process
The drinking water treatment process can be broken down into seven steps. Here is how a water treatment plant works.

Intake: Water from a surface source, such as a lake or a river, is channeled into a treatment plant. Intake screens strain out large debris such as fish, plants and sticks. If the source is groundwater, the screening process is done by nature because the water is cleaned by travelling through layers of sand and rock, so water is pumped directly to the plant.

Pre-Treatment: Chemicals such as chlorine, alum, and lime are added to the water to remove impurities, soften the water, and destroy bad taste, colors and odors. Lime is added to remove minerals, which leave deposits called "scale."

Mixing: The water is next stirred by large mechanical mixers to blend the chemicals through the water.

Coagulation and Flocculation: The water then travels to a large basin. Some of the chemicals cling to the impurities in the water (**coagulation**), forming large, heavy particles. These particles are called **floc**. They settle to the bottom of the sedimentation tank.

Filtration: From the sedimentation basin, where most of the floc has settled to the bottom, the water travels through sand beds which filter the water to remove any impurities that are left.

Chlorination: Chlorine is added to kill bacteria and prevent more bacteria from growing as the water travels to the consumer. Most water treatment plants also add fluoride at this point (to prevent tooth decay).

Distribution: After the water is cleaned, it is stored in large, elevated tanks (water towers), or covered reservoirs. The water then travels through large pipes called "mains" to houses, schools, and businesses.

Rural Wastewater Treatment
In rural and some suburban areas with suitable soils, wastewater or sewage from each house is usually discharged into a septic tank. In the septic tank, larger solids settle to the bottom while grease and oils rise to the top and are trapped. These are periodically removed by pumping to prevent overflow and backup into the house. Connected to the septic tank is a drain field that allows the soil to filter out microorganisms and particles from the wastewater.

Urban Wastewater Treatment
In urban areas, wastewater is carried by sewer pipes to a wastewater treatment plant. These plants can provide up to three different levels of purification.

Primary Sewage Treatment
In this level of treatment, large debris such as sticks or garbage are eliminated by large screens. The remaining water is held in a tank where suspended solids are allowed to settle to the bottom and are later removed. Bacteria are killed by treating the water with chlorine.

Secondary Sewage Treatment
This level incorporates all of the steps of primary treatment but also exposes the wastewater to biological processes. Water is held in a tank where **aerobic bacteria** remove organic wastes.

Advanced Sewage Treatment
This type of treatment includes the use of

special chemical or physical mechanisms to remove pollutants from wastewater. This more expensive treatment is usually necessary to protect Illinois streams.

Preparation

1. Review the background information.

2. Arrange for a field trip or a visit from a guest speaker to take place two days after giving the students the assignment. The field trip can be to a reservoir, water treatment plant, or water pumping station; guest speakers could include representatives from your local water utility or businesspeople involved in the drilling of private wells.

Procedure

1. Ask the students if they know where their drinking water comes from. Try to have them get as specific as possible in their answers. (For example, is the water stored in a reservoir prior to coming to their homes? Do they know where their well is located on their property? Does the community get its water from a lake or river?) Ask them if they know what happens to water in their homes after it goes down the drain: does it wind up in a septic tank, or is it connected to a municipal sewer system?

2. Give the students the assignment of discovering and learning the exact steps and processes that water goes through on its way to their homes. Remind them that different homes may have different water supplies, and that they are to answer regarding their own homes, not their friend's or classmates'. Instruct them to determine every step along the way: how water is purified, how it is transported, where it is kept, and so forth. They are to write their findings in a one- or two-page composition.

3. Two days after giving the assignment, take the students on a field trip to a water-related facility, or have a guest speaker come to class. Try not to announce the speaker to the class in advance. Encourage them to ask questions and to use this as an opportunity to determine the accuracy of the research they have completed thus far.

4. Give the students one more day to finish their research. When the students turn in their papers, ask them in class to explain how water first gets to their homes. As they provide answers verbally, elaborate on their answers and diagram the process on a chalkboard. Do the same with the question of where water goes.

5. Divide the class into groups of four or five students. Tell the class that each group is going to develop a creative way to communicate the water purification cycle that they have just diagrammed. Each group must select how they wish to communicate the information. They are allowed to use any means they want to, as long as it can be shared with the rest of the class. Also, each member of the group must have a role in the performance. For example, if a group decides to write a story, then each member should be involved in reciting the story. Assign a reasonable time in which groups can create their presentations.

6. Give students time over two to three days to prepare and practice their presentations.

7. Have the groups present their original presentations in front of the class (or possibly to another class or grade level.)

Wrap Up

Assessment

Prior to the presentations, instruct the students that they will be rating each other's work on set criteria. Have them grade each presentation in the following areas: Creativity; Accuracy; Completeness; and Clarity of Communication. Each student must also state what they liked about each presentation, what

they learned from each one, and what they would have the team improve upon.

Extensions

Multidisciplinary

Have the class (or some of the groups) research how wastewater was handled historically, either by settlers or by Native Americans. Have them do a similar type of presentation to the class.

Technology

Have the students discuss water conservation. Briefly review some of the technology that is available to help consumers conserve water. Have the students think of new products or mechanisms that will reduce the amount of water that is consumed in their homes or the community.

Outdoor

Have the students visit a local wetland. Use the visit as an opportunity to discuss, compare and contrast how nature and humans purify and recycle water.

Resources

• *Groundwater Protection Education Materials*
A list of groundwater brochures, booklets, audiovisuals, displays, and other materials available from several state agencies.
IDNR, Clearing House, One Natural Resources Way, Springfield, IL, 62702, 217-782-7498. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm.

• *H2O Below: An Activity Guide for Groundwater Study*
An educational curriculum for grades 3-12 developed as part of the Illinois Middle School Groundwater Project.
IDNR, Clearing House, One Natural Resources Way, Springfield, IL, 62702, 217-782-7498. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm.

• *Water Quality: Potential Sources of Pollution*
This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html.

• *Groundwater and Land Use in the Water Cycle*
This 24" x 36" color poster graphically displays various land use practices and geologic formations. Order online at: www.dnr.state.wi.us/education.

• *There's More Than One Way to Save Water*
A pamphlet that lists methods of conserving water. IDNR, Division of Education, One Natural Resources Way, Springfield, IL, 62702, 217-524-4126. To order online, go to http://dnr.state.il.us/publications/Freebies1.htm or www.dnr.state.il.us/lands/education/index.htm.

• *Kids' Stuff*
USEPA's Office of Groundwater and Drinking Water has compiled resources especially for kids to learn more about drinking water, including games, activities and experiments. www.epa.gov/safewater/kids

• *Consumer Confidence Reports*
Provides an Annual Drinking Water Quality Report that is broken up by public water supplies. It includes detection of regulated contaminants, if there is a violation or concern for each contaminant, and the likely source of contamination. http://epadata.epa.state.il.us/water/bowccr/ccrselect.aspx

Pointing to Point and Nonpoint Pollution

Subject: Science
Language Arts

Skills:
- Analysis
- Reading
- Deductive Reasoning
- Problem Solving

Concepts: 1. A , E 2. J, K
3. A, D, J, O,P

Objectives: Students will:
1) understand the difference between point and nonpoint source water pollution.

2) identify types of point and nonpoint source water pollution.

State Standards:
Language Arts: 1.B.2 b, d
1.C.2 d
Science: 13.B.2 b, f
Social Studies: 17.B.2 f

Vocabulary:
- nonpoint source pollution
- point source pollution
- sediments

Setting: Indoor

Materials:
- a copy of the Genuine Water Who-Done-It worksheet for each student (p. 79)

Time: One class period

Activity Overview

Students will read a mystery story involving numerous types of water pollution and will use their knowledge and reasoning skills to solve the mystery.

Background

The sources of water pollution can be divided into two main categories. These categories are point sources and nonpoint sources. **Point sources** are those where the pollution comes from a single identifiable source, such as a sewage treatment plant or an industry. These sites can be easily managed because you can tell who is creating the pollution.

Unfortunately, much of our water pollution comes from a multitude of different sources; there is no one point where the pollutants come from. This is called **nonpoint source pollution**. Some nonpoint sources are:
- runoff from farms
- runoff from city streets
- erosion from construction sites and stream banks
- overflows from city sewers

Nonpoint source (NPS) pollution may not be a familiar word to most of us. The symptoms, however, are familiar: green, weed-choked lakes, muddy rivers, and eroding banks of rivers, streams and lakes. In Illinois, some 35 percent of the streams and 84 percent of lakes have suffered from NPS pollution.

Effects of Sediments on Lakes, Rivers and Streams

Sediments are soil particles that erode from cropland, construction sites and stream banks. Sediments also include flakes of metal and broken pavement that wash off city streets. When these particles reach lakes, rivers and streams they do more than turn the water brown.

Sediments:
- Cause the water to become cloudy, making it difficult for fish to see and feed properly. Sediments also can damage fish gills and the feeding and breathing of aquatic insects.

- Flow into the water and build up on the river and stream bottoms. They cover spawning habitat where fish and

aquatic insects lay their eggs on the gravel bottom.

- Contain millions of soil particles. In moving water, these particles can act like a scouring pad and remove aquatic plants and animals from their habitat.

- Cause streams and rivers to become shallower and wider, which leads to flooding problems. The shallow water is also heated more by the sun. This causes water temperatures to rise; in time, cold water fish such as trout cannot survive, and only warm water fish, such as carp, are found.

- Increase the chances of boats and swimmers getting stuck in the mud of a lake or river. Muddy swimming areas can be dangerous as well as ugly.

- Cloud the water, reducing the amount of sunlight that reaches into the water. This affects the process called photosynthesis. Without photosynthesis, plants, including algae, cannot survive. This reduces the amount of oxygen available and leaves no place for fish and small organisms to live or find food.

- Harm duck and goose populations by filling in wetland areas that are used for breeding.

- Carry toxic materials that can contaminate small organisms. When fish and waterfowl eat these small organisms, the toxins build up in their bodies and can cause illnesses, birth defects and even death.

Effects of Nutrients on Lakes, Rivers and Streams

Nutrients cause the over-fertilization of lakes, rivers and streams. This leads to an increase in plant and algae growth. Plants are needed in water, but too many plants and algae are harmful to fish and make a lake less attractive for swimming, boating and other activities. Nutrients come from sediments, manure (including pet wastes) and the fertilizers used on lawns or farm fields. When these nutrients reach our lakes, rivers and streams they do more than turn the water green with plants and algae. Excess algae can reduce the amount of bottom-rooted plants by blocking sunlight. Bottom-rooted plants provide food and habitat for fish and waterfowl.

When algae and aquatic plants die they are broken down by bacteria through a process called decomposition. Bacteria take in oxygen during decomposition, which removes oxygen from the water. This makes it difficult for fish and other aquatic life to survive.

When materials such as manure, leaves and grass clippings enter a lake, river or stream, they too are broken down by bacteria. The decomposition of these materials reduces the amount of oxygen in the water and may release a gas called ammonia. Low oxygen levels and ammonia combined with warm water temperatures can kill fish.

Preparation

1. Make enough copies of the student worksheet "A Genuine Water Who-Done-It" (p. 79) so that there is one per student.

2. Review background material.

Procedure

1. Have students brainstorm what water pollution is and where it comes from. Explain the difference between point and nonpoint source water pollution, and give some examples of each. Have them organize their thoughts on water pollution and where it comes from according to these two main categories.

2. Hand out the student worksheet and tell the students that they are to refer to it as you read them the story "A Genuine Water Who-Done-It." Explain that they should not attempt to solve the mystery without hearing the com-

plete story. It may be helpful for them to take notes on the back of the worksheet to help them organize the information and keep track of the suspects.

3. Have students read the story or read the story aloud to the class, pausing at times to allow them to reflect on the information or to write down notes.

4. After hearing the story, students should circle on the worksheet who they think the culprit or culprits are and indicate why.

5. Ask the students to list all of the suspects or possible causes of pollution in the lake. The list will probably include some or all of the following: Ms. DeRose, Mr. Penn, Mr. Who's bakery, Farmer Tress, Acme Widget, the construction site, the disposal company, the snow plow.

6. Assign each of the suspects to a different place in the classroom (for example, Mr. Penn by the window, Ms. DeRose under the clock). Instruct the students, at your signal, to get up and stand in the part of the room which corresponds to the person they think was most responsible for the lake being polluted. Tell them they must go to the place they circled on their worksheet. If there are students who believe there was more than one cause, have them form a separate group.

7. Have the groups which have assembled by each suspect decide on a single main reason why they believe that person (or cause) is most responsible. Have each group select a spokesperson to explain their reason to the rest of the class. (If there is a group of students who felt there was more than one person responsible, have that group present last.)

8. Read the following answer, discuss it with the class and get their responses.

"A *Genuine Water* Who-Done-It" Answer:
What Findit discovered is that the lake has been contaminated by pollutants from a number of sources. The factory, though, was not one of them.

The sources that Findit identified during his ride were these:
1. Waste oil dumped onto the ground.
2. Oil, gasoline, and other pollutants from the road washed onto the soil and down the slope to the lake.
3. Possibility of leakage from underground storage tanks below Mr. Who's bakery shop.
4. Pesticide runoff from the farm fields.
5. Fertilizer runoff from Ms. DeRose's garden.
6. Sediment from the construction site.
7. Runoff from Well's ducks' wastes.

Findit did not have time to research the company that handled Acme's hazardous waste. If this was a reputable and law-abiding firm, there should have been no connection to the pollution in the lake. However, if the company disposed of the wastes illegally (such as dumping them down a storm drain or storing them in corroded or insecure containers), then it too could have contributed.

Wrap Up

Assessment:

• Have the students select one character (possible culprit) from the story. Instruct them to research the particular kind of pollution that the character contributed, and develop a way that the character could keep that pollutant from entering the lake. (Note: having the characters move or go out of business are not acceptable answers.) Have them write or draw their ideas or present them to the class.

Extensions

Community

• Find out if there is a similar mystery at a lake, river, or stream in your community. Take the students on a field trip for a water body

clean up. While there, have them try to identify possible sources of water pollution in the area. Have them perform a water quality assessment by checking for indicator species or performing chemical tests for dissolved oxygen, phosphates, and nitrates.

Multidisciplinary

• Have the students turn the story into a brief play, which they can then present to other classes. Alternatively, they can put on a mock trial with one of the characters as a defendant.

Outdoor

• Have students develop a list of possible nonpoint sources of pollution in and around the school. From this list each student is to develop one or two bingo-type cards, with potential pollution sources in the place of numbers. Students trade cards with each other so that no student has his or her own card. The class then goes on a walk around the school ground, getting tokens each time they pass a source mentioned on their card. The winner is the first one who gets four or five in a row.

Technological

• Have a local water quality professional (water well inspector, water utility representative, state water scientist with the IEPA or IDNR, etc.) visit the classroom. Have them explain how they monitor and protect fresh water supplies. Ask him / her to bring some of the tools and equipment they use for water quality measurement so students can see how technology plays a part.

Resources

• Water Quality: Potential Sources of Pollution, Middle School Edition

This 24" x 36" color poster depicts point and nonpoint sources of pollution. The reverse side contains two activities, Dispersion of Nonpoint Pollutants and How Substances Are Measured in Water. Available online at: http://water.usgs.gov/outreach/OutReach.html

• Illinois Water Quality Report

Provides information on Illinois watersheds and compares water quality of each area to statewide data.
www.epa.state.il.us/water/water-quality

• Clean Water Act

A historical overview of the Clean Water Act, the primary federal law that protects our nation's waters, including lakes, rivers, aquifers and coastal areas.
www.epa.gov/region5/water/cwa.htm

• Nonpoint Source Pollution

A fact sheet about nonpoint source pollution, the nation's largest source of water quality problems.
www.epa.gov/OWOW/NPS/facts/point1.htm

• Water Science for Schools

This site provides extensive background information on a wide variety of water topics. It also includes on-line activities, data tables, maps and a glossary of terms.
http://ga.water.usgs.gov/edu/

• World of Fresh Water (PDF version)

Use these activities to help your students understand the effects of pollutants on lakes, rivers, and streams. Grades 4-6.
www.epa.gov/ORD/WebPubs/fresh/fresh.pdf

A Genuine Water Who-Done-It

Inspector Findit's lunch was interrupted by an urgent call from his old friend, Don D. Well, a retired Hollywood duck trainer.

"Findit, come quickly!" Don said over the phone. "I need your help right away!"

Findit finished his sandwich and hopped on his bicycle. He quickly rode the two miles down the road to Well's house. Well lived on the shore of Lake Pez, where he had a small fishing lodge and duck training center.

"What's the problem?" asked the inspector.

"Here's the problem," Don said, "Someone has poisoned my lake!"
"What? Are you sure?"
"Absolutely. Look at this. I keep finding fish washing up on the shore or floating in the water." He showed Findit a bucket full of fish, both large and small. "I found all of these just this morning. Fish don't just die like this. Something weird is going on here!"

"But why would someone poison your lake? You don't have any enemies here, do you?"

"Not that I know of, but there may be some people out there who are jealous of my ducks. They were quite a big hit at the Oscars last year. Unless it's the widget people."

"Who?"

"That widget factory on the other side of the lake. You should see their smokestacks— always billowing smoke and steam and stuff."

"But what has that got to do with your fish, or your ducks? And why would they pick on you?"

"With all that pollution coming out of the stacks, there must be something going on there. I don't know why they'd single me out for this treatment, but that's what I want you to find out."

Findit left and went back to his bicycle, almost stepping in several piles of duck droppings along the way. He decided to ride around the lake and see if anyone had seen anything unusual. The first person he came across was Mr. Penn, who was working on his car.

"No, I haven't seen any suspicious people around here," said Penn in response to Findit's question. "And I'd probably see somebody, too. I change my oil a lot, so I'm out here working on my car frequently."

Findit noticed that while he was talking, Penn was pouring a pan of used motor oil on the ground next to his driveway. "Say, are you sure you're supposed to do that?" Findit asked.

"What do you mean?" said Penn, "It's my property, and so far I haven't noticed it hurting the grass or the flowers. Besides, it's not as though I was dumping it down the storm drain or anything."
"Hmm," thought Findit as he walked away, "I might have a suspect."

The next person he met was Ms. DeRose, who was in her garden.

"No, I haven't seen anybody either," she replied, "and I'm out in my garden a lot these days, so I'd see somebody suspicious."

"Those flowers are quite large," said Findit. "How do you get them to grow in this area? Isn't the soil too harsh?"

"Oh, heavens yes. That's why I use so much of this special fertilizer. I practically have to pour it on, but as you can see it works wonderfully." Findit noticed that, as Ms. DeRose watered, the garden plots overflowed somewhat, and a mixture of fertilizer and water spilled out into her yard.

"Hmm," he thought, "another suspect."

Farther down the street, he decided to stop in at Mr. Who's bakery for a donut. He asked Mr. Who if he had seen anybody suspicious in the area.

"No, I haven't seen anybody like that around here. In the year since I built this place, most of the customers I've had have been regulars—you know, people from the area, commuters stopping in on their way to work, or Well's usual customers."

"So, a lot of people drive by here, huh?"

"Oh yes, quite a few. And you know what bothers me? Some of these people leave their cars running while they come in here to buy donuts. I look outside and see all that smoke in the parking lot—icck!"

"You know, I don't think I noticed your shop last time I came here. You say you just built this place last year?"

"Yes, it used to be a gas station, but it went out of business. I bought the property, put up this shop, and things have been going well."

"A gas station, you say. Did they remove the storage tanks when they moved out?"

"Hmm, I don't think so. There really wasn't time."

"Another suspect," thought Findit as he walked out munching on a bear claw.

Next on his journey he came across Farmer Tress, who was getting ready to get into his cropduster.

"Now that's odd, 'cause if anybody was trying to poison Don's lake, I'd know it."

"How?" asked Findit.

"My cousin Rick owns the cornfield across the lake from Well's place. I fly the plane over there a lot to spray. I can see the whole lake from up there. If somebody was there, I'd see it."

"Hmm," thought Findit as he rode away. "Another suspect."

Finally, he arrived at the Acme Widget Plant. He asked to speak with the plant manager about how wastes were handled.

"We have a very elaborate system for that," the manager, Ms. Robinson, explained. "Of course, we're connected to the local sewer system, so most of our organic wastes go there. We do generate a small amount of toxic waste, though. We try to keep it to a minimum, but we do have paints and solvents involved in our work. We keep those in a special area of the plant, and then have them removed once a week and taken to a hazardous waste disposal site."

"And who does that?" asked Findit.

"We have a contract with a disposal company. They pick it up and make all of the arrangements."

After taking a brief tour of the plant, Findit got back on his bicycle and rode back to Well's house. As he rode along, he noticed a construction project on the road that wound around the lake. A large number of trees had been pulled out, and there appeared to be soil and dirt eroding the slope down to the water.

As he rode along, he noticed several other places where the grass and vegetation on the side of the road closest to the lake was either dead or browned. He thought he noticed a slight grade in the road, making it slant slightly toward the water.

This might be another clue, he thought.

"Hey, Don," he said as he came back to the house, "I have a question. Does this road out in front get plowed in the winter?"

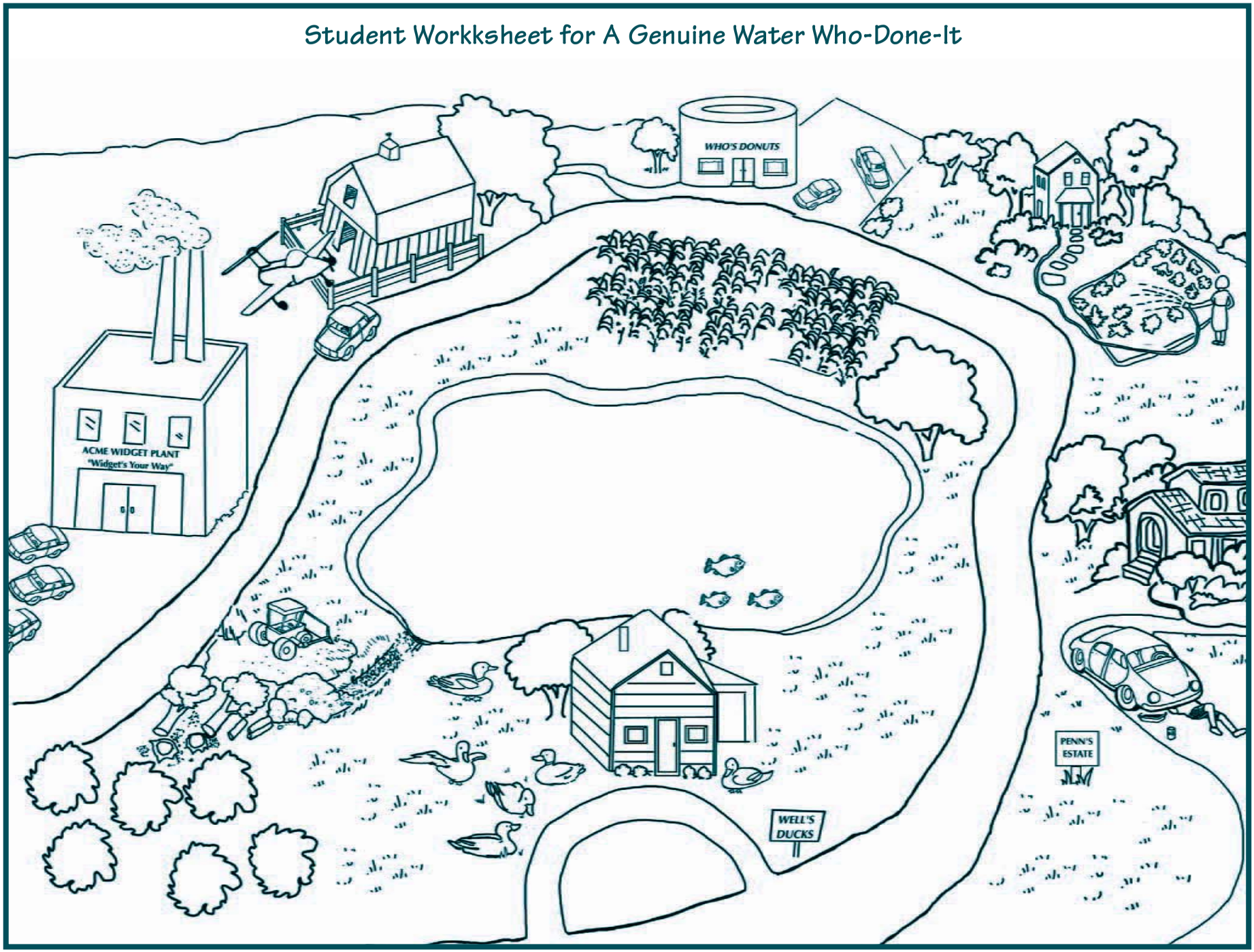
"It gets plowed and salted both. That's a real busy road there. Sometimes they plow so much they scrape everything off the road, snow, sand, oil, you name it."

Findit spent a few minutes looking at his notes and then said, "Well, I've solved the mystery."

Who poisoned the lake? And how did Findit know?

An Original Story by: John Vymetal-Taylor, 2000.

Student Workksheet for A Genuine Water Who-Done-It



Hasting to Waste

Subject: Science

Skills:
- Observing
- Hypothesizing
- Measuring
- Comparing/ Contrasting

Concepts: 1. D, P, R
3. H, J, L

Objectives: Students will:
1) design a landfill and observe what happens to materials when placed in it.

2) recognize that materials and design can affect the integrity of a landfill.

State Standards:
Science: 11.B.2 c, d, e
11.A.2 a, b, c, d, e

Vocabulary:
- incinerate
- leachate

Setting: Indoor

Materials:
- clear 2-liter bottles (one for every three students)
- rulers
- scale(s)
- soil, sand, clay
- assorted trash items (organic and inorganic)
- graduated cylinder
- plastic wrap
- plastic gloves
- food coloring
- Student worksheets (pp. 85 and 86)

Time: One class period for set up, one period three weeks later and 10 minutes every other day

Activity Overview

In this activity students will design models of leakproof landfills and will observe how each functions.

Background

Waste Management - A Problem for All of Us

Garbage! It's a problem all right, but someone else's—not mine. That's the reaction that some of us have. And yet, have you ever counted how many garbage bags and trash cans your family puts out on collection day, or noticed how much trash you and your classmates throw away each week?

Food scraps, newspapers, candy wrappers, milk cartons, and cardboard boxes are among the hundreds of items that people throw away. The average person in Illinois throws away 6.6 pounds of garbage every day. About a third of that is packaging waste, and about 10 percent of it is food waste. This adds up to two tons of food waste generated by the average person by the time he/she is 18 years old, five tons by age 45 and eight tons by age 74.

Even more garbage or waste is generated each time we eat at a restaurant, go to the ball park or visit the doctor. Industries that make the things we like to use, such as bicycles, toys, baseballs and computers, add to the mountains of trash. We wouldn't have many of the things we buy or use without producing this waste.

Solid Waste

Solid waste is paper, food scraps, old stoves and other garbage that people throw away, personally take to the landfill and set out at the curb for garbage trucks to haul to landfills. Each year in the United States 209.7 million tons of municipal solid waste is generated. What should we do with it?

Litter

If we toss garbage away carelessly, it litters the roads, ravines, ditches and waterways. Litter is a form of land pollution and open dumping is illegal.

During a three year research project done by Keep America Beautiful, Inc., it was found that people litter for one of three reasons:

- they feel no sense of ownership for the property
- they believe someone else (a park maintenance or highway worker) will pick up after them
- litter has already accumulated

Although motorists and pedestrians are most often blamed for litter, Keep America Beautiful, Inc. identified seven sources that contribute to the problem: commercial refuse sources, including dumpsters; household trash handling; construction/demolition sites; uncovered vehicles; loading docks; motorists; and pedestrians. From these sources, litter is carried in every direction by wind, water and traffic. It moves until trapped by a curb, wall, fence, a row of trees or other stationary object. Once trapped, litter becomes not only an eyesore, but an invitation for people to add more.

Sanitary Landfills or Landfilling

If we dump trash in open areas, it smells bad, looks ugly, attracts rats and insects, and may be hazardous. Since 1970, when the IEPA was created, most open dumps have either been closed or turned into modern sanitary landfills. Such landfills have been constructed to hold wastes and to keep them from contaminating surface and ground waters and soil.

A sanitary landfill is lined with clay and thick plastic sheeting to prevent leakage. Rainwater can mix with other liquids created by decomposing garbage to produce leachate. Leachate can contaminate water supplies if it leaks out of the sanitary landfill. To prevent this, landfills are constructed so that **leachate** drains into collection pipes, then is pumped into a collection system to be treated. As trash slowly decomposes, gases, chiefly carbon dioxide and methane, are produced. These gases can build up and eventually escape into the air. To prevent this from happening, the gases are vented safely through pipes or energy recovery systems. Every day as garbage is brought to the landfill, it is spread and crushed by a bulldozer or compactor. At day's end, the garbage is covered by a layer of soil to cut down on odors and to keep insects and rodents away. Groundwater monitoring wells are dug near the landfill to check water for contamination.

When landfills reach their capacity (become filled), they are capped with a seal of clay and two to five feet of soil, and grass is planted on the site. Some closed landfills are turned into parks, playgrounds, golf courses and even ski slopes. Landfills are tested for leachate and gas control for many years after they have been closed.

Unfortunately, there are a few problems at landfills. If landfills are not properly designed, managed and inspected, they can cause pollution problems. It is hoped that in the future, there will be less need for new landfills, as people use less, and reuse and recycle more.

Incineration

To **incinerate** means to burn something to ashes. The ashes from waste burned in an incinerator take up less space in our landfills than unburned waste; this extends the life of our existing landfills. Burning waste can create heat, which may be used to produce steam. The steam can generate electricity for homes and businesses. Incinerators such as this are referred to as waste-to-energy plants.

Ash from the incinerator must be tested for hazardous qualities and disposed of in a landfill. Some special landfills are made just for ash disposal. Gases produced by incineration must be controlled through complex filter systems to control air pollution. Not all materials can be incinerated.

Preparation

1. Make copies of the student worksheet, so that there is one per team. (pp. 85, 86)

2. Carefully cut the tops from the clear 2-liter bottles so that you form a cylinder open at one end.

3. Pour two inches of sand in each of the bottles.

4. Gather a small amount of garbage, both organic and inorganic. The lunch room may be a good source of identical garbage that is the same age (banana peel, juice box, straw, potato chip, paper clips, tooth picks, etc.).

Procedure

1. Ask the students to explain what garbage is. Ask them for examples of what goes into their garbage at home. Have them explain why these things are thrown away. Ask them if they know where their garbage goes once it leaves the dumpster or curb. Once the concept of "dump" or sanitary landfill has been mentioned ask students to explain:
   - Why do we use landfills? Why don't we just leave garbage in plain view?
   - How is a landfill formed? Is garbage just thrown in or are there special processes to consider?

2. Explain to the students that they will replicate how landfills work and will perform experiments to check for effectiveness and design. Explain to the class how a sanitary landfill is structured and discuss the components that are necessary for its success.

3. Divide the class into three teams. Assign each a number from 1 to 3. Tell teams with the number 1 that they will build a "no-frills" dump without any sort of liner. Team 2s are asked to design a landfill with a plastic liner. Team 3s are asked to design a landfill with a clay liner.

4. Give each team a student worksheet.

Have the teams draw their landfill models. Teams should be sure to include the necessary layers and indicate the thickness of each layer in inches on the worksheet (for example, 2 inches of sand, 1/2 inch liner (if provided) 2 1/2 inches of soil, 2 inches of garbage, 1 inch of soil to top it off). Teams can be creative; the thickness and number of the layers can vary, but they must all start with a two-inch base of sand and must have all of the following:

a) clay or plastic (if provided) = liner
b) garbage (organic- food or plants, and inorganic - plastic or synthetic)
c) soil = daily cover layer

Have students develop a hypothesis to state what they think will happen to the garbage in their landfill.

5. Distribute the two-liter bottles with the two inches of sand already in them. Distribute the plastic and clay to the appropriate groups. Have a supply of soil and garbage for all groups.

6. Have teams write their names on the bottles with tape or permanent markers. Have teams assemble their landfills based on their drawings.

7. Teams should weigh their models and record the weight on their worksheets.

8. Models should be stored in a warm area away from sunlight.

9. Every other day, give the students time to inspect their landfills for any sign of change. Have them measure the weight and changes in height and record these findings on their worksheets. Once a week, have students pour in 50 ml of water (to simulate rain). Make sure

to have students weigh their models before adding the water.

10. After three weeks, have students discuss the following:

- What changes have they seen in the garbage in their landfills?
- What, if anything, has started to decompose?
- Is there any mold or fungus growing in your landfill?
- Has the weight or size of the landfill or any of its layers changed? If so, what do you think this means?
- Are all the layers of your landfill the same as when you started? Why or why not?
- How do your results compare with your hypothesis?
- How does your landfill compare with the results of the other teams?
- Do you think your landfill could withstand a heavy rain or an illegal toxic dumping?

Wrap Up

Assessment

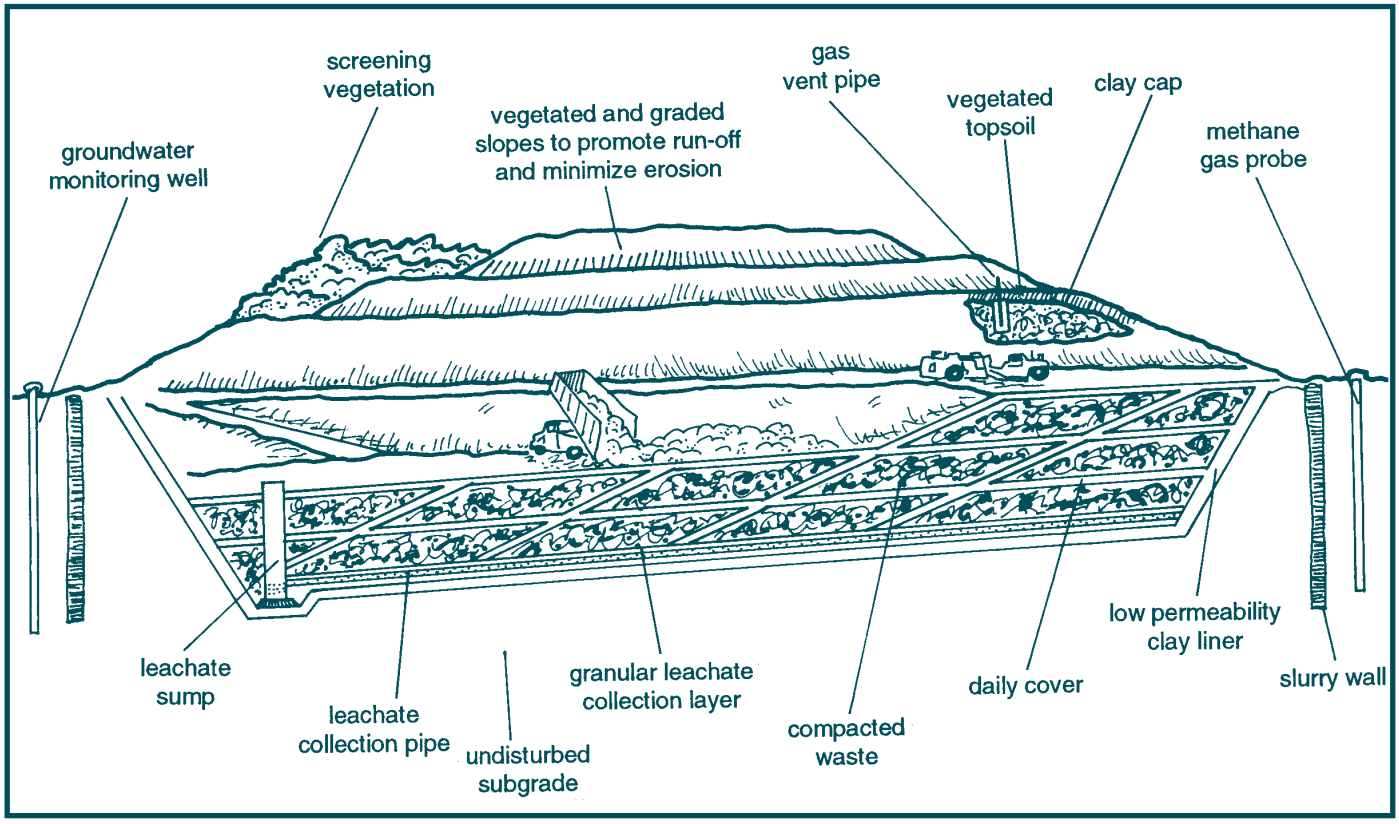
• Have students make one last hypothesis - Which of their landfills, if any, would not allow leachate to escape. Have them write down their predictions.

Test their predictions with the following simulation. Fill a beaker with 100 ml of water and six drops of food coloring (avoid yellow, as it does not show very well) for each model. Dump this "toxin" into each of the landfill models and have teams report if any of it reached the sand layer. Have the class review the results. Were any types of landfills more successful in resisting the toxin? What's the big deal if a landfill leaks anyway? Discuss leachates and the impacts of a landfill's contents seeping into groundwater.

Extensions

Community

• Visit a local landfill. Before going, have students hypothesize what they think it will be



like (will it have an odor, how large or small will it be, will garbage be visible). Additionally, have them prepare a list of questions for the landfill representative.

Multidisciplinary

• Have students keep a journal during the entire activity. Have them look closely (maybe with a magnifying glass) at their landfill model and compare it with the other models. Ask them to record and/or draw any changes that they may see during the process.

Outdoor

• Have students do a quick inventory of the things that are being taken to the curb in their neighborhoods on trash pick-up day. Ask them to determine if there are any items that could be disposed of in another manner (composting, recycling, donating to charity, buying items with less packaging, etc.). Have students brainstorm ways that they could educate others about where the trash goes.
• Do a more in-depth study in which students weigh the garbage they or their families throw out in one week. How does that compare to the amounts that could be recycled or composted?

Technology

• Invite someone who designs and/or builds landfills as their occupation to come speak to the class. Have students develop questions to ask him or her that are relevant to their landfill development experience.

Resources

• *IEPA Bureau of Land - Open Dumps*
Provides information about the laws and hazards of open dumps.
www.epa.state.il.us/land/open-dumps/index.html

• *IEPA Bureau of Land - Landfill Capacity Report*
The site contains the annual report on the status of sanitary landfill space.
www.epa.state.il.us/land/landfill-capacity/index.html

• *Household Waste Disposal Solutions*
An online guide for proper disposal of common household items that require special treatment.
www.epa.state.il.us/land/hazardous-waste/household-haz-waste/hhw-disposal.html

• *Consumer's Handbook for Reducing Solid Waste*
This site describes how people can help solve a growing problem...garbage! www.epa.gov/epaoswer/non-hw/reduce/catbook.htm

• *DCEO's Vermicomposting Kit: EEEK! There's a Worm In My Room (Grades K-adult)*
Contains lesson plans, a video and all the information you would need to know about setting up a vermicomposting (food composting with worms) bin of your own! (Free Rental!)

To reserve an educational kit, contact Brett Ivers at 217-524-5859 or brett.ivers@illinois.gov. www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm or www.istep.org.

• *DCEO's The Case for Investigating the 4Rs (Grades K-adult)*
Contains videos, lesson plans and a variety of products made from recycled materials. (Free Rental!)

To reserve an educational kit, contact Rebecca Enrietto at 217-785-7440 or rebecca.enrietto@illinois.gov. www.istep.org www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm

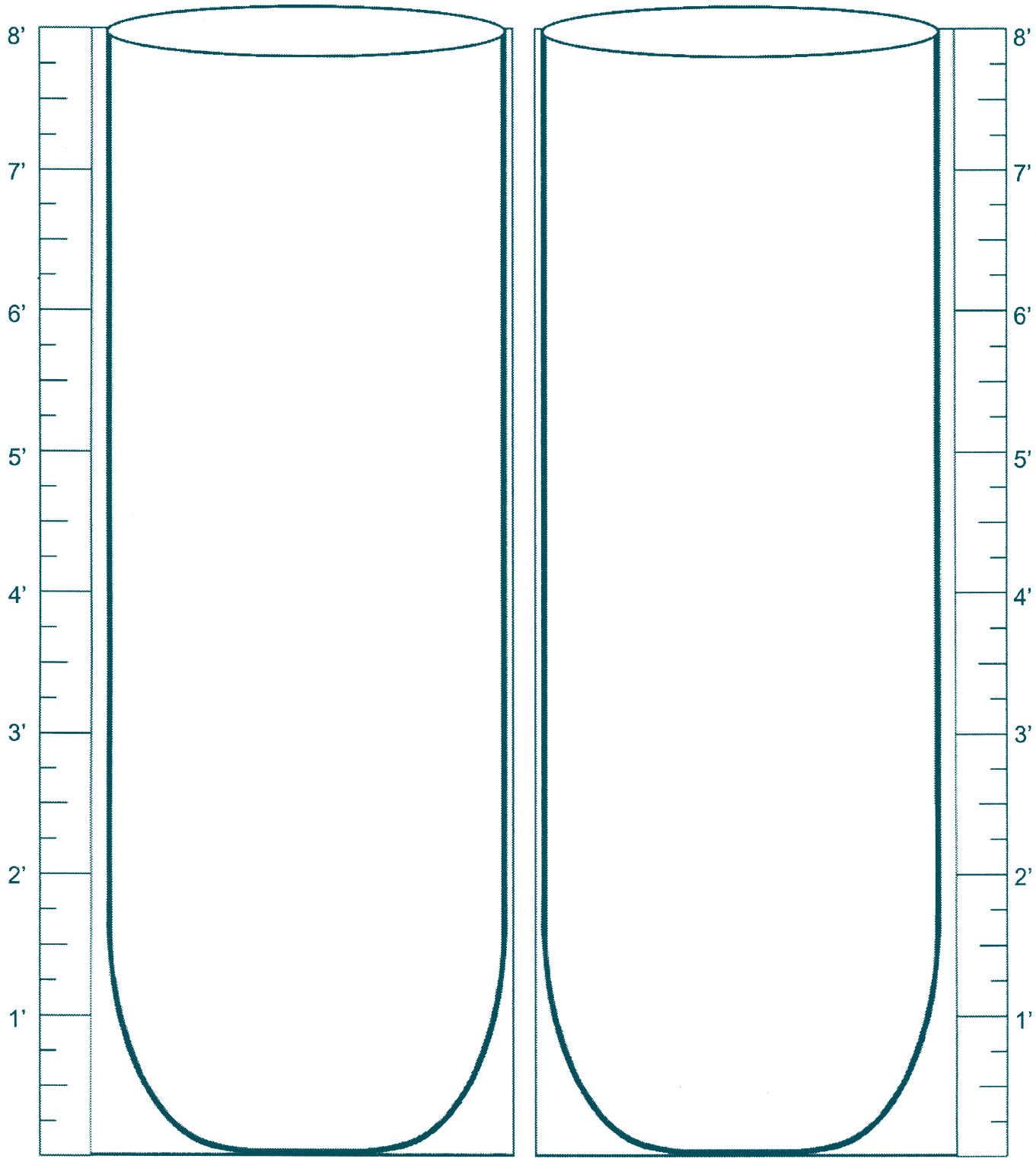
Adapted From: "Leachate Legacy," Environmental Resource Guide—Nonpoint Source Pollution Prevention. Air & Waste Management Association. Pittsburgh, PA. 1992.

Hasting to Waste Student Worksheet

Landfill Model

Directions: Draw and label the layers of your landfill. Record the thickness of each layer

Begin - Today	End - In 3 weeks



HYPOTHESIS - What do you think will happen to the garbage in your landfill?

OBSERVATION CHART

Day / Date	Weight	Measurement	Changes / Observations
1			
2			
3			
4			
5			
Water			
6			
7			
8			
9			
10			
Water			
11			
12			
13			
14			
15			

Conclusion - Was your hypothesis correct? Why or why not?

Common Household Hazardous Waste

Subject: Science
Social Studies

Skills:
- Researching
- Classifying
- Analyzing

Concepts:
1. E, P
2. B
3. K, L

Objectives: Students will:
1) be able to identify common household products that contain hazardous waste properties.

2) identify proper storage and disposal methods for household hazardous waste.

State Standards:
Language Arts: 1.A.2 a
Science: 11.A.2 b 13.A.2 a 13.B.2 a, f
Social Studies: 17.C.2 c

Vocabulary:
- corrosive
- flammable
- household hazardous waste (HHW)
- hazardous
- ignitable
- reactive
- toxic

Setting: Indoor & Home

Materials:
- blackboard
- "Home Inventory of Potentially Hazardous Household Products" for each student (p.90)

Time: Two class periods

Activity Overview

Students identify and discuss various types of **household hazardous waste (HHW)** and disposal methods. They then complete a home inventory with the help of their parents or guardians.

Background

Many of the chemicals and products we have in our homes are potentially harmful. Most of these are safe if used correctly. However, disposal of these items or of their empty and almost-empty containers may become a problem. Because of their properties, they should not simply be dumped down kitchen or storm drains or placed in a regular landfill. Disposal in this manner is not illegal, but it is not the best disposal option. Whenever possible, purchase only what you need of these items and use them according to label instructions. Any leftover contents should be donated or shared with someone who can use them. Some hazardous items require special treatment and disposal to protect the environment and the public.

Household wastes are considered **hazardous** if they have any of the following properties: **Corrosive** (able to eat away the containers they are in, or the walls of trash cans or landfill liners); **Toxic** (poisonous to humans or animals); **Ignitable** or **Flammable** (able to catch fire and burn); or **Reactive** (able to explode). Some hazardous wastes are in more than one category. For example, fingernail polish is both toxic and ignitable.

Labels are often put on hazardous items to indicate just how dangerous they are. The chart below explains the three most common labels and their common meaning.

Warning	Toxicity	Example
CAUTION	Moderately toxic, Lethal dose: 1 ounce to 1 pint	ammonia, paints, floor polishes
WARNING	Very Toxic, Lethal dose: 1 tsp. to 1 tbsp.	antifreeze, bleach, some fertilizers, many pesticides
DANGER	Extremely Toxic, Lethal dose: a taste to a tsp.	rat poison, mercury batteries, some pesticides, paint thinner, drain opener, some oven cleaners

Preparation

1. Review background material related to types of household hazardous waste and their disposal.
2. Generate one copy for each student of "Home Inventory of Potentially Hazardous Household Products" (p.90).

Procedure

1. Write the words "household hazardous waste" on the board. Ask if anyone knows what the phrase, or individual terms, refer to. Discuss with them the various categories of hazardous wastes.

2. Ask the students if they think they have any such substances at their own homes. If so, where are they kept? Create the following chart on the board. Have students give examples of HHW that is stored in each location.

HHW Examples	
Kitchen:	**Basement:**
Bathroom:	**Garage:**

As products are mentioned, ask students the following: Why do they think they have them? What are they used for? What safety precautions do their parents take?

3. Ask the students what they think is the best way to dispose of these items. Can they think of any reasons why they should not be put in with the regular trash? (For example, corrosives could eat through cans, reactives could explode if they come in contact with other chemicals.)

4. Discuss the different types of warnings that might be found on labels. The most common labels, increasing in level of hazard, will be: Caution, Warning, and Danger.

5. Distribute the "Home Inventory of Potentially Hazardous Household Products." Instruct the students to complete the survey at their own homes, with the assistance of an adult. Make it clear to them that they are not to handle any of these products without the permission and supervision of an adult. Instruct them to wash their hands after completing the survey.

Wrap Up

Assessment

•The following day, have the students report their findings. On the board or on an overhead, prepare a tally sheet to determine which hazardous substances were found most often, and where they were stored. Look for common answers regarding: Where were they stored? What was the most common warning on the labels? Which products had instructions for safe disposal? What did they think were the most appropriate disposal means for these items? Was there any disagreement? (Be sure to correct any obviously incorrect answers, with explanations.)

Extensions

Community

• Have the class perform an inventory of the school janitorial supplies (with the permission of the principal and/or janitor). Students should then research and suggest alternatives for the school to use that will do the following: 1) clean as efficiently, 2) pose less of a hazard to the janitor, 3) save the school money. Students may wish to share their findings with the school administration.
• Have students research what they should do if they come in contact with one of the substances on the worksheet. What are the local numbers for poison hotlines or emergency numbers?

Multidisciplinary

• Have students research non-hazardous alternatives to the items listed on the work-

sheet. Have them create a list of ingredients necessary for each alternative. Have them go to the store and obtain the prices for each ingredient and the price for the product to be substituted. For example, a non-hazardous alternative to drain cleaners consists of baking soda and white vinegar. Students would determine the cost for these two items as well as a common commercial drain cleaner.

Outdoors

• Visit U.S. EPA's "Make A Difference in Your School: A How to Guide for Engaging Students in Resource Conservation and Waste Reducation" for ideas and examples on how to engage students in hands-on activities. www.epa.gov/epaoswer/education/pdfs/mad-guide.pdf.

Technology

• Have students visit the U.S. EPA's interactive web site "Learn About Chemicals Around Your House." www.epa.gov/kidshometour

This site allows students to choose a room in a house and then select those products that contain pesticides or toxic substances.

Resources

• *IEPA, Bureau of Land - Household Hazardous Waste (HHW) Collections*
This site provides information on the collection schedule and the accepted HHW waste types. www.epa.state.il.us/land/hazardous-waste/household-haz-waste/index.html

• *U.S. EPA's Make A Difference Campaign for Middle School Students*
This web site provides a wealth of information and resources as well as examples and guides on how to make a difference at your school. www.epa.gov/epaoswer/education/mad.htm

• *Clean Sweep U.S.A.*
Keep America Beautiful (Grades 5-8)
An interactive web site that provides background information and six different lesson plans regarding waste management, source reduction, composting, recycling, trash as a source of energy and landfills. www.kab.org/kids/educators.htm

• *Keep America Beautiful*
Learn how you can get involved in cleaning up your community. The three focus areas of this nonprofit public education organization consist of the following: litter prevention, beautification and community improvement, and waste reduction. www.kab.org

• *Earth 911*
Provides community specific information on recycling, pollution and the environment. www.1800cleanup.org or www.earth911.org

• *Consumer's Handbook for Reducing Solid Waste*
This site describes how people can help solve a growing problem...garbage! www.epa.gov/epaoswer/non-hw/reduce/catbook.htm

• *DCEO's The Case for Investigating the 4Rs Investigating the 4Rs.*
This kit contains videos, lesson plans and a variety of products made from recycled materials. Grades K-adult (Free Rental!)

To reserve an educational kit, contact Rebecca Enrietto, Illinois Department of Commerce and Economic Opportunity (DCEO), Recycling Education Unit, at 217-785-7440 or rebecca.enrietto@illinois.gov. www.illinoisbiz.biz/dceo/Bureaus/Energy_Recycling/Education/ISTEP_cases_program.htm
www.istep.org

Name:_____

Home Inventory of Potentially Hazardous Household Products Student Sheet

Take this worksheet home and with your parent's or guardian's help try to locate the 10 items listed below. On the item's package or label, you should be able to find the hazard characteristic. In the column labeled Proper Disposal, write the number or numbers of the way you think the item should be disposed of:

1) Buy only what you need.
2) Use it up for its intended purpose.
3) Donate it to someone who can use it.
4) Recycle it.
5) HHW (Household Hazardous Waste) collection.

Do You Have?	Item	Where Is It Stored?	Warning Labels	Hazard Characteristics	Proper Disposal
	Car Battery				
	Shaving Cream Can				
	Used Motor Oil				
	Empty Spray Paint Can				
	Drain Cleaner				
	Ant & Roach Killer				
	Furniture Polish				
	Rug Spot Remover				
	Flashlight Battery				
	Ammonia				

Name:_____

Home Inventory of Potentially Hazardous Household Products Answer Sheet

Take this worksheet home and with your parent's or guardian's help try to locate the 10 items listed below. On the item's package or label, you should be able to find the hazard characteristic. In the column labeled Proper Disposal, write the number or numbers of the way you think the item should be disposed of:

1) Buy only what you need.
2) Use it up for its intended purpose.
3) Donate it to someone who can use it.
4) Recycle it.
5) HHW (Household Hazardous Waste) collection.

Proper Disposal is listed in rank order. The first number listed is the most appropriate answer.

Do You Have?	Item	Where Is It Stored?	Warning Labels	Hazard Characteristics	Proper Disposal
	Car Battery	Answers	will vary	Corrosive, Toxic	4
	Shaving Cream Can	Answers	will vary	Reactive	2 & 5
	Used Motor Oil	Answers	will vary	Flammable, Toxic	4
	Empty Spray Paint Can	Answers	will vary	Reactive	2 & 5
	Drain Cleaner	Answers	will vary	Corrosive, Toxic	1, 2, 3 & 5
	Ant & Roach Killer	Answers	will vary	Toxic	1, 2, 3 & 5
	Furniture Polish	Answers	will vary	Flammable, Toxic	1, 2, 3 & 5
	Rug Spot Remover	Answers	will vary	Flammable, Toxic	1, 2, 3 & 5
	Flashlight Battery	Answers	will vary	Toxic	4 & 5
	Ammonia	Answers	will vary	Corrosive, Toxic	1, 2, 3 & 5

Illinois Pollution Jeopardy

Subject: Language Arts
Science
Social Studies

Skills:
- Teamwork
- Researching
- Comparing/ Contrasting
- Public Speaking
- Problem Solving

Concepts: 1. A-F 2. C 3. A, E, G, I, M, O, R

Objectives: Students will:
1) identify and research different forms of pollution.

2) present a short report on their own research.

3) understand how different types of pollution are related to and different from each other.

State Standards:
Language Arts: 4.A.2 b 4.B.2 b 5.A.2 a, b
Science: 12.E.2 a & 13.B.2 f
Social Studies: 17.B.2 a 17.C.2 a
Physical Dev. & Health: 22.C.2

Vocabulary:
- air pollution
- global climate change
- groundwater
- hazardous waste
- non-hazardous waste
- pollution prevention
- surface water

Setting: Indoor

Materials:
- 4 inch x 6 inch index cards (two per student)
- tape
- stopwatch
- six copies of the Group Planning Student Page (p.96)
- six copies of the Question / Answer Worksheet (p.97)

Time: Five class periods

Activity Overview

Students take part in developing a game that will help the entire class to understand what types of pollution affect Illinois.

Background

Pollution can be categorized and classified in many different ways. In this activity, students will research pollution based on the following definitions.

Pollution Prevention focuses on ways to avoid producing pollution by changing or modifying plans, practices or habits. It also includes activities that protect natural resources through conservation or efficient use.

Air Pollution consists of particulates, nitrous oxides, carbon monoxide and other harmful chemicals which make the air itself harmful or dangerous for people, animals, plants or structures.

Global Climate Change addresses pollutants which appear to have an effect on Earth's weather and climate.

Hazardous Waste refers to solid wastes which are inherently toxic to humans or other animals and plants. It includes toxic chemicals, medical waste and radioactive wastes.

Non-hazardous Wastes includes all other solid wastes, those which are not immediately toxic but which are still harmful in large concentrations or quantities. These include some organic wastes, garbage, unrecyclable packaging and litter.

Surface Water and **Groundwater** are more accurately locations for pollution rather than types, but are separated to clarify the different kinds of problems they face. Surface water includes rivers, lakes and streams, and the focus is on the pollutants released into them. Groundwater comes from the reserves of water hidden underneath the earth in aquifers. Both surface water and groundwater are affected by nonpoint source pollution: pollutants which find their way into water from a number of different sources including industries, residences, leaking underground tanks and runoff from streets and farms.

Preparation

1. Make copies of the group planning worksheet, so that there is one per team.

2. Gather resources that may be helpful in the students' investigation of their topic area.

3. Arrange for students to visit the library on the second day of research.

4. For the fifth day prepare a "Jeopardy" game board. Using 8 1/2 x 11 inch paper create the category titles (Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution, Ground Water Pollution).

5. For the fifth day put together the "Jeopardy" game board. Tape the six categories horizontally to the chalk board or a wall with enough room underneath for six index cards to be taped vertically. Upon receiving the cards from the students select six cards from each category. Label the backs of these cards with point values from 10 through 60. Tape these cards to the blackboard or wall under the appropriate category from 10 through 60.

6. With the remaining two cards, create a "Double Jeopardy" game board with the same topics as the first. This time value the cards 100 and 120. Tape the double jeopardy cards under the appropriate category.

Procedure

Day 1

1. Have students brainstorm what they know about pollution and what causes pollution (it may be helpful for students to participate in the other activities in this section, if they haven't already). As they name the types and causes of pollution, write their answers on the board. Ask them what their answers have in common and categorize them under the following six headings: Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution and Groundwater Pollution.

2. Divide the class into groups of four. Explain to the class that they will be creating a "Jeopardy" game which they will then play. The game will focus on questions and answers about pollution found in Illinois.

3. Ask each group to choose which of the six pollution categories they would like to investigate. On a piece of scratch paper, have them indicate a first and second choice. Collect the sheets and designate a category for each group, making sure that each group has a different assignment.

4. Give each group a Group Planning Student Page (p. 96) and instruct the students to use the page to organize their group and plan their investigation.

5. Each group begins to carry out their plan. Suggest that they should be collecting ideas for their questions and answers as they gather information.

Day 2

6. Groups should continue to carry out their plans, gathering information from a variety of sources, analyzing and evaluating the data.

Day 3

7. Groups finish their research. Instruct the groups to prepare a brief (two to five minutes) report to share with the rest of the class.

Day 4

8. Ask the research groups to give their brief reports. After each report, the teacher should clarify content, if necessary, and ask for questions from the other groups.

9. After all groups have shared their reports, ask students if they are familiar with the TV game show "Jeopardy." Make sure they under-

stand that players are given answers to questions and that they must come up with the question that fits the answer. For example, a player may be given the answer "Soda cans made of this metal are recyclable" and must come up with the question "What is aluminum?" Point out that a good answer has enough information in it so that only one right answer fits. Teachers may wish to ask students for examples of answers that do not have enough information and for examples of those that do.

10. In groups, have students decide on eight answers in question form that represent the type of pollution researched: two questions on natural causes, two questions on human causes, two questions on the natural system, and two questions on pollution prevention or other remedies for that topic.

11. Give the groups the master question/answer worksheet. Have the students write their answers in the left column and the correct question on the right.

12. Give each group eight 4x6 inch index cards. On the first line of each card, have students write the pollution topic they investigated (Air Pollution, Global Climate Change, Hazardous Waste, Non-Hazardous Waste, Surface Water Pollution, Groundwater Pollution). Have the groups write each of the eight answers on a card below the pollution topic heading. See example below.

Surface Water Pollution
This petroleum product is often washed off
roads or parking lots into creeks, rivers, or lakes.

13. Collect the cards and the master question/answer worksheet.

Day 5

14. Prepare the Jeopardy gameboard as noted in #4 under Preparation.

15. Create new groups so that each group has one member from each of the research teams. (Basically, you should have four teams of six participants if you have a class size of 24 students.)

16. Either assign each team a number or allow them to select a team name. Make a scoreboard on the blackboard for recording each team's points and penalties.

17. Display and explain the "Jeopardy" rules.
- After the teacher reads the answer, the first team to have all team members raising their hands will be called on by the teacher to guess the question. All team members must say the question together. Or, you may wish to use nosiemakers or push button lights.
- If the team guesses the right question, they will earn the points given to that question.
- If they guess incorrectly, the point amount is subtracted from their team's score and the next team to have all members raising their hands gets to guess. This continues until one team guesses the right question or until all teams pass. If no team guesses the right question, the teacher reads the correct question from the master list.
- When called on, a team has five seconds to guess the question.
- Within a team, players rotate picking the category and point amount for the next answer.
- Play continues until all answers are revealed.

18. Play the first round of the game. As a team selects a category and point amount,

turn that card over, tape it again to the board with the answer side showing, and read the answer. Consult the master list to verify the "right" question. If a team guesses correctly, place the point amount on the scoreboard: if they guess incorrectly, place the point amount with a minus sign. At the end of the round tally the scores.

19. Play "Double Jeopardy," adding the team scores from this round to the scores from round one. Rules do not change, only the points per question increase.

20. After the game has ended, ask students the following questions.

- What similarities were there between the types of pollution?
- What were the major differences?
- What type of pollution do you expect to find in our community? Why?
- What types of things can be done to prevent or reduce pollution?

Wrap Up

Assessment

- Use all of the student-generated questions in a formal assessment, such as a quiz or test, to confirm individual student comprehension.

Resources

- Illinois Environmental Protection Agency
http://www.epa.state.il.us

- United States Environmental Protection Agency
http://www.epa.gov

Adapted From: "Community Jeopardy," Community Connections. The Oakland Museum. Oakland, CA. 1992.

Date: _____ **Group Members:** _____
_____
_____
_____

Group Planning Student Page

1. The type of pollution we will investigate: _____

2. Research

Your group must have someone investigating the following research areas. Write your name next to the research area you will investigate. Do your research for the questions listed on a separate page.

_____ **Natural Causes:**
- Find at least two natural causes of this type of pollution.
- What type of natural or human communities does it affect?
- What type of harm or damage can it cause?

_____ **Human Causes:**
- Find at least four human causes of this type of pollution.
- What type of natural or human communities does it affect?
- What type of harm or damage can it cause?

_____ **Natural Systems:**
- What natural systems are involved in this type of pollution?
- Can this type of pollution affect other natural systems (air, land, and water)?

_____ **Possible Remedies:**
- Find at least three ways in which this type of pollution could be prevented or reduced.
- Identify at least one strategy that is controversial or that different people will disagree about. Why will they disagree?

3. Resources

What resources do you plan to use for your investigation?

4. Roles

Your group must have someone responsible for the following roles. Write your name next to your role. Everyone must have a role.

_____ **Research Coordinator:** Makes sure each person has something to research and helps to find resources.

_____ **Question / Answer Coordinator:** Makes sure each person in the group completes their question/answers on time.

_____ **Card Coordinator:** Makes sure the group creates eight cards and that all have the pollution topic listed on each.

_____ **Facilitator:** Takes any group questions to the teacher for clarification. (Do this after making sure that no one in the group knows or agrees on the answer to the question).

Date: _____ **Group Members:** _____

Master Questions / Answer Student Worksheet

Pollution Topic: _____

Answers:	Questions:
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.