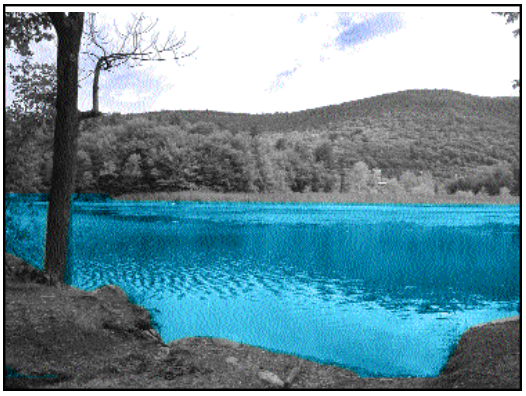
Clean Water

More than 30 years ago, the United States faced an enormous environmental crisis. At the time, Americans were pumping leaded gas into massive automobiles. Smoke and sludge seeped into our air, groundwater, and soil from industrial sources. Air pollution was commonly accepted as the smell of prosperity, as people were unaware of how harmful it was. Some of the worst threats were apparent in our nation's rivers, lakes, oceans, and harbors. Lake Erie was declared dead, oil spills on both coasts posed threats to marine wildlife and human health, and the Boston Harbor seemed more like a cesspool than a waterway. Public outrage at such environmental disasters, empowered by the first Earth Day in 1970, achieved a rare political alignment, enlisting bipartisan support for the creation of the United States Environmental Protection Agency (EPA) and the passage of the Clean Air, Clean Water, and Endangered Species Acts.



The 1972 Federal Water Pollution Control Act, commonly known as the Clean Water Act, seeks to "restore and maintain the chemical, physical, and biological integrity of the nation's water." Consequently, states adopted uniform minimum water quality standards, monitored by the newly-created EPA. Today, reduced toxic flows have lowered fish kills allowing lakes and rivers to revive. Municipal wastewater treatment plants, supported by billions of dollars in federal investments currently serve almost 190 million people, 50 million more than in the late 1960s.

Sources: United States Public Interest Research Group (www.uspirg.org), Clean Water Network (www.cwn.org).

Healthy Watersheds, Healthy Water

A watershed is the region that draws water and snowmelt into bodies of water. Every waterway—whether a small tributary, stream, or lake—has its own associated watershed. Watersheds can be large or small and can extend across county, state, and national boundaries.

In addition to acting as drainage basins, watersheds capture precipitation and filter and store water. Within each watershed there is a diverse system of ecoregions, marine life, and air sheds. Everyone living and working within a watershed needs to cooperate to ensure healthy conditions because water moves downstream in a watershed. Any activity that negatively affects water quality will change the characteristics of the water downstream as well and impact on the water quality of the body of water.

Simple choices in daily activities that can affect watershed health include: dumping used motor oil down a sewer; over-fertilizing lawns and gardens; applying sand and chemicals to driveways and sidewalks; removing vegetation such as plants, trees, and grasses along a riverbank; leaving pet waste on the ground; and poorly maintaining home septic systems. Communities as a whole can also affect the water quality of a watershed through land use decisions such as where to locate housing, shops, factories, parks, and farms. By analyzing a watershed's physical characteristics and land use patterns, students will understand how their watershed is changing and what they can do to protect it. Raising awareness by involving individuals and their communities creates a collaborative effort to preserve home watershed areas. Students can play a powerful role in this process.

Locate your watershed: www.epa.gov/surf

Source: Adapted with permission from Earth Force (www.earthforce.org)

Testing for Water Quality

Water quality testing determines whether water is safe for different types of use such as swimming, fishing, drinking, and irrigation. Knowledge of the water quality within your watershed provides understanding about human activities and our role in the ecological processes. Typically, tests for water quality identify several indicators that can be used to determine the health of a watershed. Key indicators include alkalinity, dissolved oxygen, nitrates, pH, temperature, and turbidity. A glossary of key terms follows:

Alkalinity measures the ability of the water to neutralize (or buffer) acids and keep the pH from changing. Sources: Rocks, soils, salts, plant activities, and certain wastewater discharges. Effects and Hazards: High water alkalinity causes higher algae and plant growth; while low alkalinity indicates that the water's ability to buffer acids is poor. If there are drastic changes in alkalinity, many chemical and biological processes will be affected.

Dissolved oxygen measures the presence of oxygen gas molecules in water. These oxygen molecules keep organisms living, sustain species reproduction, and support many chemical processes that occur in water. Water that maintains high dissolved oxygen levels is generally considered environmentally healthy; although saltwater, warm water, and water at high altitudes can contain less dissolved oxygen and still be part of a health-sustaining ecosystem. Effects and Hazards: Low dissolved oxygen levels stress fish and other aquatic organisms.

Nitrates are essential for plant growth, although too much nitrate may indicate a pollution problem. Sources: Soil, animal wastes, and decomposing plants; sewage, fertilizers, and animal waste. Effects and Hazards: High levels of nitrates affect dissolved oxygen levels and lead to excessive plant growth, affecting the types of plants and animals that can live in the water. Infant blood poisoning, cancer, and genetic changes have been attributed to high levels of nitrates.

pH measures the acidity of a solution as an "index" of the amount of hydrogen ions present in a substance and affects many chemical and biological processes. Sources: Acidity increases due to mine draining, industrial waste, and acid precipitation.

- pH is measured on a scale of 0-14, with a neutral pH at 7
- A pH less than 7 is an acid, with more hydrogen ions
- A pH greater than 7 is basic and has more hydroxide ions
- Most natural water has a pH value between 5.0 and 8.5. Rainwater has a pH between 5.5 and 6.0. Salt water has a pH between 8.0 and 8.5
- Most aquatic animals prefer a range of 6.5 to 8.0
- All water with a pH of less than 5.0 or greater than 8.5 should be viewed as suspicious

Temperature measures the degree of heat in the water which affects the rate of many of the waterways' biological and chemical processes and the amount of dissolved oxygen. Sources: Air temperature, the amount of runoff, the temperature of water running into the waterway, amount of sunlight, and water cloudiness. Effects and Hazards: Temperature affects the rate of photosynthesis and decomposition in plants. High temperatures may be a sign of thermal pollution from industrial sites.

Turbidity is the clarity of the water. Clear water has a low turbidity while murky water has a high turbidity. Sources: Small particles suspended in water such as algae, clay, microorganisms, silt, organic chemicals, decaying vegetation, or chemical wastes. Effects and Hazards: Turbidity can interfere with the process of disinfecting water. Particles may absorb or bond with toxic substances and prevent their removal during treatment.

Source: Building Environmental Education Services (www.beesinc.org)

Pollutants and Human Activities

There are many different sources of water pollution. Water quality changes quickly as water composition is altered by various ground surfaces over and under which it flows and combines with rock, minerals, other elements and numerous materials which are a direct result of human activities. The latter will be of particular importance to students as it relates to how their daily lives can affect our water sources.

Point and Non-point Source Pollution

Pollution that comes from a single, identifiable source, such as a factory or discharge from a sewage treatment plant, is called point source pollution. Once the source is identified, it becomes easier to improve water quality. Non-point source (NPS) pollution is attributable to diverse sources. The EPA reports that NPS pollution is a leading cause of water quality problems. NPS is primarily caused by rainfall or snowmelt moving over and through the ground causing runoff to pick up and carry away natural and human-made pollutants. This runoff finally deposits the pollutants into lakes, rivers, wetlands, coastal waters, and even our underground sources of drinking water.

Example Pollutants

- Excess fertilizers, herbicides, and insecticides from agriculture and residential areas
- Oil, grease, and toxic chemicals from urban runoff and energy production
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks
- Salt from irrigation practices and acid drainage from abandoned mines
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems

How to Reduce and Prevent Non-point Source Pollution

Some activities are federal responsibilities such as ensuring that federal lands are properly managed to reduce soil erosion. Some are state responsibilities: for example, developing legislation to govern mining and logging and to protect groundwater. Others are handled locally, through zoning and erosion control ordinances. As citizens, we play an important role by practicing conservation and by making it our personal business to properly dispose of home hazardous water, using non-polluting lawn and garden supplies, recycling plastics and other detrimental debris. Finally instilling an awareness that will engender careful and conscientious practices in our daily activities both personally and through our community programs does much to assist in controlling NPS pollution and will ultimately safeguard our watershed.

Source: Environmental Protection Agency (www.epa.gov/owow/nps/qa.html)

Preparation for Lesson Plans

To purchase or create an inexpensive test kit, please refer to our website at www.earthday.net/goals/water_testing_kits.stm. Either way, your students can generate a report of "snapshot" results by entering their data at www.earthday.net/goals/water_reporting.stm. If possible, plan ahead to arrange a field trip or determine an on-campus outdoors site in which to perform these water quality tests. If this is not possible, give yourself and your students at least one week to bring in samples from an appropriate source. These sources include lakes, streams, ponds, creeks, or ocean—not puddles, tap water, or storm drains.

Recommended Internet Resources can be found on our website at www.earthday.net/ goals/clean_water.stm

Lesson Plan 1: Introduction to Water Quality

OVERVIEW:	KEY ISSUES/ CONCEPTS
In this collaborative activity, students learn about clean water, and standards used to measure water quakity. Using historical information, scientific background, and investigation, students learn about the water cycle and how human impacts can both positively and negatively affect water quality in local and regional watersheds.	Water Quality Watersheds Relative Impacts SUBJECT AREAS Chemistry, Biology Environmental Studies History, Geography GRADE LEVEL: 5-8

Setting: Indoor
Class Size: 50 and under

Preparation: Students research and find articles and information from local sources, newspapers, magazines and the Internet. (Don't forget to bring in some extra materials!)

Materials: Newspapers and magazines with articles relative to water quality, reference books, in-class Internet access if possible.

Time: 45 minutes to 1 hour

Objectives:

- Describe water, watersheds and the water cycle, human interactions and their effect on the water cycle
- Identify local watershed(s) using research skills through books, magazines and Internet
- Understand the importance of clean water

Activities:

1. Discussion (15 minutes) Use this time to introduce topics and discussion about water

- What does water do for us? Where does it come from?
- What would happen if it were polluted? Define polluted. Why is it important to have clean water? What is clean water?
- Does our state or community have certain standards for water quality? Do these vary according to how the water is used (e.g., drinking water, recreation)?

2. Research (20-25 minutes) Put students in groups of two and assign each group a question. Use newspapers, magazines and other publications with pertinent articles. Have students use the Internet (see Recommended Internet Resources on our website, www.earthday.net/goals/clean_water.stm) encyclopedias, and other media to research water pollution. If possible, invite a local water expert from your local water utility, local environmental groups, and/or State Environmental Protection Department to present information.

3. Closure (5 -10 minutes) Share information. Assign homework:

- Have each pair create a hypothesis for lab for next class
- Have each student bring in a jar and lid taking sample

Lesson Plan 2: Chemical Water Quality Testing

OVERVIEW:	KEY ISSUES/CONCEPTS:
This is a hands-on activity where students learn about key chemical indicators of water quality and about the health of their own watershed through field experience. Students collect water samples, analyze the quality of the collected water, and test their predictions, while also learning about how humans affect the water cycle.	Water Quality Chemical Testing Scientific Method SUBJECT AREAS: Chemistry, Biology, Environmental Studies, Earth Science GRADE LEVEL: 5-8

Setting: Indoor and outdoors
Class Size: 50 and under

Materials: Water testing kits or thermometers, Secchi disk, pH strips, dissolved oxygen test tabs, glass jars (some airtight some not) to collect additional samples for biological testing during next class, samples of different types of water.

Time: 45 minutes-1 hour (allow more time if testing outdoors)

Objectives:

- Determine what makes water of good or poor quality
- Discuss and define key indicators to water quality
- Gain scientific field experience while collecting water samples
- Use "snapshot" tests to evaluate and determine the quality of water sampled

Activities:

1. Discussion (5-10 minutes) Students share results from research. Discuss testing process. Information can be found either in the kit directions or on our website.

2. Water testing (25 minutes) If testing outdoors, assign pairs to a specific spot to sample. Try to test in many different areas to ensure diverse results. If possible, schedule as a field trip to increase available time and have students sample several different areas and compare the results. Becuse students are only testing a small sample on one paticular day, the results are considered a "snapshot" of water quality. Make sure you have some pond water or ocean water samples they can compare with their tap water.

If testing indoors, students should have brought in samples. Make sure you have some pond water or ocean water samples they can compare with their tap water.

3. Closure (5 minutes) Assign homework:

- Students document their lab findings either in narrative format or as a laboratory write-up

Visit www.earthday.net/goals/clean_water.stm for a bonus lesson plan on biological water testing, supplementary resources, links and activities.

Lesson Plan 3: What Does This Mean?

OVERVIEW:	KEY ISSUES/CONCEPTS:
In this follow-up exercise, students work together to interpret their results from water quality testing. They learn about the sources and effects of pollutants on water health, tying local watershed health to the Earth's systems.	Water Quality Pollutants Personal Impact SUBJECT AREAS: Environmental Studies, Social Studies, Civics GRADE LEVEL : 5-8

Setting: Indoor
Class Size: 50 and under

Materials: Reports on water quality from your local water utility, local environmental groups, and/or State Environmental Protection Department.

Time: 45 minutes

Objectives:

- Describe pollutants, their sources, and their effects on health of water
- Generate an overall idea of the health of local watersheds using results, consensus-building, and brainstorming skills

Activities:

1. Discussion (5-10 minutes) Compile all hypotheses and results as a class and brainstorm about what the results mean. Translate into real world language. Compare with existing reports on water quality from local expert resources.

2. Classroom activity (20-25 minutes) Have the class determine and diagram (e.g. chalk or draw map) the source of their community's fresh water. Predict events or circumstances that could negatively affect the availability and health of the community's drinking water. What would the impact be if the community water source ran dry? Brainstorm ways in which the community could reduce its freshwater consumption.

3. Closure (5-10 minutes) Assign homework:

- Have students consider implications of pollution on the limited fresh water supplies by writing a law for Congress to consider, that would penalize companies that introduce toxic waste into any ground or surface water
- Students should include justifications, provisions and penalties, and they should be prepared to address opposing arguments

Lesson Plan 4: What Can We Do?

OVERVIEW:	KEY ISSUES/CONCEPTS:
In this follow-up exercise students evaluate their proposed laws and learn how humans affect water quality. They learn how they can take civic action to influence policy,	Water Quality Pollutants Personal and Community Impact SUBJECT AREAS: Environmental Studies, Civics Social Studies, Language Arts, Art GRADE LEVEL : 5-8

Setting: Indoor
Class Size: 50 and under

Materials: Art materials, newspapers and magazines from Lesson Plan 1, reports on water quality from your local water company, local environmental groups, and / or State Environmental Protection Department.

Time: 45 minutes

Objectives:

- Identify how students affect water quality through daily interactions affecting the water cycle
- Identify opportunities for civic action on a personal, local, or national level

Activities:

1. Discussion (10-15 minutes) Students share their "laws," provide supporting arguments, address and defend questions and opposing comments. Students then use consensus building skills to formulate a law that gains majority approval. Display this law prominently for students to keep in mind as their "goal" when pursuing the following activities.

2. Classroon Activity (20-25 minutes) Suggested projects (in groups or individually):

- Have students write a persuasive letter to the Editor of their local newspaper about why it is important to test water, why it matters both locally and nationally. See www.earth day.net / goals / clean_water / letters.stm for writing tips and model letters.

- Have students turn lab reports into art and / or presentation projects: posters, oral and / or written reports, displays on the status of their local watershed. Presentation should incor porate student results and what students think needs to be done to improve local water quality

3. Closure (5 minutes) Discuss ways to impact policy and community practices. Students can generate an “official,” personalized report containing their “snapshot” results in preparation for presenting them to others. (See suggested Earth Day Activities.)

Join the Earth Day Network
Water for Life Campaign!

Our blue planet is awash in water, yet accessible fresh water is less than one-tenth of one percent of all of Earth's water. Half of this water is tapped and many of our critical watersheds suffer from pollution, overexploitation and political conflict —abroad and in your backyard.

This year, the 2003 Earth Day campaign is "Water for Life." Join with millions of people around the globe who are focussing on solutions to water problems in alliance with Earth Day and the United Nations International Year of Freshwater. Tie your student's results and experiences from testing water quality to local and global citizenship.

Clean Water and the World: Our Thirsty Blue Planet

Abroad, the impact of threatened water is felt strongly. Here are some facts:

- More than one billion people lack access to clean drinking water.
- As population grows in developing countries, this number is expected to double in 25 years
- Accessible fresh water in lakes, rivers and aquifers is only one-tenth of one percent of all Earth's water.
- Over half of this water is tapped, and almost all areas suffer at least one of three major threats to their water supply: pollution, overexploitation, and political conflict. Some examples:

  In Mexico City, groundwater pumping has lowered the city's water table in places by more than 60 feet in 50 years, causing parts of the city to sink.
  China's Yellow River, which irrigates 18 million acres, ran dry at its mouth in 10 of the past 12 years.
  Residents of the Kibera slum in Nairobi, Kenya, pay up to four times the price Americans pay for water
- One flush of a toilet takes the same amount of water that is used in a day by a person in 30 of the world's poorest countries
- Women in Africa and Asia routinely walk several miles a day to get water, carrying up to 70 pounds on their heads.
- More than 80 countries, including the United States face water shortages.

Activity: How Much Water is Available for Worldwide Needs?

Fill a 2-liter bottle with water and add a few drops of blue food coloring to represent all the water on earth. Have students calculate 2.5% of 2 liters, placing the quantity (50 mL) in a clear container to represent the amount of fresh water on Earth.

Of this amount, remove 70% (have students calculate- 35 mL) to represent the amount of water trapped in glaciers, or water that is too deep in the ground to be realistically recovered. The remainder—less than 1% of the Earth's total water supply is left to support human needs for agriculture, drinking and washing, as well as for lakes, rivers and freshwater ecosystems.

Have the class discuss the implications of this finite amount of fresh water available for all humans and other species.

Sources: BirdLife South Africa (www.birdlifesa.org), National Geographic Society (www.ngs.org).

Earth Day Activities

Opportunities for service learning and civic participation

Letter-Writing Campaign

Local Campaign: Have students write letters to key environmental decision-makers in their community and state governments. Students can include their "snapshot" results and voice their concerns, thanks and suggestions for improving the health of their local and global watersheds. Visit www.earthday.net/goals/clean_water/letters.stm for writing tips, model letters, and additional information.

Global Campaign: Ask for aid to the world's thirstiest places! Each year, the United States Congress allocates billions of dollars for projects in developing countries. Students can voice thier support 8for clean water programs in the neediest countries and regions. They can write their congressional representatives and persuade them to increase monetary aid for clean water, health and sanitation to community-based programs abroad. Visit www.earthday.net/findmyrep.stm to learn how these letters can make a difference.

Official's Name
Full Address

Your Address
City, State, Zip Code
Date

Salutation: (Dear _____)

Body: Your letter should have three parts. 1) Identification of the issue—(briefly describe the case and say why it is important to you); 2) a request for action you would like the official to take; and, 3) Your "thank you" for the official's time and a request for a response to your lettter.

Closing: (Sincerely yours,)
Your name (and age if you are a student)

Source: Global Response www.globalresponse.org

Media Outreach

Working in groups, have students write and distribute a press release, letter to the Editor or "Op-Ed" article to local media in order to encourage reporters to cover water quality and your class' activities.

Community Art Exhibit

Find a community sponsor (library, grocery store, shopping mall, etc.) where students can hang their awareness-building artwork in a high traffic area. Include projects that highlight possible solutions as well as problems.

Political Action

Your students may not be old enough to vote but that doesn't mean they can't have a voice. Have students meet with government officials or attend town hall meetings and raise the issue of water quality. Have students evaluate elected officials' positions on watershed protection and other environmental issues and issue them "scores."

Community Water Testing Night

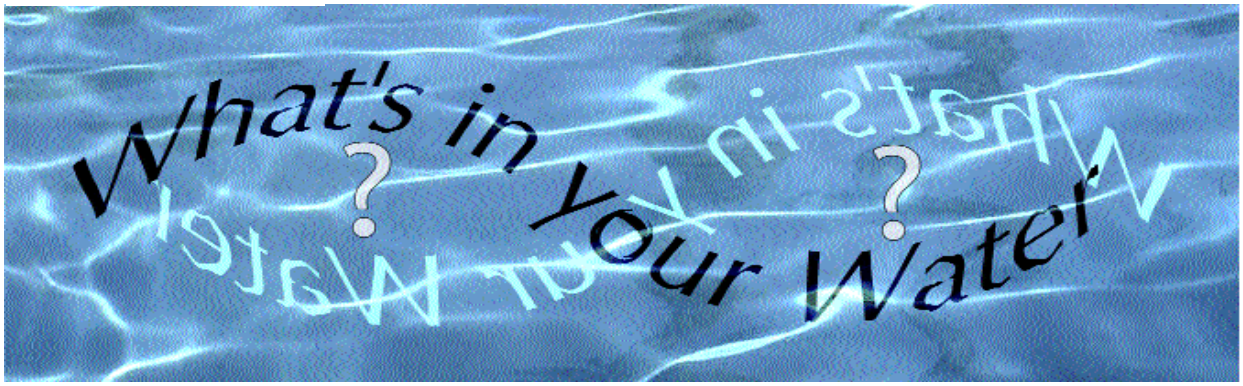
This activity will not only raise awareness, but will also give community members the opportunity to participate in testing similar to what the students did. Invite parents, media (students might draft a media advisory) politicians, water experts, etc.

- Include a water quality testing station so visitors can test water samples themselves. Identify the sources on a map.
- Students can present reports, show posters and art projects.
- Encourage citizens to take action, provide opportunities for signing on to the letter-writing campaign, engaging political leadership on this issue.
- If local politicians attend your event, try to organize a follow-up forum with city or county leadership, including possible introduction of legislation to protect the local watershed.

Every Day is Earth Day!

An Educator's Guide to Water Quality

Spring 2003



Four Lesson Plans Grades 5-8

Introduction to Water Quality
Chemical Water Quality Testing
What Does This Mean?
What Can We Do?

Topics Covered:

Clean Water
Healthy Watersheds,
Healthy Water
Testing for Water Quality
Pollutants and Human Activity
Water for Life Campaign
Earth Day Activities

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www.earthday.net

Dear Educator,

Every year, millions of people use Earth Day to focus their efforts on important environmental issues. For the past twelve years, Earth Day Network has helped by providing you with issue-based activity guides. Starting now, our new goal is to include opportunities in our educational materials for students to take civic action to protect the environment. April 22nd is an opportunity to highlight student environmental efforts, integrate service learning, and encourage civic participation.

This year our Earth Day Campaign is "Water for Life," coinciding with the UN International Year of Freshwater. The "What's in Your Water?" guide is an excellent way to get involved. It will help you and your students measure the health of your local water resources and take beginning steps toward becoming responsible citizens by using their results to engage in a dialog with community leaders and elected local, state and federal officials.

In this guide you will find basic information about water quality and lesson plans with hands-on activities for performing simple and fun water quality tests in your community. There are also many suggestionssuggestions for action and civic participation based on your "snapshot" results. On our website at www.earthday.net you may either purchase an inexpensive test kit or create your own simplified version.

As one of the more than 95,000 educators in the United States who coordinates Earth Day events or activities, you are a vital part of the Earth Day movement. We invite you to take a moment to register on our website: www.earthday.net/howto/teacher-reg.stm and provide us with your comments on our new programs, campaigns and goals. As a thank you, we will enter your name in a drawing to be held on April 22nd, Earth Day 2003, for a set of four signed, specially-created Peter Max prints and a drawing for one of 20 Peter Max Prints (unsigned).

Today, 32 years after the first Earth Day, Earth Day Network is an alliance of 5,700 organizations in 184 countries working to promote global environmental consciousness and a peaceful, just, and sustainable world. Educators are an integral part of this mission. We thank you for your ongoing participation, commitment to the earth and to future generations of ecologically literate and responsible citizens.

Sincerely,

Kathleen Rogers

Kathleen Rogers