ENVIRO Mysteries

WATER + ? = TROUBLE!

Teacher Guide

Dear Science or Health Educator:

Will drinking this water today mean I might get cancer when I'm older? Is it too late to do anything about all the chemicals people put on their lawns? Students are overwhelmed by questions like these every day. They know we need to find answers to these questions — not just locally, but nationally and globally as well. But they often feel powerless to do so.

That's why we created **EnviroMysteries** — to show students that they can become active participants in finding their own personal voice in these crises by becoming literate in science and health — understanding the process of scientific inquiry and, more importantly, seeing how they can use this process to evaluate information they hear and make informed decisions based on fact.

Because of this emphasis, **EnviroMysteries** embraces the National Science Education Standards, as well as the Benchmarks for Science Literacy, which specify how students should progress toward the goal of science literacy by becoming involved in hands-on, minds-on scientific inquiry. The project also relies on the criteria for health literacy, as defined by the National Health Standards, to encourage students to become critical thinkers and problem solvers.

You will probably find the video and teacher guide easier to use if you review them both in advance. We expect that different people will use them in different ways. Whichever path you decide to follow in working with **EnviroMysteries**, we hope you enjoy using the materials to give your students an opportunity to see that learning and understanding science and health is an inquiry-based process in which they all can participate with success.

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ABOUT EnviroMysteries

EnviroMysteries is one of the first projects in the country to focus middle school students' attention on the connection between health and their environment. Students today live in a world where they are exposed to many physical and chemical elements. The media is filled with increasingly disturbing news about the hazards of pesticides in our food and chemicals in our water supply. How does this effect them? What identified and potential risks are they facing? And, more importantly, what can they do about it? **EnviroMysteries** will help them find answers to these and other questions.

We hope that you will use the project materials to best meet the needs of your curriculum. They are designed to be used in any order that you think is feasible. These materials include:

A Videotape

This **EnviroMysteries** videotape contains four sections:

Water + ? = Trouble!: The Drama — Running time: 18:30
The drama concentrates on the story of a small town that is beset by an outbreak of cholera, as seen through the eyes of a team of teen environmental reporters.

Elena's Documentary — Running time: 3:00
Elena's documentary concentrates on the importance of water to life, and the physical properties and molecular structure that make this resource so important. She focuses on the acute waterborne illness caused by Giardia lamblia.

Drew's Documentary — Running time: 2:40
Drew's documentary explores the ways in which we can purify a contaminated water supply to maintain the integrity of this finite resource.

Maya's Documentary — Running time: 3:00
Maya's report uses the hydrologic cycle to explore the ways in which chronic exposure to chemicals such as mercury can lead to significant health problems

A Teacher Guide

The guide contains sections that correspond to the four sections of the videotape. In each section, you will find a synopsis of the content and activities, experiments, and discussion questions that relate to that content.

The guide also contains a critical thinking activity that you can use to culminate your work with **EnviroMysteries**, a data sheet containing current Safe Drinking Water Standards and a synopsis of waterborne illnesses, a glossary, a list of Internet resources and books that might be helpful to explore this subject further.

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Content Background

As you and your class work with **EnviroMysteries**, we hope you will use this information to form goals and objectives to help your students understand the importance of protecting our water resources.

Water is the most basic necessity for life.

In 1996, scientists were ecstatic to discover that there might have been life on the Moon. How did they come to that conclusion? They found evidence of water, locked in a crater on the dark side of this nearby satellite. Where there is water, scientists assume there is life.

Humans alone drink about five times their body weight each year. A loss of only seven percent of this vital fluid can lead to circulatory failure.

Elements dissolved or suspended in water can both help and harm you.

One of the more important properties of water is its ability to hold materials in suspension or solution. (Water has, in fact, been described as the universal solvent). This is critical to body functions, as it brings our tissues the food, gases, minerals, and hormones they need to survive, and removes bodily waste. However, water can also carry contaminants with it that can affect the body immediately (acute waterborne illness) or over a period of time (chronic waterborne illness) as the body tries to respond to the invasion.

Since water travels in a continuous loop through our environment, actions that harm its purity today will have long-standing effects.

We will never have more water on earth than we do right now. In its various forms (liquid, gas, and solid), the water that we have available to us today has traveled through an endless loop of precipitation, evaporation, and condensation since Earth began.

As this hydrologic cycle continues, various contaminants that become part of our water supply can affect people in different ways. Responses can vary from person to person, based on the amount of material one is exposed to, the length of exposure, and one's general state of health. For example, contaminants are usually more toxic at lower doses to people whose immune systems are compromised, for example.

Students can be empowered to affect the quality of water in their lives today and tomorrow.

When they first hear about this subject matter, students often react fearfully. Much of that fear stems from a sense of helplessness. They need help in realizing that they can have a positive effect on our water quality today and throughout their lives, by learning to become true and thinking health-literate scientists, able to make individual decisions based on sound principles of both science and health.

TIPS ON USING PROJECT MATERIALS

- You might want your students to keep a project journal where they can reflect their opinions and summarize their experiences as they complete activities, discussions, and experiments.
- Questions about the connection between health and environment are a constant part of the news we get each day. You might want to establish a bulletin board where students can post these reports.
- Consider using cooperative learning groups to complete any class activities, or adapt materials for a teacher-directed group activity.

Using The Video

- Preview the tape to see how you can best use it as a resource in your science or health classes.
- You can fast forward the tape and watch the documentaries at the point where they are introduced in the drama if class time permits.
- Encourage your students to ask the tape to be stopped at points where they need clarification.
- Students might benefit from repeated viewings of the video. Perhaps the tape could be available as a station for student consultation as they work with project materials.

Using The Teacher Guide

- Consult activity sheets to determine what materials you should gather for the students. Alternately, you can assign students this responsibility.
- Internet Investigations are suggested for each part of the videotape. If your students do not have access to the Internet, you can use these suggestions as a springboard for research projects using more traditional sources.
- You could use information on the Data Sheet on Page 15 as a basis for student research projects.
- The Glossary on Page 16 might be a basis for a student-generated project glossary.

What's The Story?

The day of Greenville's annual oyster roast was picture-perfect. Gulls circled greedily above the townspeople as they completed their preparations for the bounteous dockside feast. This year, the EarthWatch team had been chosen as the beneficiary of the gathering's profits and the team was hard at work, making sure that everything went smoothly. Despite a few hiccups — such as running out of lettuce — the day seemed complete: the seafood — supplied by Drew's father — was delicious; everyone seemed to have a good time. The EarthWatch team was pleased.

Until they found out that a number of people who had eaten at the oyster roast had become very, very sick.

A preliminary diagnosis of cholera galvanizes the team. As good reporters, they are concerned that the real story get out, despite what the town gossip Miz Winger is saying about Logan's Seafood. But, on a personal level, they are very worried: could their somewhat sloppy food-handling at the roast be at fault? And what if it were the seafood? Maya's dad and the whole health department are working around the clock to try to find the source for the problem. But until they do, the team — and the whole town — is in limbo.

The team decides to focus their next EarthWatch program on the situation, and quickly reviews what they know and what they have done. Cholera is a waterborne illness, so water — and what it can do for you — and to you, if you aren't careful — become the program's theme. The trio selects three segments to include in the broadcast: one on acute waterborne illnesses, such as Giardia; one on chronic waterborne problems, such as mercury contamination; and one on the ways in which we try to protect people from these diseases by water treatment systems.

The health department investigation is tedious, as these scientists work carefully to eliminate various culprits. Several items have been checked off that list; much to Drew's relief, his dad's seafood is finally cleared. Despite all their work, the department cannot find a definitive answer, and tempers flare as the process drags on. The reporters ignore the rumors that are constantly swirling about them to doggedly follow the story. But the nagging question remains: how did so many people get cholera?

The kids are as surprised as anyone in Greenville when they inadvertently discover that they knew the answer all along. They remember that they had purchased extra lettuce for the oyster roast, lettuce that, it turns out, had come from an area that had been overrun with sewer water during a storm. They clue Maya's dad in on the new information, and the case is solved.

Who's In The Cast

The EarthWatch team is a high-energy group of teen reporters whose high school video broadcasts on the environment are fast becoming the talk of the town. The trio in charge of these productions includes Maya Bennett, Drew Logan, and Elena Velasquez.

Maya Bennett — a newcomer to Greenville — is an effervescent high school senior who loves to take command of any situation.

Her dad, **Dr. Jesse Bennett**, moved his family to Greenville when he accepted a position with the local health department.

EarthWatch's ace camera operator **Drew Logan** is a native of this small bayside community. After school, you'll usually find him working the counter at Logan's Seafood, his dad's business — unless he has managed to convince his advisor to let him take the video camera home just one more time.

Elena Velasquez is a quietly dedicated environmentalist. She takes her work with EarthWatch very seriously, and really enjoys her growing friendship with her compatriots.

Miz Winger is the town gossip, always looking for some conclusion to jump to. Unfortunately, she often finds one.

Old Man Chapman is a reclusive figure who has lived in Greenville for as long as people can remember. You'll usually find him down at the town dock — fishing for his supper.

The activities of the EarthWatch team model the process of scientific inquiry for the audience, and mirror of what is being done by the Health Department.

Watching The Drama

What Is Cholera?

Most people associate cholera with conditions that occur in underdeveloped countries, where sanitation is sometimes inadequate, so it was natural that the EarthWatch team was very surprised when they heard about the cholera outbreak in their own town. However, cholera outbreaks can and do occur in this country — although they are rare. The University of California Davis reports, as of 1993, there were 91 cases of cholera reported from 1973 - 1992 that were unrelated to foreign travel. Bacteria called Vibrio cholerae are responsible for creating this acute water-borne illness. When the bacteria are swallowed, they make their way through the digestive system until they attach to the wall of the small intestine. There, they release toxins that make their host sick. Symptoms include watery diarrhea, vomiting, and occasional muscle cramps. Problems typically occur when victims lose so much water and electrolytes that they are in danger of severe medical problems such as heart attack or stroke. As Maya learns, it's not the disease that kills, but the rapid loss of water and electrolytes. If they can be replaced in a timely fashion, the victims usually recover. In addition, the victims are usually immune to the disease when they encounter it again. There are vaccines that can be used to give people short-term immunity to Vibrio cholerae type 01, but other types of the disease have been discovered, and just because people are immune to one form of the bacteria does not mean they are immune to all forms of the bacteria.

Before Watching The Drama

- Duplicate the activity sheets to be used during and after viewing the tape.

- Brainstorm with your students about the effect their environment has on them to explore the connection between people and their surroundings. Can they study better in a cold room or a warm room? Do their allergies worsen in a particular season or weather condition? How do they feel on a warm spring day? Together, develop a survey students can use to find out how people in their grade or school respond to these or other environmental conditions. How would your class conduct this survey in your school?

- How much does your class know about the water that they drink every day? Does it come from a reservoir or well? Is it treated before it enters their homes? Brainstorm to discover what they know and what they would like to know abut this important resource. What are some sources they could consult to answer their questions?

While Watching The Drama

- Direct students to review the questions on the "Just the Facts" activity sheet before viewing. As they watch, they can record the information they uncover. Decide on a signal they can use to pause the video if needed to give them a chance to record the information.

After Watching The Drama

- One of the first people to uncover how disease is affected by environment was Dr. John Snow. Using a scatter map, he traced cholera cases in London during 1834 to decide on a probable course for the epidemic that had stricken a neighborhood. Based on this mapping technique, he postulated that a neighborhood water pump was the source of the disease. Evidently, the water source had been contaminated from a nearby cesspool. The water handle on the pump was removed, and the disease soon died off. Students can work in pairs or other small groups to see how this technique works as they complete the "Disease Detectives" activity sheet.

- What if . . . Mr. Logan's Seafood was actually the cause of the cholera outbreak — or if they never could clear him from blame? Discuss these possibilities with your class. Direct them to work in groups to brainstorm and write a story based on what they think might happen if either of these two outcomes had happened in the video.

- How is the EarthWatch team's work like that done by the scientists at the Greenville Health Department? Use the processes involved in scientific inquiry to brainstorm and complete a chart that shows similarities and differences.

Internet Investigations . . . Who was Typhoid Mary? . . . What does an epidemiologist do? . . . How does the FDA make sure that fish sold commercially is safe to eat?

The most common sources of cholera are raw or undercooked seafood (so Miz Winger's suspicions about Logan's seafood had some merit), raw fruits and vegetables, and foods that have been exposed to the bacteria during preparation.

Directions: As you watch the video, try to answer as many of these questions as you can.

What are some things you see happening with the food and water during the oyster roast?

How does the Earth Watch team find out about the cholera outbreak?

How does Miz Winger find out about the cholera outbreak?

Why is Drew upset about the rumors Miz Winger spreads?

Why did the town have a meeting?

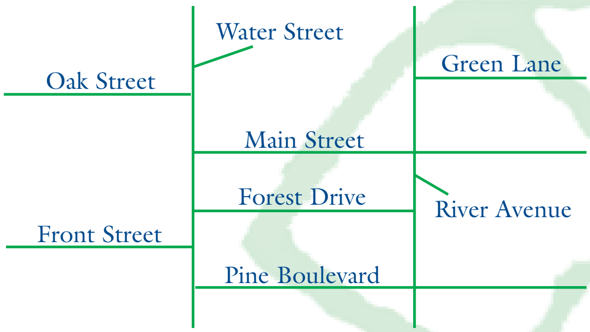
What does Old Man Chapman say about his sickness?

How does the EarthWatch team find out what probably caused the cholera?

Disease Detectives

Directions: In 1854 Dr. John Snow became one of the first people to realize that there might be a connection between the environment and people's health. There was a severe outbreak of cholera in certain London neighborhoods. Snow discovered that there was a connection between many of the cases of cholera and the use of a nearby public water pump. You can find out how this disease detective worked by completing this activity.

1. Place a dot on the map for each person who became ill. Their illness was diagnosed as leptospirosis, an intestinal disease caused by a very small bacterium which can be carried by water.



People who became ill:

Carlos Ramirez	10 Oak Street
Pilar Dominguez	10 Oak Street
Tavon Wright	50 Water Street
So Young Choo	55 Water Street
Dante Boone	11 Oak Street
Taylor Davis	29 Front Street
Maureen Polk	44 Front Street
Terry O'Hara	22 Oak Street
Linda Freed	14 Oak Street
Manny Freed	14 Oak Street
Rene Warren	12 Pine Boulevard

2. Where do most of the people who became sick live?

3. Based on this, you might expect that something near that street was causing people to become sick. To find out what it might be, think about these statements:

- All the people who became sick go to the same school.
- All the people who became sick had eaten at the same neighborhood restaurant.
- Carlos, Tavon, Taylor, Manny, and Rene all play on the same soccer team. They practice at a neighborhood park, and often get drinks from the water fountain there.
- All the homes where the sick people live get their water from the same source.
- Pilar, Taylor, So Young, and Dante had gone on a school trip to visit a nearby river.
- Pilar, Carlos, Linda, and Manny all went to a neighborhood restaurant just before they got sick.
- Pilar, So Young, Dante, Maureen, Terry, and Linda had stopped for a drink at the neighborhood park's water fountain.
- So Young's, Tavon's, Rene's, Terry's, and Maureen's mothers all shop at the same neighborhood store.
- All the people who became sick had eaten hot dogs at a neighborhood soccer game.

Now, circle the statements that say something about all the people who had become sick.

4. Based on this, what do you think made these people sick?

On the back of this page, outline a plan to find out what really happened. Be sure to explain the reasons behind your plan.

Before Viewing The Documentary

• Duplicate the activity sheet "Keep Us in Suspension" for your class to use after viewing the documentary.

• Review these terms with your class to check their comprehension: waterborne, distilled water, molecule, atom, mixture, suspension, solution, bacteria, virus, protozoa, parasite, microorganism, gastroenteritis. Definitions for these terms appear in the glossary at the end of this guide.

• Prepare five glasses of water: one in which you have mixed a teaspoon of salt, one in which you have mixed a teaspoon of sugar, one that holds plain tap water, one that holds water mixed with a teaspoon of dirt, and one that holds distilled water.

• Challenge your students to find a way to identify which glasses of water are safe to drink without actually drinking the water. (All five are potable, although the muddied water may be unappealing.)

• Water and life are almost synonymous. Brainstorm with your class to see if you can think of any living thing that does not need water to survive. You might want to remind your class that some living things can absorb water from the atmosphere.

After Viewing The Documentary

• Direct student teams to find an innovative way to display the following information about events that relate to epidemics of acute waterborne diseases. Can they find a way to indicate other historical events that occurred during the same time frame?

1854	Asiatic cholera epidemic in St. James Parish, London, traced to contaminated water supply
1872	Filtering water through sandbeds began to be used
1885	Typhoid epidemic in Plymouth, PA found to be caused by improperly disposed waste materials
1890	Several typhoid epidemics in northeastern US found to be caused by rivers carrying diseased waste
1896	Kentucky's George Fuller experimented with chlorination
1908	East Jersey Water Company was ordered by the courts to make its water supply pure and safe. They used chlorination.
1910	More U.S. cities began to chlorinate their water supply
1926	Failure of Detroit's water treatment system caused an epidemic of bacterial dysentery
1933	Leaky sewer line at a Chicago World Fair hotel caused an outbreak of amoebic dysentery
1970	Outbreak of cholera in Jerusalem linked to eating crops irrigated with disease-carrying water
1974	US passed the Safe Water Drinking Act

What's The Story?

The focus of this documentary is water — its components, its physical properties, and its ability to form solutions which can both help and harm us. These are the points Elena makes during the video:

• You cannot rely on what water looks like to make sure it is healthful to drink. Diseased water can look the same as distilled water.

• Water molecules are formed by two different atoms: two hydrogen atoms and one oxygen atom resulting in a slight molecular charge imbalance. As such, water molecules often attract other molecules to form mixtures, or suspensions, and solutions.

• In a solution, water molecules combine with other molecules to form a different molecular structure. This is what happens in sugar water.

• In a suspension, or mixture, water molecules do not chemically combine with other molecules, but they carry the other molecules along with them.

• Our bodies depend on water's ability to carry food, minerals, gases, and hormones throughout its structure and to remove waste materials as well.

• Water can also carry harmful substances that can cause acute illnesses. Acute waterborne illnesses can be caused by bacteria, viruses, or protozoa.

• Acute illnesses are marked by sudden onset and a less protracted course of the disease.

• A protozoa called Giardia lamblia is responsible for causing giardiasis (also known as "beaver fever"). Bacteria are responsible for causing diseases like typhoid and cholera. Viruses are responsible for such acute waterborne illnesses as Pontiac fever.

Internet Investigations . . . How does chlorine work to make water safe to drink? . . . What percentages of our body structures are made of water? . . . How much water should you drink each day? What happens if you don't?

Keep Us In Suspension

Directions: Water has many properties, or characteristics, that make it very valuable to all living things. One of these is the ability to make solutions (one substance is dissolved into the water or chemically recombined with it) and suspensions (particles of one substance are carried by water, but not chemically combined with it). To find out more about this property, you will need:

- A gallon jug of fresh clear water from the tap (make sure to thoroughly wash jug before you put fresh water in it)
- Five clean, clear plastic glasses; all of them should hold the same amount of water
- One-half cup of sugar; one-half cup of salt; one-half cup of dirt; one-half cup of baking soda; one half cup of sand
- Five clean plastic spoons
- Clean measuring cups and measuring spoons

1. Pour the fresh water into each of the five plastic glasses. Make sure each glass has the same amount of water.

2. Add a 1/2 teaspoon of sugar to the water in the first cup. What happens?

Add a 1/2 teaspoon of each of the other materials to each of the other four glasses. What happens?

1/2 teaspoon salt in glass 2 ____
1/2 teaspoon dirt in glass 3 ____
1/2 teaspoon baking powder in glass 4____
1/2 teaspoon sand in glass 5 ____

3. Stir each of the glasses of water 5 times. Use a separate spoon for each glass. What happens?

Glass with sugar ____
Glass with salt ____
Glass with dirt ____
Glass with baking powder____
Glass with sand ____

4. Based on what you have seen, which glasses hold solutions?

Which glasses hold suspensions?

5. Pick one glass that holds one material in solution. How much more material can you add to the glass before some of it settles to the bottom? What happens?

Glass with ______________________________ How much added ______________________________

What happens if you add too much material to the water?

BONUS: Could you do anything to the water to make it hold more material in solution?

Before Viewing The Documentary

• Duplicate the activity sheet "For a Rainy Day" for your class to use after viewing the documentary.

• Review these terms with your class to check their comprehension: chlorine, water treatment plant, aeration, coagulation, sedimentation, toxic, hydrologic cycle. Definitions for these terms appear in the glossary at the end of this guide.

• Brainstorm with your class to think of ways in which they could collect drinkable water — or make any available water safe to drink — if they were camping in a wilderness area. Purchase a water treatment kit and use it to disinfect water collected from a puddle in the school yard or a nearby stream. Can your class determine what happens microscopically to the water?

• How does your school dispose of dangerous chemicals such as those found in cleansing solutions and paints or used in science labs? Your class could interview a member of the janitorial staff to find out. If there is no plan in place, your class might want to write to the local school board about the situation, with their recommendations for change.

After Viewing The Documentary

• Work to empower students to see their role in keeping our water safe by brainstorming to find ways in which they can a) use less water, b) use the water they have wisely, and c) keep dangerous elements out of the water supply. Drew offers a few suggestions in the video; if you need other suggestions to start the discussion, consult some of the sources in our Resources section.

• If you can find any evidence of chlorine (called free chlorine) in water, then the water is generally considered to be safe to drink. Collect water samples from several places in your school. Add a teaspoon of starch and a few crystals of potassium iodide to each sample. A blue-purple color will indicate the presence of free chlorine. (You should advise students that some home water treatment systems remove free chlorine, and they may not get the same results if they conduct the test at home.)

• In addition to man-made systems, nature also filters and cleans water. To investigate this process, provide for each group of students: cotton, gravel, coarse and fine grade sand, a clear plastic container with holes in the bottom, pieces of clay, and clumps of dirt with plant roots embedded in it. You will need large jars of muddy water for yourself. Ask student teams to use their materials to invent a filtration system that will clean up the muddy water. Pour 500 ml of muddy water in each invention. Which system made the water the clearest?

What's The Story?

The focus of this documentary is keeping water clean — either through water treatment systems or by not allowing damaging materials to become a part of our water supply. These are the points Drew makes during the video:

• There are several steps in the process of treating our water to make sure that it is drinkable: aeration, first chlorination, coagulation, sedimentation, filtering and final chlorination to kill microbes as it travels to its destination.

• Aeration involves exposing water to air to release dissolved gasses in the water.

• Chlorine is used as a disinfectant to kill microorganisms.

• Dirt and debris are removed from water through a process called coagulation. In this step, a sticky substance called floc is added to the water, which attracts particles of debris.

• The dirt and the floc both settle to the bottom of sedimentation tanks, where they are scooped out of the water.

• During filtering, water is passed over sand or carbon to remove dirt and microorganisms.

• Earth's water supply is finite: less than 1 percent of water on Earth is available in potable form. It travels in a continuous loop through our environment. That is why our impact on this resource can have long-lived effects.

• Keeping dangerous materials out of water is much more cost-effective than trying to remove them once they are part of the water supply.

• People can make personal choices that will ensure the quality of our water for years to come.

Internet Investigations . . . What are designer swamps? . . . How does a septic field work? . . . Can free chlorine be a problem?

For A Rainy Day

Directions: This is an activity for the next rainy day at your school. To get ready for the activity, use the box below to make a map of your school grounds. Be sure to include trees, shrubs, gardens, hills, playgrounds, ball fields, parking lots, and any other permanent objects on the grounds in your drawing. If there are any storm drains on the property, be sure to note their location on the map.

1. After the next rain storm, survey the school grounds. Mark your map to show any large pools or puddles of water. Measure or estimate their size and record it on the chart below. Watch the puddles/pools and record when the water "disappears."

PUDDLE/POOL LOCATION ON	ESTIMATED SIZE	DATE PUDDLE/POOL WAS GONE

2. Based on your investigation, shade in the lowest areas on your map (HINT: water flows from the highest to the lowest points. Water usually collects at low points.) Think about what you have discovered. Where did the water collect? Where did it not collect? What does this say about the land around your school?

3. Your map shows a mini-watershed, an area that "sheds" its water from highest to lowest point. Where do you think the water in the puddle/pools went? Find a topographical map of your area to help you determine what might happen to the water once it leaves your school grounds. Design a poster or write an announcement to let all the people in the school know what happens to the water. Be sure to explain that what they do on the school grounds (dropping trash, dumping oil, etc.) can affect the water.

Before Viewing The Documentary

- Duplicate the activity sheet "Case Study: Contamination" for your class to use after viewing the documentary.

- Review these terms with your class to check their comprehension: precipitation, condensation, evaporation, landfill, waste incinerator, vaporize, decompose, accumulate, mercury, food chain. Definitions for these terms appear in the glossary at the end of this guide.

- According to the U.S. Safe Drinking Water Act, water can only contain 2 parts per billion of mercury to be considered safe to drink. Use these comparisons to show how small this amount really is: two parts per billion is equal to 2 steps on a journey 19 times around the world at the equator; 2 seconds of time in 32 years; or 2 drops of water in a full Olympic-sized pool. Can your students explain other ways to think about this number? Consult the chart on the "Data Sheet: Water & Health" in this guide to find out more about allowable levels of other contaminants.

- Distilling water in a lab setting is one way of demonstrating the hydrologic cycle. Involve your class in this activity as observers or experimenters. Boil a liter of tap water until it forms steam (evaporation). Place a sheet of sturdy plastic folded to form a V in the steam vapor (condensation); the V should be inverted. Taper the plastic sheet so that condensed water can flow into a clear container (precipitation). Can your students think of ways in which this process is different from the natural hydrologic cycle?

After Viewing The Documentary

- The response to different illnesses varies from person to person; some people never get the illness, but carry it to others. This is also true when we talk about chronic exposure to contaminants such as mercury. To help your class think about personal susceptibility, ask them to think about the last cold they had: how long did it last? did they have a fever? did they have to stay home from school? The information could be collected and displayed in a chart or graph. Extend the discussion to brainstorm about things that may have affected the seriousness of their colds. Based on this, what kinds of things does your class think could affect the way people respond to chronic exposure to chemicals?

- Direct students to copy or bring in labels from household products that contain chemicals. Display the information they have found. Ask them to use the Safe Drinking Water Standards chart on Page 15 to check to see if the products contain chemicals listed there. How should their families dispose of these materials so that they do not become part of the water supply?

What's The Story?

This documentary concentrates on the way in which chemical contaminants enter our water supply as water continues in an endless cycle in our universe, and the ways this chronic exposure can effect people. These are the points Maya makes during the video:

- Earth's finite water supply travels in a continuous loop (the hydrologic cycle) through our environment.
- This cycle includes several phases, including precipitation, evaporation, and condensation.
- Contaminants such as mercury can easily be incorporated into the water supply at any phase of the hydrologic cycle.
- Trash incineration can release materials as gases into the atmosphere. These gases are then washed back to earth as water condenses in the atmosphere.
- Trash collection in landfills causes contaminants to be released into ground water, which collects in above-ground locations such as streams and lakes, and in underground storage areas called aquifers.
- Contaminants can also enter the water supply as water travels through land where pesticides and herbicides have been applied, or through the air where chemicals have been released through burning coal or oil.
- In the case of mercury, bacteria in the soil can transform it to methylmercury, which is easily absorbed by the body and very toxic.
- Chronic exposure to contaminants can cause health problems, depending on dosage, length of exposure, and individual susceptibility.

Internet Investigations . . . How did the term "mad as a hatter" come about? . . . What does Dancing Cat Sickness have to do with mercury contamination? . . . What happened at Love Canal ?

CASE STUDY: CONTAMINATION

Directions: Sometimes, we cannot see chemical contaminants that are part of our water supply. But we can test for them to discover if they are there. To see how this works, you will need:

- a clear plastic shoe box
- powdered lemonade mix
- 6 plastic straws cut in half
- a book or block of wood
- a fine mist spray bottle filled with tap water
- building or aquarium sand
- 12 one-inch pieces of wide range pH paper (available at a drug store)

1. Make the shoe box slope by placing a book or block of wood under one of its shorter sides. One end of the box should be about 1" higher than the other.
2. Place a layer of sand in the bottom of the box. Try to make the layer deeper at the raised end, and shallower at the lower end.
3. With your finger, create a small hole in the deeper end of the sand. Put one teaspoon of lemonade mix in the hole and cover it up with sand. The lemonade mix represents an invisible contaminant.
4. Tape 12 one-inch pieces of pH paper to the top of the desk or table where you are working.
5. Use the mister to wet the end of the box where the sand is more shallow. Be careful not to wet the area where you put the lemonade mix. Take a test sample of the wet sand by pushing a straw piece into it. Drop the sand on one piece of pH paper. Did anything happen to the paper?

   ____

6. Now, wet the area where you buried the lemonade mix.
7. Decide where you would like to take other sand samples to trace where the lemonade mix "contaminant" may have traveled. Because the lemonade mix is acidic, the samples from areas where it has gone should show a more acidic reading.
8. Assume that the box below represents the top of the shoe box as you look down on the sand. Decide on 11 other locations where you are going to take samples, and mark them with numbers on the diagram. Record what happens to the pH paper when you take the samples.

Based on your tests, shade in the route you think the lemonade mix traveled.

RESULTS:

Test sample: ______________________
Sample 1: ______________________
Sample 2: ______________________
Sample 3: ______________________
Sample 4: ______________________
Sample 5: ______________________
Sample 6: ______________________
Sample 7: ______________________
Sample 8: ______________________
Sample 9: ______________________
Sample 10: ______________________
Sample 11: ______________________

9. Based on your results, what factors do you think made the lemonade "contaminant" travel?

   ____

BONUS: How do scientists actually test groundwater to see if it contains any contaminants?

Putting It All Together

Directions: The EarthWatch team has a new assignment — and they need your help. There's a new environmental situation in Greenville and the team needs you to gather information from the Health Department. They've arranged for you to interview Dr. Bennett. Read the EarthFax below to find out details about the situation. Fill in the chart with questions that you plan on asking Dr. Bennett. The EarthWatch team will probably need more information on this topic to prepare their report. On the back of this page, make a list of possible sources you might use. Consult two of these resources and write a brief report on this subject to give to the EarthWatch team.

EarthFax: A landfill opened in Greenville 10 years ago, and now people living near it are saying that it's causing cancer.

Five years ago, traces of household chemicals were found in test wells in the landfill and in a nearby river. The EPA says these chemicals — trichloroethylene, tetrachloroethylene, and methylene chloride — are probable carcinogens (substances that cause cancer). However, these chemicals were not found in the neighborhood water supply. The air in the area was never tested. These chemicals can dissolve into the ground or evaporate into the air.

Out of 70 residents who live near the landfill, 10 have had cancer, and 7 have died. This is much higher than the cancer rate for the general area; the state reports say that, for every 100,000 people, they expect 434 cases of cancer. If that rate held for this small neighborhood, people living there could expect a new cancer case to be reported every 3 years. But 8 of the 10 cancer cases in the neighborhood have happened in the past 10 years.

However, at least 5 of the 7 deaths reported in the neighborhood were the result of lung cancer. Each of the victims smoked. Statistics show that smokers are more likely to have cancer. In addition, 5 cancer cases occurred in 2 families. Statistics also show that cancer can run in families. Scientists expect to find patterns of illness in situations like this. But there are none. With the exception of the lung cancers, all the other 5 cancer cases were different.

Additionally, scientists are split on this particular case. Some of them say that — until they can show that the people living next to the landfill have a significant rate of a particular type of cancer — which they can't — then the people living there are safe. Others say that they just can't predict what will happen, because assessing risk in cases like this is more an art than a science.

But the people in the area are convinced the landfill is making them sick, and no one was doing anything about it. The county has now decided to close the landfill, strip it of toxins, and pipe county water into the area to replace the wells which now supply the neighborhood with water.

Questions I Need To Answer

1. ______________________________

____

2. ______________________________

____

3 ______________________________

____

4. ______________________________

____

5. ______________________________

____

6. ______________________________

____

7. ______________________________

____

8. ______________________________

____

Data Sheet: Water and your Health

EPA National Drinking Water Standards

# denotes identified cause of cancer
* denotes probable cause of cancer
+ denotes possible cause of cancer

Organic Chemicals	MCL
*1,1,1-Trichloroethane	0.2 mg/liter
*1,1 - Dichloroethylene	0.007 mg/liter
1,2 - Dichloropropane	0.005 mg/liter
1,2 - Dichloroethane	0.005 mg/liter
*Acrylamide	—
#Benzene	0.005 mg/liter
+Carbon tetrachloride	0.005 mg/liter
*Dibromochloropropane	0.0002 mg/liter
*Epichlorohydrin	—
*Ethylene dibromide	0.00005 mg/liter
Ethylbenzene	0.7 mg/liter
Monochlorovenzene	0.1 mg/liter
Styrene	0.1 mg/liter
*Tetrachloroethylene	0.005 mg/liter
Toluene	1.0 mg/liter
Trichloroethylene	0.005 mg/liter
*Trihalomethanes	0.1 mg/liter
*Vinyl chloride	0.002 mg/liter
Xylenes	10 mg/liter
cis-1,2 -Dichloroethylene	0.07 mg/liter
o-Dichlorobenzene	0.6 mg/liter
*p-Dichlorobenzene	0.075 mg/liter
trans-1,2-Dichloro-ethylene	0.1 mg/liter

Herbicides

*Alachlor	0.002 mg/liter
*Atrazine	0.003 mg/liter
*Pentachlorophenol	0.001 mg/liter

Pesticides

*Aldicarb	0.003 mg/liter
*Aldicarb Sulfoxide	0.004 mg/liter
*Carbofuran	0.04 mg/liter
*Chlordane	0.002 mg/liter
*Endrin	0.002 mg/liter
*Heptachlor	0.0004 mg/liter
*Heptachlor epoxide	0.0002 mg/liter
*Lindane	0.0002 mg/liter
*Methoxychlor	0.04 mg/liter
*Toxaphene	0.04 mg/liter

Radionuclides

#Alpha Emitters	15 pC/liter
#Beta-particle emitters	4 mrem/year
#Radium 226 & 228	5 pC/liter

Inorganic Chemicals

#Arsenic	0.05 mg/liter
*Asbestos	7 million fibers/liter
Barium	2.0 mg/liter
Cadmium	0.005 mg/liter
Chromium	0.1 mg/liter
Copper	1.3 mg/liter
Fluoride	4.0 mg/liter
Lead	0.015 mg/liter
Mercury	0.002 mg/liter
Nitrate	10 mg/liter
Nitrite	1.0 mg/liter
Selenium	0.05 mg/liter
Sodium	none; must be reported at 20 mg/liter

Microbiological

Giardia lamblia	zero colonies
Legionella	zero colonies
Total coliform	less than 1 colony/100mL

These standards establish the MCLs (Maximum Contaminant Levels) for regulated substances in drinking water, according to the Safe Water Drinking Act of 1974 and its amendments. An MCL is the highest permissible level of an contaminant that can appear in the water as it is drawn from a customer's tap. MCLs can also be expressed in parts per billion. For example, the MCL for Benzene and Trichloroethylene is 5 parts per billion (ppb). The MCL for 1,1,1 Trichloroethane is 200 ppb.

Acute Waterborne Illnesses

Caused by Bacteria

Campylobacteriosis	Salmonellosis
Cholera	Schistosomiosis
Legionnaire's Disease	Shigellosis
Leptospirosis	Typhoid fever

Caused by Viruses

Hepatitis	Norwalk virus

Caused by Protozoa

Amebiasis	Cryptosporidiosis
Amoebic dysentery	Giardiasis

Chronic Waterborne Illnesses

Methemoglobinemia (Blue Baby Disease) caused by nitrates.

Illnesses brought on by prolonged exposure to chemicals and heavy metals such as cancer, kidney disease and reproductive problems.

Glossary

Accumulate: in chemical contamination, the amassing of a certain element in water, with increasing risks for the population
Acute waterborne illness: any of a number of diseases which result from exposure to a toxic bacterium, virus, or protozoa carried by water
Aeration: removing impurities from water by exposing it to air
Aquifer: a water-bearing stratum of permeable rock, sand, or gravel
Atom: the smallest particle of an element
Bacteria: any of a number of single-cell microscopic organisms, which multiply by simple division
Chlorine: a common nonmetallic element distinguished by a heavy, irritating gas of disagreeable odor
Cholera: an acute waterborne illness marked by severe gastroenteritis
Chronic waterborne illness: any of a number of diseases that result from prolonged exposure to chemicals, herbicides, pesticides, or radionuclides that are carried by water
Coagulation: the process of becoming more viscous or solid, accomplished during water treatment through the use of a flocculent such as alum
Condensation: the act of changing from a gas or vapor to a liquid
Decompose: a chemical reaction in which one substance breaks down into simpler substances
Distilled water: water that has been purified by boiling the liquid and recondensing the vapor, removing any contaminants
Evaporation: the process of changing from a liquid to a gas
Food web: the intricate connection between plants, animals, and humans, in which one species serves as a food source for the other
Gastroenteritis: inflammation of the lining of the stomach and/or intestines, causing diarrhea, nausea, and vomiting
Hydrologic cycle: the movement of water through our environment through evaporation, condensation, and precipitation
Landfill: a place where wastes are disposed by covering them with earth
Mercury: a heavy metallic element that is poisonous
Methylmercury: an extremely toxic substance formed when mercury combines with bacteria in the soil
Microorganism: any microscopic organism, including bacteria, viruses, and protozoa
Mixture: a combination of two or more substances in such a way that they are not chemically combined
Molecule: a group of atoms held together by a covalent bond
Parasite: plants, animals, or microbes that attach to a host to feed off of it
Precipitation: any form of moisture condensing in the air and depositing on the ground
Protozoa: any of a large group of microscopic organisms, including amoeba and paramecia, which consist of a single, relatively large complex cell
Sedimentation: in water treatment plants, the settling out of contaminants from the water, accomplished through the use of a substance called a floc
Solution: a uniform mixture in which one or more substances is dissolved in the other
Suspension: a mixture in which the particles of one substance are mixed with another, but not dissolved
Toxic: poisonous
Vaporize: process by which a substance at its boiling point changes from a liquid to a gas
Virus: any of a large group of submicroscopic infectious agents
Waste incinerator: a facility for disposing of waste products by burning
Water treatment plant: a facility where contaminated water is purified through an extensive series of treatments, including aeration, disinfecting, coagulation, and sedimentation
Watershed: the total land area that drains directly or indirectly to a stream or river
Waterborne: carried by water
Water borne illness: an illness caused by a microorganism or substance carried by water

Internet Resources

http://www.epa.gov
The Environmental Protection Agency's web site
http://www.acnatsci.org/erd/ea/KYE_mainpage.html
The Academy of Natural Sciences Environmental Research Division's site
http://riceinfo.rice.edu/TELRC/TELRC.html
The Texas Environmental Library and Resource Center site
http://www.wqa.org
The Water Quality Association home page
http://www.edf.org
The Environmental Defense Fund's homesite
http://grn.com/grn/
The Global Recycling Network's site
http://vm.cfsan.fda.gov/~dms/risk.toc.html
The U.S. Food and Drug Administration and the International Food Information Council's student site about food risks and safety
http://ftphomel.gte.net/jwagner/edujump.htm
Science Educators' Jump Site
http://www.wri.org/wri/enved
World Resources Institute's education and reference web site
http://chppm-www.apgea.army.mil/gwswp
Site of the Army's Center for Health Promotion & Preventative Medicine's Ground Water and Solid Waste home page
http://es.inel.gov/partners/index.html#top
Site of the Enviroscience Partners for the Environment home page

Books

Give Water a Hand, University of Wisconsin Extension, Cooperative Extension Environmental Resources Center, College of Agriculture and Life Sciences, Madison, WI 53706 1 (800) WATER20
Drinking Water: A Community Action Guide, Concern, Inc. 1794 Columbia Road, NW, Washington, DC (202) 328-8160

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