The School District of the City of Erie
CTE - Conservation Through Education
Resource Conservation
Grade 6 Science Curriculum

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Greening our Schools:
Making our schools more environmentally friendly by promoting the conservation of resources

GOALS

The students will be able to

- Explain what it means to be "Green" and why it is important to sustain the Earth's life support systems: Air, Water, Soil, and Energy.
- Describe the science facts and misconceptions surrounding the issues relating to renewable and nonrenewable resources, alternative energy sources, global warming, climate change, and the negative and positive impact human actions have on the environment.
- Apply scientific methods by learning how to design a resource conservation plan, collect and interpret data, problem solve and put into action their plan to reduce waste, have a positive impact on the environment, and save money.
- Form committees and work collaboratively.
- Use audit results to develop recommendations, short term and long term goals for their school.
- Create an action plan to implement resource-saving recommendations.
- Develop monitoring strategies to maintain conservation measures.
- Choose various areas of resource use to conduct audits, identify usage patterns, and recommend reduction strategies.

Next Generation Science Standards

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capital consumption of natural resources impact Earth's systems.

MSESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Common Core State Standards

ELA/Literacy

RST.6.8.1 Cite specific textual evidence to support analysis of science and technical texts.

RST.6.8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

WHST.6.8.1 Write arguments focused on discipline content.

WHST.6.8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6.8.9 Draw evidence from informational texts to support analysis, reflection, and research.

Mathematics

MP.2 Reason abstractly and quantitatively.

6.RP.A.1 Understand the concept of a ratio language to describe a ratio relationship between two quantities.

7.RP.A.1 Recognize and represent proportional relationships between quantities.

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

Pennsylvania Environment & Ecology Standards

4.2 Renewable and Non-Renewable Resources

4.3 Environmental Health

4.8 Humans and the Environment

E2 Plan: Energy and Education
Introduction/Background Information for the Teacher

The purpose of the **E2 Plan: Energy and Education** is to promote a comprehensive, education- based conservation program for the Erie City School District. It builds upon past successes, involves many parties and utilizes various tools and resources, including those available under the national **Energy Star** program. The **Energy Star Challenge** is a national call-to-action to improve the energy efficiency of America's commercial and industrial buildings by 10 percent or more.

Energy Star (ES) is a government-backed, voluntary program that helps organizations and individuals protect the environment through superior energy performance by providing energy efficient solutions for homes, businesses, and institutions. **Energy Star Portfolio Manager (ESPM)** is a benchmarking system that tracks the energy usage through the development of a building profile.

Plan Priorities
Based on the district potential for resource conservation, and the prior successes of the CTE – Conservation Through Education Program, this plan proposes that a comprehensive program be implemented based on the following priorities and guiding principles:

- **Environmental Stewardship**
- **Behavioral Change**
- **Student Involvement**
- **Educational Impact**
- **Cost Effectiveness**
- **Community Involvement**

The focus of the project is to:
- Incorporate "green" literacy and practices into the Erie City School District science curriculum
- Facilitate student-led resource audits
- Interpret data and design an action plan
- Implement recommendations
- Design reduction strategies to achieve efficient resource consumption

School district energy guidelines are included that give recommendations to administrators, staff, teachers, IT personnel, and students.

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Pre-Assessment

Lesson # 1 - LIFE SUPPORT SYSTEMS

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Part II: Energy Timeline
Part III: Tour of Asbury Woods Nature Center (DVD)
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Background Information for Teacher

What does being green mean anyway?

Being green is doing things in an environmentally friendly way. Being green can range from recycling to building a structure using environmentally friendly techniques and materials.

Why does it matter?

It matters because everyone and everything on our planet depends on each other and the four life support systems for survival. **The four life support systems that make life possible on Earth are: Air, Water, Soil, and Energy (Sun).** These are our natural resources that we must protect and use wisely. This is what Environmental Education is all about. Understanding how the environment works, how we fit in, and how our actions have a positive or negative impact on the environment gives people the knowledge to make environmentally sound decisions. One person's actions can make a difference, because each of these individual actions can have a negative or positive impact.

Where does our energy come from?

Sometimes we take the energy we use in our everyday lives for granted not considering where it comes from and how the acquisition of materials to supply it impacts the earth. When we turn on a light switch, many steps have taken place to bring that energy to our homes, schools and businesses. The sun produces the energy that drives the process of photosynthesis in which plants make food for themselves and animals. As plants die and their bodies are decomposed underground over millions of years, fossil fuels are formed: coal, oil and natural gas. Primarily coal is used as the fuel to produce electricity. When it is burned, the energy is used to boil water that produces steam. The steam turns a turbine and the mechanical power is converted to electricity in a generator. Power stations send the electricity to residential and commercial customers.

What impact does using fossil fuels as an energy source have on the environment?

Fossil fuels such coal, oil and natural gas must be extracted from the ground by mining or drilling. They must then be transported on land and sometimes by water. When they are burned to produce heat, they released impurities into the air such as carbon dioxide, mercury, and sulfur and nitrogen compounds.

The activities in this lesson are written to give students the background knowledge on the life support systems and how we can change the way we utilize and treat these resources so that we can have a positive impact on the environment and make sure there is enough of these resources for the future. It will show students that "being green" really does save money, resources, and has a positive impact. The activities are designed so the students will gain the knowledge to take action to make their schools and homes as "green" as they can be even if the building was not constructed to be a green building. Also, they will learn to make environmentally friendly "green" decisions in their everyday lives.

Part I: Life Support Systems

Purpose: To introduce the Life Support Systems and "Being Green" concepts

This will help us answer the questions: "What does it mean to be green?" and "Why does it matter?"

Objectives:

After this lesson the students will be able to:

1. State what the four life support systems are: Air, Water, Soil and Energy
2. Explain how we utilize these life support systems in our daily lives to survive.
3. Discuss how life support systems are not in endless supply and why it is important to preserve and conserve these systems for the future.

Time: 30 minutes

Materials:

1. Earth Photo

Procedure:

1. Show the representation of the earth to the students. Tell them that the Earth is a very special planet. Life is possible on Earth because of four things. Two are very obvious by looking at the globe or picture (water and land, which we refer to as soil). Ask them to list the four (non-living), things that are needed for the animals, plants and people (living things), to survive on Earth.

These four things are called our "Life Support Systems". They are Air, Water, Soil and Sun, (energy).

2. Write their answers on the board. Below are ways to discuss and explain the life support systems, how we need them to survive, and how we can pollute and waste them. Thus, the need to be green and to live green does not just involve saving energy, using it wisely, and finding renewable alternatives, but also includes conserving and protecting our water, air, and soil as well.

Misconceptions:

Note: Students may say oxygen instead of air. It is not the only component of air. The air is made up of gases such as nitrogen, hydrogen, etc. as well as oxygen.

Note: The students may say things like, clothes, food, and shelter. All three of these can be listed under the soil category because clothes and food come from either plants or animals (ultimately from the soil) and shelters made of a combination of wood that come from trees and other materials made from the soil.

Note: The students may not say energy or sun. They may say electricity, gas, or oil. The fourth life support system that enables life to exist on earth can't be seen in the picture, but it directly or indirectly supplies all of the energy on earth.

3. Lead a discussion about the human impact on the four life support systems.

- Ask the students "Is our **Air** Clean? "What are some of the ways we pollute our air?"
- "Is our **Water** Clean? "What are some of the ways we pollute our water?"
- "What causes soil erosion and why is it harmful?"
- "What are some ways we waste energy?"

Part II: Energy Timeline

Purpose: To trace how electricity is produced from the sun to a light switch
This will help us answer the question: "Where does our energy come from?"

Objectives:
After this introduction the students will be able to:
1. Explain the steps it takes to produce electricity beginning with the energy from the sun.
2. Emphasize how all processes on the earth that require energy relate back to the sun.
3. Explain that when we use electricity, we have an impact on the air, water, and soil on the earth. Our goal is to use resources, such as electricity, wisely so that we can minimize the negative impacts.

Time: 30 minutes

Materials:
1. Energy timeline

Procedure:
1. Why we consider the sun's energy as the life support system instead of coal, oil, gas, or electrical energy, is that all energy can be traced back to the sun. The coal, oil, and gas used to generate electricity, were once prehistoric plants and animals that lived millions of years ago.
- Ask the students if they have ever heard the term fossil fuels. Coal, oil and gas are referred to as fossil fuels because they are like fossils of these plants and animals.
- Ask the students "For example, where do we get electricity to light the lights in the room?" They may say the light switch on the wall.

2. Use the "Energy Time Line" pictures that follow the electricity coming from the light switch back to the sun to demonstrate that all energy can be traced back the sun.

3. Tape or Velcro the pictures and arrows to the whiteboard or wall as you follow the path starting with the light switch → power lines → electric plant that generates the electricity by burning coal, oil, or gas → coal, oil, gas → millions of years being buried under soil → plants and animals that lived millions of years ago → air, water, soil (three of the life support systems needed for the plants to grow and survive) → sun (energy from the sun needed for plants to make sugar during photosynthesis and used for energy to grow and survive). Thus all energy can be traced back to the sun.

4. Another way to use the timeline is to have students place them on the wall in the order they feel is correct and then discuss each step.

5. Lead a discussion about how electricity is used and how it impacts the environment.
- What impact does burning coal to produce electricity have on the environment?
- How do we get coal? How is it transported?
- What problems do we have with energy supplies of coal, oil and natural gas?

6. Introduce the word **Conservation**. Ask the students if they know what the word means. It means protection of resources and wise use. Because we and all other life on Earth need the life support systems to survive it is up to us to protect and use these resources wisely.

Part III: Asbury Woods Nature Center DVD and Tour of Building

Background Information:

Sustainable design seeks to reduce negative impacts on the environment and the health of building occupants and at the same time improve building performance. The basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy, productive environments.

Sustainable design principles include the ability to:

- optimize site potential;
- minimize non-renewable energy consumption;
- use environmentally preferable products;
- protect and conserve water;
- enhance indoor environmental quality; and
- enhance operational and maintenance practices.

Building construction and operation have extensive direct and indirect impacts on the environment. Buildings use resources such as energy, water and raw materials, generate waste (occupant, construction and demolition), and emit potentially harmful atmospheric emissions.

The term "**Sustainable**" can now be introduced. It adds to the meaning of the terms "green" and "conservation". It means that resources will be available for generations to come.

Purpose: To show examples of sustainable design for educational buildings

Objectives:
After this introduction the students will be able to:

1. Identify parts of buildings that waste resources.
2. Define the term sustainability.
3. Explain how green design structures conserve resources.

Time: (3) 45 minute class periods

Materials:
1. Asbury Woods DVD
2. Earthships Article

Procedure:
1. Show the DVD (18 minutes)
2. Lead a discussion on green design strategies. Consider types of windows and doors, how buildings are heated or air conditioned, what types of lighting are used, the purpose of insulation, types of flooring, etc.
3. Take note of the type of windows in your classroom. Do you think the windows are energy efficient? Look at the lights in your room. How many fixtures are there? How many light bulbs are in each fixture? What types of light bulbs are in the fixtures?
4. The next day, take a walk through the school building to notice the various structures in the school building that provide light, heat, insulation, water; those that consume energy such as lights, computers, vending machines, etc. How efficient is your school building? Are there places where resources are wasted?

Part IV: Earthships Article
This article highlights the use of recycled materials to construct homes called Earthships. These homes use very little natural resources and create minimal amounts of waste after construction is complete.

'Earthships' in the Desert Save Owners Cash

http://abcnews.go.com/Technology/earthship-homes-desert-save-owners-cash/story?id=12501438
(Access the website to view a video of Earthship homes.)

Out in the desert near Taos, N.M., they're building houses out of garbage.
Using old tires packed with dirt, trashed appliances, and discarded bottles and cans -- the stuff that stays in landfills forever -- architect Mike Reynolds and his crew are turning our trash into solar-powered, self-sustaining, energy-efficient houses.
"It's kind of a machine, not a house," Reynolds said. "And it's a machine that involves biology and physics to make it so that the people can NOT need municipal utilities."

He calls his creations "Earthships." They are off-the-grid wonders of physics -- angled south to catch the sun's rays through solar panels on the roof so they remain naturally cool in summer and warm in winter. No heat or air conditioning required, Reynolds said. Earthships hover at about 70 degrees year-round, even when it's below zero in the high-desert winter.

"You just have to orient it right," Reynolds said. "Admit the sun in the winter, because it's low. And block it in the summer, because it's high."

Touring his "model" home, a three-bedroom, two-bath Earthship which Reynolds calls The Phoenix, he points out that Earthships are comfortable on homeowners' wallets as well.

"The total utility bill of this house would be $100 per year to run the propane for the cook stove," Reynolds said. "That's $100 per year total."

Earthships begin with a foundation of old tires, about one thousand per house, each individually packed solid with dirt so they're firm as bricks. Reynolds said he "contrived" the use of tires just to recycle them at first. "But now, as an architect, engineer, contractor, builder," he adds, "I could not dream up a better way to build. If somebody gave me $30 million to invent the best building block, I'd invent the tire."

The tires are stacked high and cemented with desert mud, interspersed with aluminum cans, to form walls. The recycled cans create an irregular surface to hold the next course of mud, Reynolds said. Walls are then built to form rooms, just like a regular house -- living room, bedrooms, kitchen, and baths. Rainwater is captured and used -- and re-used. What looks like stained glass is actually the bottoms of plastic bottles and cans, added to let in light and give interest to the walls.

Saving on Utility Bills

On the roof of The Phoenix, there are cisterns to collect and hold rainwater, and solar panels, in addition to decorative green and gold scalloping along the roofline, which gives the house a whimsical look. Those, Reynolds points out, are junked avocado and gold kitchen appliances -- refrigerators, stoves, dishwashers -- from the '70s and '80s, cut into pieces to decorate the homes.
"Every dump is just full of them, so we harvest all those baked-enamel panels," Reynolds said.

But are owners living a rustic lifestyle inside their Earthship? Not unless they want to. In his showplace, The Phoenix, Reynolds has a flat screen TV, a fireplace with a waterfall and wi-fi. There's also a stocked fishpond, and an attached greenhouse for home-grown fruits and vegetables.

The Thorne family from upstate New York drove four days in an RV to come stay in The Phoenix. "I want to bring this back to the East Coast," Bruce Thorne said, as his wife Lita exclaimed over the "green" utilities and the stained glass-like plastic and metal cans decorating the walls.

Addressing People's Needs

Earthships aren't cheap -- they cost about the same to build as a traditional house. They range from about $100,000 for smaller models, to $1.5 million for the Phoenix. (Reynolds admits he priced it high, primarily because he's ambivalent about selling). But many owners, like Alix and David Henry, save money by doing some or most of their own construction. The Henrys outgrew their one-bedroom earthship when daughter Helen was born. They've added on to make room for their larger family.

Like Mike Reynolds, Alix Henry is an architect. She said her parents used to think she was crazy for living in an Earthship -- until utility costs skyrocketed. “My mom actually commented about what a good position we're in," Alix Henry said, "because we don't have any utility (payments) and we don't have a mortgage, so a lot of what's going on in the world is not affecting us."

If Mike Reynolds has his way, whole of subdivisions these unusual structures would be built all across the United States and around the world. They're already in Europe, in other cities across the United States, on the Caribbean island of Bonaire, and, most recently, in earthquake-ravaged Haiti, providing an efficient way of recycling the rubble there. Reynolds and his team go back to Haiti in January 2011 to install systems in the house they built earlier this year. In response to those who view these unusual and unconventional homes as strange, Reynolds points to that $100 a year utility bill, as well as all the junk salvaged from landfills that go into creating Earthships. "We're addressing the garbage issue, we're addressing the water issue, we're addressing the energy issue, heating and cooling, housing, and food," Reynolds said. "All of the things that people need, we're addressing them now."

ABC News' Charles Herman contributed to this report.

Lesson #2: ENERGY

Part 1 - Non-renewable Energy: “Coal Mining: How Do They Do It?” Video

Cookie Mining Activity
Oil Spill Clean-up

Part 2 – Renewable Energy: **Powerpoint Presentation**
Wind Turbines
Solar Panels

Background Information for Teacher - Part 1

How is coal formed?

Coal was formed from plants that lived millions of years ago. When the plants died, they were buried under sand and silt and began to decompose. Over time, the sand and silt built up, putting heat and pressure on the thick layer of dead plants changing it into coal.
Note: Refer to energy timeline in Lesson #1

How is coal extracted?

Coal is buried underground and is harvested through the process of mining. There are various types of coal mining. Underground mining uses deep shafts in which miners travel miles deep into the earth to get to the coal deposits. Above-ground mining can remove seams of coal through open-pit mining, in which a large hole is dug to expose the coal, or strip mining, in which layers of the earth are removed to expose the coal seams.

How is the land reclaimed?

When coal is mined, the land that the coal came from must be reclaimed so that people can use the land again. Environmental laws require mining companies to restore the land to its original state. This includes filling the hole and disposing of the overburden, placing a layer of soil over the area, and replanting the natural vegetation.

Background Information on Nonrenewable Energy
Some of the following information was found on the Department of Energy's Fossil Energy Website
http://www.Fe.doe.gov/education/energylessons/index.html

Non-Renewable Resources:

1. Oil, gas and coal were formed 300,000,000 years ago.
    a. Oil and gas formed from plants and animals that lived in the oceans, lakes, swamps and rivers. Pressure/heat buried plants and animals under layers of sediment and turned them into oil and gas.
    b. Coal was formed the same way but from trees, ferns, and animals that lived on land in swamps that, in some cases, were covered by oceans.

2. Facts on Coal: According to the Department of Energy
    a. America has more coal than other fossil fuel and more reserves of unused coal than other countries.
    b. Coal is used primarily to make electricity by burning it in power plants to power generators.
    c. It produces more than ½ of all the electric power we use.
    d. There is enough coal left in the United States to provide power for the next 200 to 300 years.
    e. Coal causes pollution - nitrous oxide, sulfur dioxide, carbon monoxide, carbon dioxide, and acid rain formed when the nitrous oxide and sulfur dioxide combine with water in the air. The addition of carbon dioxide to the atmosphere contributes to global warming.

3. Facts on Oil: According to the Department of Energy
    a. Oil is necessary for 40% of all of our energy needs and more than 99% of it is used for vehicles.
    b. It is getting harder to find new deposits of oil. They are very deep in the earth.
    c. The United States depends upon large amounts of oil imports from foreign countries. The price of oil and gasoline continue to rise. Burning oil and gasoline put pollutants into the air such as carbon dioxide and contribute to global warming.

4. Facts on Natural Gas: According to the Department of Energy
    a. Natural gas causes less pollution when burned than oil and coal.
    b. Can be used to power cars and trucks.
    c. A method to extract natural gas from shale is called "fracturing or fracking". It uses large amounts of water under pressure to release gas that is trapped between layers of shale underground.
    d. Even though natural gas burns cleaner than coal or oil, it still emits pollutants into the air and contributes to global warming.

5. Nuclear Power Plants:
    a. The fuel for nuclear power plants is uranium which must be mined from underground.
    b. The nuclear power process has relatively little impact on the environment.
    c. The biggest concern is a nuclear leak or disaster that could emit radioactive wastes into the environment which remain harmful for millions of years.
    d. Nuclear wastes are currently stored at each power plant with no feasible disposal plan.

Part I: "Coal Mining: How Do They Do It?" Video (5 minutes 43 seconds)
http://science.discovery.com/tv-shows/how-do-they-do-it/videos/how-do-they-do-it-coal-mining.htm

Part I: Cookie Mining Activity

Purpose: The purpose of this lesson is to use chocolate chip cookies to represent coal deposits to show that it it is difficult to remove these resources from the ground and that once you do you have to reclaim (restore) the land.

Objectives:
After this activity the students will be able to:

1. Explain that coal is a non-renewable resource.
2. Describe how coal is mined from the earth.
3. Demonstrate land reclamation.

Time:

1. 45 minutes

Materials:
Needed for each student

1. 2 different kinds of chocolate chip cookies (cookie A/hard and cookie B/soft)
2. 2 toothpicks
3. 2 napkins
4. 1 piece of paper

Procedure:

1. Explain to the students that they will be comparing two different land sites containing coal. They will mine the coal from each piece of land.

2. Ask the students how we use coal. Discuss the ways in which we use coal every day. Coal is a nonrenewable energy resource. Once we use it, we cannot make more of it in a short period of time.

3. Show the students their "land" (cookies) and the "mining equipment" (toothpicks). Emphasize that the cookies are not to be eaten during the mining. Differentiate between cookie A and cookie B.

4. Explain the mining process to the students, using the directions on the worksheet.

5. Make a chart on the board with the class totals from the cookies A and B. Compare the results.

6. Eat the extra cookies!

7. Follow up discussion:

- Ask the students which type of cookie was easier to mine and which type of cookie contained the most coal (chips). Discuss with the students how this compares with coal resources. Do some areas have coal that is easier to mine than others? Do some areas have more coal than others?
- Ask if it was easier to mine the chips on the surface of the cookies or chips from inside the cookies?
- Discuss the differences between surface and underground mining.
- Ask the students if their reclaimed cookies looked like the original cookie. Discuss land reclamation and why it is important.

NON RENEWABLE ENERGY RESOURCES
Chocolate Chip Mining Activity Data Sheet

Name:_____

1. Trace the outline of cookie A on a piece of paper. Map the location of the chocolate chips you can see on the top of the cookie. Label map A.
2. Count the number of chips you can see on the top and sides of the cookie. Record this number on the chart.
3. Using the toothpick, carefully mine as many chocolate chips as you can from the cookie. Set the chips aside in a pile.
4. Count the number of chips mined from the cookie. Record the number on the chart.
5. Put the cookie back together without the chocolate chips. Compare to your map of the cookie.
6. Repeat the procedure for cookie B.

MY TOTALS: CLASS TOTALS:

Cookie	# of surface chips	# of chips mined	Cookie	# of surface chips	# of chips mined
A			A		
B			B		

Which cookie was easier to mine and why?

What is reclamation and why is it important?

List two ways we use coal today.

Additional Activities:

COAL ENERGY AND CLASSROOM ACTIVITIES
This hyperlink provides a 28 page lesson plan and activities guide for middle school level and above. Plans address history of coal as a resource through active mining practices, types of coal, fossil fuels as nonrenewable resources and more. (www.efmr.org/edu/coal2009.pdf)

"Electronic Field Trip to a Coal Mine" (57 minutes)
This video covers many areas related to coal mining: how coal is found, types of coal, types of machinery, safety precautions, surface mining, underground mining (drift, shaft, and slope mines; methods to extract coal), careers and training in the mining industry,

ENVIRONMENTAL LITERACY
Supported by the Environmental Literacy Council, this website provides information about air, land, water, climate, ecosystems, coal mining, food, environment and society.
(www.enviroliteracy.org/article.php/1122.html)

Part II: Oil Spill Cleanup Activity

Background Scenario:

For many decades now, fossil fuels such as oil and coal have been used as energy sources for lighting, heating, transportation, manufacturing, and industrial processes. Burning fossil fuels releases carbon dioxide and other pollutants such as mercury into the air. Due to increased concern about global climate change, many countries are now faced with the choice of continuing their fossil fuel based energy or developing new technologies that can reduce or eliminate the need for these products.

In order to extract coal, oil, and natural gas from underground, people have to mine or drill. This often has significant impacts on the surrounding land, plants, and animals. Impacts of drilling can be the construction of roads, drilling sites, and pipelines. Oil then must be transported to refineries where it is converted to gasoline and other products. This transportation can result in oil spills as ships move around the oceans.

One such accident occurred on March 24, 1989. A large tanker called the Exxon Valdez dumped 10.9 million gallons of oil into Prince William Sound, an untouched area of wildlife. The incident killed hundreds of thousands of birds and damaged local fisheries. Another oil spill occurred on April 20, 2010 when an off-shore platform in the Gulf of Mexico called the Deepwater Horizon exploded. The spill caused extensive damage to marine and wildlife habitats and to the Gulf's fishing and tourism industries. Skimmer ships, floating containment booms, anchored barriers, sand-filled barricades along shorelines, and dispersants were used in an attempt to protect hundreds of miles of beaches, wetlands, and estuaries from the spreading oil.

Purpose: To understand that oil is a nonrenewable source that has negative impacts on the environment when extracted from the ground has potential environmental risks when transported from one site to another.

Objectives:

In the Oil Spill Cleanup activity, the students will be able to:

1. describe some of the environmental consequences associated with fossil fuel usage.
2. discuss the risks of transporting fossil fuels.
3. demonstrate methods used in an oil spill cleanup.

Time: 45 minutes

Materials:

Per team of 4 or 5 students:

- Aluminum pan or plastic tub
- Small paper cup
- Water
- Cooking oil
- Habitat items: rocks, sticks, feathers
- Cleaning items: sponges, cotton balls, spoons
- Oil spill worksheet and pencil (1 per student)
- Paper towels

Your challenge today is to determine what materials will best cleanup an oil spill.

Preparation:

1. Fill pans with water from containers.
2. Pour oil in small cups for each group.
3. Hand soap or sanitizer and paper towels can be used to clean hands.

Procedure:

1. Have students read background information.
2. Place habitat items in pan of water (rocks, sticks, and feathers).
3. Pour cooking oil into pan.
4. Place names of group members onto data sheet.
5. Record observations.
3. Experiment with various cleaning items (spoons, sponges, and cotton balls).
4. Record observations on worksheet.

Discussion:

1. What connections can be made between this activity and real oil spills?
2. What alternatives are there to using fossil fuels such as oil as energy sources?

Save pan, rocks, and sticks.
Clean up with soapy water.

Oil Spill Cleanup

Name_____
Date_____

Use this table to document how natural materials interact with oil.

Natural Object	Reaction with oil	What does this mean for real oil spills?

Rock		
Stick		
Feather		

Use this table to document how cleaning materials interact with oil.

Cleaning Object	**Reaction with oil**	**What does this mean for real oil spills?**
Sponge		
Cotton Ball		
Spoon		

Lesson #2: ENERGY (continued)

Part 2 - Renewable Energy

Background Information:

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electrical power, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships.

Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network. Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms provide electricity to isolated locations. Utility companies increasingly buy surplus electricity produced by small domestic wind turbines.

Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land. The effects on the environment are generally less problematic than those from other power sources. As of 2011, Denmark is generating more than a quarter of its electricity from wind and 83 countries around the world are using wind power on a commercial basis. In 2010 wind energy production was over 2.5% of total worldwide electricity usage, and growing rapidly at more than 25% per annum. The monetary cost per unit of energy produced is similar to the cost for new coal and natural gas installations.

Solar power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaics convert light into electric current using the photoelectric effect.

Commercial concentrated solar power plants were first developed in the 1980s. The 354 MW SEGS CSP installation is the largest solar power plant in the world, located in the Mojave Desert of California. Other large CSP plants include the Solnova Solar Power Station (150 MW) and the Andasol solar power station (150 MW), both in Spain. The over 250 MW Agua Caliente Solar Project in the United States, and the 221 MW Charanka Solar Park in India, are the world's largest photovoltaic power stations.

Hydroelectricity is the term referring to electricity generated by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water. It is the most widely used form of renewable energy, accounting for 16 percent of global electricity generation – 3,427 terawatt-hours of electricity production in 2010,[1] and is expected to increase about 3.1% each year for the next 25 years.

Hydropower is produced in 150 countries, with the Asia-Pacific region generating 32 percent of global hydropower in 2010. China is the largest hydroelectricity producer, with 721 terawatt-hours of production in 2010, representing around 17 percent of domestic electricity use.

The cost of hydroelectricity is relatively low, making it a competitive source of renewable electricity. The average cost of electricity from a hydro plant larger than 10 megawatts is 3 to 5 U.S. cents per kilowatt-hour. Hydro is also a flexible source of electricity since plants can be ramped up and down very quickly to adapt to changing energy demands. However, damming interrupts the flow of rivers and can harm local ecosystems, and building large dams and reservoirs often involves displacing people and wildlife. Once a hydroelectric complex is constructed, the project produces no direct waste, and has a considerably lower output level of the greenhouse gas carbon dioxide (CO_2) than fossil fuel powered energy plants.

Geothermal systems involve closed loop geothermal heat pumps circulating a carrier fluid (usually a water/antifreeze mix) through pipes buried in the ground. Single-home systems can be "vertical loop field" systems with bore holes 50–400 feet deep or, if adequate land is available for extensive trenches, a "horizontal loop field" is installed approximately six feet subsurface. As the fluid circulates underground it absorbs heat from the ground and, on its return, the now warmer fluid passes through the heat pump which uses electricity to extract the heat from the fluid. The re-chilled fluid is sent back into the ground thus continuing the cycle. The heat extracted and that generated by the heat pump appliance as a byproduct is used to heat the house. The addition of the ground heating loop in the energy equation means that more heat is generated than if electricity alone had been used directly for heating.

Switching the direction of heat flow, the same system can be used to circulate the cooled water through the house for cooling in the summer months. The heat is exhausted to the relatively cooler ground (or groundwater) rather than

delivering it to the hot outside air as an air conditioner does. As a result, the heat is pumped across a larger temperature difference and this leads to higher efficiency and lower energy use.

This technology makes geothermal heating economically viable in any geographical location. In 2004, an estimated million ground source heat pumps with a total capacity of 15 GW extracted 88 PJ of geothermal energy for space heating. Global geothermal heat pump capacity is growing by 10% annually.

Biofuel is a type of fuel whose energy is derived from biological carbon fixation. Biofuels include fuels derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases. Biofuels are gaining increased public and scientific attention, driven by factors such as oil price hikes and the need for increased energy security.

Bioethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn or sugarcane. Cellulosic biomass, derived from non-food sources, such as trees and grasses, is also being developed as a feedstock for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions. Bioethanol is widely used in the USA and in Brazil. Current plant design does not provide for converting the lignin portion of plant raw materials to fuel components by fermentation.

Biodiesel is made from vegetable oils and animal fats. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using transesterification and is the most common biofuel in Europe.

In 2010, worldwide biofuel production reached 105 billion liters (28 billion gallons US), up 17% from 2009, and biofuels provided 2.7% of the world's fuels for road transport, a contribution largely made up of ethanol and biodiesel. Global ethanol fuel production reached 86 billion liters (23 billion gallons US) in 2010, with the United States and Brazil as the world's top producers, accounting together for 90% of global production. The world's largest biodiesel producer is the European Union, accounting for 53% of all biodiesel production in 2010. As of 2011, mandates for blending biofuels exist in 31 countries at the national level and in 29 states or provinces. The International Energy Agency has a goal for biofuels to meet more than a quarter of world demand for transportation fuels by 2050 to reduce dependence on petroleum and coal.

Hydrogen fuel is a zero-emission fuel which uses electrochemical cells or combustion in internal engines, to power vehicles and electric devices. It is also used in the propulsion of spacecraft and can potentially be mass-produced and commercialized for passenger vehicles and aircraft.
Because pure hydrogen does not occur naturally, it takes energy to manufacture it. There are different ways to manufacture it, such as, electrolysis and steam-methane reforming process. In electrolysis, electricity is run through water to separate the hydrogen and oxygen atoms. This method can be used by using wind, solar, geothermal, hydro, fossil fuels, biomass, and many other resources. The more natural methods of making electricity (wind, solar, hydro, geothermal, biomass), rather than fossil fuels, would be better used as to continue the environment-friendly process of the fuel. Obtaining hydrogen from this process is being studied as a viable way to produce it domestically at a low cost.

Part 2 - Renewable Energy: Powerpoint Presentation

Purpose: The PowerPoint presentation on renewable resources will give the students some background, benefits, and drawbacks on alternative energy sources such as wind, solar, hydropower, geothermal, biofuel, and hydrogen.

Objectives:
After this activity the students will be able to:

1. Define and list examples of renewable and non-renewable energy resources.
2. Understand that non-renewable energy sources such as coal are used to generate more than ½ of all our country's electrical power and how dependent the world is on oil to produce gasoline.

3. Explain why is important to look at alternative, clean or "green" sources of energy to replace non-renewable, pollution causing, limited supply sources of fossil fuels.
4. List the benefits and drawbacks of solar, wind, hydropower, geothermal, biofuels, hydrogen sources of energy and where they are currently being used to generate electrical power.

Time: 45 minutes

Materials:
Projector/screen/computer/Powerpoint presentation on alternative energy sources

Procedure:

1. Ask the students to list renewable and non-renewable energy resources.
A. Non-Renewable: Oil, Coal, Gas, Nuclear power
B. Renewable: Wind, Hydropower, Solar, (others: Geothermal, Biofuels, Hydrogen)

2. Discuss the dependence we have on non-renewable energy sources.
A. Coal is used to generate more than ½ of all our country's electrical power.
B. Oil is used to produce gasoline to power 99% of our cars and trucks.
C. Nuclear power produces radioactive wastes. That creates problems of long-term storage.

3. Explain, list, and discuss reasons why is important to look at alternative, clean or "green" sources of energy to replace non-renewable, pollution causing, limited supply sources of fossil fuels.

Some of the reasons and drawbacks the students may suggest in the discussion of non-renewable energy use: pollution, global warming, limited supplies, hard to find new sources, methods of getting the coal, gas, and oil can harm the environment, dependence on foreign products, etc.

4. Tell them there are also benefits and drawbacks of alternative, clean, "green" renewable sources of energy; solar, wind, hydropower (hydroelectric), geothermal, biofuels, and hydrogen fusion.

5. Show the PowerPoint Presentation on Alternative Energy Sources. (30 minutes)

Alternative Activities:

http://www.thinkgreen.com/teacher-results
Video Clips ("Nonrenewable Resources" and "Renewable Resources" 5min. 45secs. each)
Interactives ("Energy Consumption", "Future Power", "How to Light Up a Room", "Power Up)

Examples of local or regional uses of renewable energy sources: wind farm along Route 80 and 76 in Central PA, water generation at Niagara Falls, and solar panels to power local homes and schools.

Part 2 - Renewable Energy: Wind Turbine Activity (see directions in binder)

In this activity, groups of students construct a wind turbine and test the energy output by manipulating variables such as speed of the fan, distance of the fan from the turbine, blade design, etc.

4 turbine kits and 4 fans provided

2 class periods

Note: It may take one class period to construct the wind turbine and connect the multimeter and a second class period to perform the experiments.

Part 2 - Renewable Energy: Solar Panel Activity (see directions in kit)
In this activity, pairs of students construct a solar panel to power a small fan.

15 solar panel kits provided

2 class periods

Note: This activity will take one class period to build the panel and one class period to test the fan. Be sure to place the panel in full sunlight.

Lesson #3:"WHO WANTS TO BE AN ENVIRONMENTALIST?"

(Adapted from the "Who Wants to be a Millionaire" TV Game Show)

Purpose: The purpose of this activity is to assess the knowledge of the students on the concepts and content concerning the topics of sustainability, life support systems, and renewable and non- renewable resources.

Objectives:
After this activity the students will be able to:

1. Work together as a team.
2. Follow directions.
3. Identify the four life support systems.
4. Define what it means to be "Green".

5. Explain what the sustainable use of resources means.
6. Compare renewable and non-renewable resources.
7. Describe how life support systems are the abiotic factors in the earth's ecosystems.
8. Explain the advantages and disadvantages of renewable and nonrenewable energy sources.

Time: 30 – 40 minutes

Materials:

1. Projector/screen/computer/Environmentalist Game
2. Environmentalist Game:
   a. Life lines: 50/50, Phone a Naturalist, and Ask the Audience.
   b. Question categories, (Easy, Medium and Difficult)
3. Cell phone for phoning the Naturalist.

Procedure:

1. Have another teacher or someone in the school office act as your phone a friend (Naturalist), use a cell phone to call them when the group uses that life line. Make sure the "Naturalist" has the questions and answers.

2. Split the students up into three equal groups. The groups should sit together so they can discuss the questions and answers before one person, being the designated spokesperson, gives the answer they all agree upon.

"Who Wants to be an Environmentalist?"

- On the TV show, the contestant has life lines to help with the questions and are only used once.
  1. One of the lifelines is ask the audience. The "audience" can be the rest of the class who must vote honestly for the correct answer.
  2. The second lifeline is ask the "naturalist".
  3. The third lifeline is 50/50 where only 2 answers will remain.
- Tell them they will have three questions each, starting off with an easy question, then medium question, then a hard question. When one group is answering their questions, all groups should try to answer the question because the questions contain important vocabulary and concepts.
- The group discusses each question and the spokesperson gives you the best answer.
- If you can, have the teams play for candy, fake money, or some other prize.

"Who Wants to be an Environmentalist?" Game - Questions and *Answers*

Easy Questions:

1. Which of the following best describes what it means to be "Green"?
   a. Eating green beans
   b. Recycling
   c. Doings things in sustainable ways
   d. Having green as your favorite color
2. Which of the following is considered not to be a fossil fuel?
   a. Oil
   b. Coal
   c. Gas
   d. Wood
3. Which of the following produces half of the energy used in the United States?
   a. Solar
   b. Wind
   c. Nuclear
   d. Coal

Medium Questions:

1. Which of the following is NOT a way to "Green" up your home or school?
   a. Use 15 watt fluorescent light bulbs
   b. Turn down the thermostat
   c. Turn off the lights when leaving a room
   d. *Use disposable plates and cups*

2. Which of the following energy sources can be converted directly into electricity?
   a. *Solar* c. Wind
   b. Water d. Coal
3. The first oil well was drilled in what state in 1859?
   a. Ohio c. Virginia
   c. *Pennsylvania* d. Texas

Hard Questions:

1. Which of the following does NOT cause climate to change on its own over time?
   a. Changes in the energy received by the sun c. Movement of the earth's tectonic plates
   b. Changes in the tilt of the earth's axis *d. Use of alternative energy sources*
2. In 1800, what resource provided 95% of the United States' energy needs?
   a. Coal c. Gas
   b. Solar d. *Wood*
3. The United States has enough coal to last for how many years?
   a. 10 -20 years *c. 200-300 years*
   b. 50-100 years d. 700-800 years

Adapted from Pre-Visit #1 of the June, 2006, by: Steve Wasiesky and Andrea Platz, "Project Green" "It's Easy Being Green" © Asbury Woods Nature Center, Millcreek Township School District, 4105 Asbury Rd. Erie, PA 16506, 814-835-5356.

REVIEW LESSONS:

COLOR A WATERSHED (Preparation activity for the Watershed Map Game)

Time Required: (2) 45 minute class periods

Materials: (per group of 2-3 students)

- One sheet of unlined paper
- Masking tape
- Water-soluble markers
- Permanent markers
- One spray bottle filled with water

(Note: Use sheets of newspapers to cover desks if lab tables are not available.)

Introductory Activity: (to be done as a class and led by teacher):

- ✓ A copy of "Whatzzzzup-Stream?" and "Stop Pointless Pollution" articles for each student.
- ✓ Read the watershed information together as a class.

- ✓ Discuss the Lake Erie watershed in which all of the streams in our area flow into Lake Erie.

Procedure: (for groups of 2 or 3 students):

1. Crinkle the piece of unlined paper into a ball.
2. Smooth it out slightly onto the lab table or newspaper. Be sure to leave some ridges and valleys.
3. Tape each side of the paper to the lab table or newspaper with small pieces of masking tape.
4. Use a water-soluble blue marker to color the tops of the ridges. Do this over the entire map many times over.
5. Use a black or brown permanent marker to draw in roads. (Think about where the roads should go before you begin drawing.)
6. Use a green or yellow permanent marker to draw in trees and farms. (Think about where these should be placed.)
7. Use other colors of permanent markers to draw in homes, stores, factories, etc.

Record what colors are used for each part of the map in the table below:

KEY

Color	**Map Area**
Blue	Ridges

8. When your map is complete use the spray bottle to soak the map. **WATCH WHAT HAPPENS!**

Questions: (Answer these on the back of this paper.)

1. What did the blue marker represent?
2. Where did the blue color go?
3. What is a watershed?
4. How many watersheds do you have on your map?

http://water.epa.gov/polwaste/nps/kids/middleschool/upload/whatzzzzzup_article.pdf

http://water.epa.gov/polwaste/nps/kids/middleschool/upload/stoppointless_article.pdf

There are activity sheets to accompany the articles on the EPA website.

- **Life Support Systems Watershed Game**

Directions:

The Really Big Watershed Game is played with three students acting as the game pieces. Another student may roll the die and others may be in charge of distributing each color of ping pong balls. The remaining students may watch the game and participate in the next round.

A large die is rolled and the player moves that many water drop (spaces) up his/her river on the game board. All players can move per roll or one player per roll of the die. The colors refer to different colored ping

pong balls that the players collect or discard depending upon what happens to that portion of the river/stream. Blue ping pong balls represent water. Each student should start out with 8 – 10 waters. When told on the game board to give up colored balls, this means all colors except blue.

When students reach Lake Erie, we look at the composition of the "water" in his/her collection bucket. The bluer the water, the cleaner it is. The more colors present, the more polluted the water is.

Concepts discussed are runoff, water use and misuse, sedimentation, natural and human water treatment, and energy usage and its effects on water systems.

- **Environmental Jeopardy™**

Electronic version; Game answer key follows

- **Enviroscape™ Activity**

This game can be borrowed from the Conservation District Building or Environment Erie.
http://erieconservation.com/ 814-825-6403

Nate Millet
nate.millet@environmenterie.org

ENVIRONMENTAL JEOPARDY™ - Elementary Version

LIFE SUPPORT SYSTEMS	RENEWABLE AND NONRENEWABLE ENERGY	ENERGY CONSERVATION	ENVIRONMENTAL IMPACTS	CLIMATE CHANGE
$100: All energy can be traced back to what? **A: The sun**	$100: Is hydropower renewable or nonrenewable? **A: renewable**	$100: What is one effective way of saving energy in your home? **A: turning off the lights, unplugging appliances, turning down the thermostat, insulating, etc.**	$100: What is the term used to describe restoration of the land to its original condition after mining has taken place? **A: Reclamation**	$100: Name one significant effect of global climate change. **A: Melting glaciers, rising sea levels, warmer oceans, changing precipitation patterns, changes in plant & animal ranges**
$200: What are the four life support systems?	$200: Is nuclear power renewable or nonrenewable?	$200: What is the most efficient light bulb?	$200: What energy source produces radioactive waste than remains harmful for thousands of years?	$200: What is the term that means "local temperature and precipitation changes"?

A: Air, Water, Soil, Energy	**A: Nonrenewable**	**A: LED**	**A: Nuclear**	**A: Weather**
$300: What do the terms "biotic" and "abiotic" mean? **A: living and nonliving**	$300: What gas is produced by burning fossil fuels in our atmosphere which can cause global warming? **A: carbon dioxide**	$300: What appliance in the home uses half of the energy produced from nuclear power plants? **A: refrigerators**	$300: What is the unit of measure used when operating a light meter? **A: footcandle**	$300: What is the term that means "changes in temperature and precipitation over a long period of time"? **A: Climate**
LIFE SUPPORT SYSTEMS	**RENEWABLE AND NONRENEWABLE ENERGY**	**ENERGY CONSERVATION**	**ENVIRONMENTAL IMPACTS**	**CLIMATE CHANGE**
$400: What does the term "sustainability" mean? **A: Using resources wisely so that there is enough for future generations**	$400: What type of renewable power uses the internal heat of the earth as an energy source? **A: Geothermal**	$400: What percentage of energy is used for lighting in the U.S.? (You must be within 5 points of the correct answer.) **A: 20% (15%-25%)**	$400: Biofuels are produced from what type of material? **A: Plant and animal bodies**	$400 At the current rate, the Earth's global average temperature is projected to rise how many degrees Fahrenheit by 2100? (You must be within 5 degrees of the answers) **A: 3 to 7 degrees Fahrenheit**
$500: Describe the steps of the energy timeline. **A: Sun – Plants (water/soil/air) – Plants Die (millions of years pass) – Fossil Fuels – Power Generating Plant – Electric Lines – Light Switch on wall**	$500: Most of our electricity is generated at power stations. Where do most power stations get their energy? **A: Coal**	$500: If every American turned their water heater down by 10 degrees, how many million tons of carbon dioxide emissions would be saved each year? (You must be within 5 points of the correct answer.) **A: 45 (40-50)**	$500: Acid rain is formed when nitrogen and sulfur compounds combine with what compound in the atmosphere? **A: Water (vapor)**	$500 What are the three types of fossil fuels? **A: coal, oil, and natural gas**

Lesson #4: SCIENTIFIC INQUIRY

Part I: Scientific Method

- Review the steps of the scientific method
- "Rachel Carson: Environmentalist and Writer" Article

Part II: Experimental Design

Purpose: To identify and analyze the parts of an experiment

Objectives:

Students will be able to:

1. Identify the independent and dependent variables
2. Identify which variable is being manipulated
3. Identify control
4. Identify constants
5. Write a hypothesis
6. Construct appropriate data tables
7. Construct appropriate graphs
8. Analyze data

9. Draw conclusions

SCIENTIFIC METHOD/EXPERIMENTAL DESIGN SCENARIO

The students of Begonia Middle School wanted to find out what amount of fertilizer would make sunflower plants grow best.
They decided to plant sunflower seeds in the following way:
3 pots with no fertilizer
3 pots with 1 gram of fertilizer
3 pots with 2 grams of fertilizer
3 pots with 3 grams of fertilizer

The students mixed the fertilizer with the soil in each pot. The plants were placed in sunlight on the windowsill of their classroom and given the same amount of water each day.

Answer the following questions:

1. Can you state the problem?
2. What might the students research to help them formulate a hypothesis?
3. What is the standard that the results are being compared to?
4. Name the variables that must be controlled?
5. What is the independent variable?
6. What is the dependent variable?
7. Can you formulate a hypothesis?

After 2 weeks, the plants were measured and the following results were obtained:
No fertilizer plants: 1 cm; 2 cm; 1 cm
1 gram of fertilizer plants: 3cm; 2 cm; 2 cm
2 grams of fertilizer plants: 4 cm; 3 cm; 5 cm
3 grams of fertilizer plants: 1 cm; 1 cm; 1 cm

8. Calculate the average plant growth for each type of soil.
9. Construct a data table and include all results. Make sure every part is labeled.
10. Graph the average plant growth for each type of soil.
11. Was your hypothesis correct? Show evidence that your claim was supported or not.

Rachel Carson: Environmentalist and Writer

"Man's way is not always best"
By Kathy Wilmore
http://www.scholastic.com/browse/article.jsp?id=4964

When you hear the world "revolutionary," what image comes to mind? Do you look back in history to see someone like George Washington or Paul Revere? How about the environmentalist and writer Rachel Carson? She may not look the part, but Rachel Carson was a true revolutionary. Her work as a writer and scientist stirred people up and helped launch a new age of environmental awareness in the United States.

In 1962, Carson published *Silent Spring*, her fourth book on nature. It had an almost fairy-tale beginning: "There once was a town in the heart of America where all life seemed to live in harmony with its surroundings."

However, something in that town went horribly wrong. Sickness and death appeared everywhere: among flowers and trees, cattle and sheep, even humans. "There was a strange stillness," wrote Carson. "The birds, for example — where had they gone? The few birds seen anywhere... trembled violently and could not fly. It was a spring without voices. On the mornings that had once throbbed with the dawn chorus of (many) bird voices there was now no sound: only silence lay over the fields and woods and marsh."

Carson went on to explain the cause of that eerie silence: "Pesticides" (insect-killing chemicals) had gotten into the water, air, and soil and were killing or sickening all sorts of creatures — including humans. "Can anyone believe," she wrote, "it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called "insecticides" [insect killers] but biocides [life killers]."

If we are not more careful with the chemicals we use, warned Carson, the nightmarish silence described in *Silent Spring* could come true.

Anything But Silence

The reaction to Carson's book was anything but silence. It caused such an uproar that a *New York Times* headline declared: SILENT SPRING IS NOW NOISY SUMMER.

Chemical manufacturers were furious with Carson. They ran ads telling Americans to ignore *Silent Spring*. They questioned Carson's abilities as a scientist, calling her a hysterical fanatic. Pesticides, they said are perfectly safe — don't worry about a thing.

But Americans did worry. The White House and the Congress were flooded with letters from anxious citizens demanding that something be done. President John F. Kennedy called for a special committee of scientists to investigate Carson's claims. Congress also formed an investigation committee.

The soft-spoken Carson would rather have spent her days on the rocky coast of Maine, where she did much of her research as a "marine biologist" (scientist who studies sea life). But the storm of debate surrounding her book and its critics pulled her into the limelight.

Coming to Terms with Nature

In defending her research, Carson told Americans to think for themselves. Who had the most to win or lose if she turned out to be correct? "As you listen to the present controversy about pesticides," said Carson, "I recommend that you ask yourself: Who speaks? And why?"

The main thing to consider, she said, is our future. What kind of world do we want to leave our children? "I deeply believe," Carson told Congress, "that we in this generation must come to terms with nature."

Carson's ideas may not seem revolutionary today. But back in 1962, few people were familiar with such terms as pollution and ecology and environmental awareness. U.S. industries were constantly coming out with useful and exciting new products, but few people stopped to think if there could be negative side effects to any of them. Humans did what was convenient for them. Nature to most people was something that just took care of itself.

A Message To Remember

President Kennedy's commission supported Carson's warnings. So did other government studies. Armed with such new data and the public outcry, Congress began passing laws to ban or control the use of potentially dangerous pesticides. It also called for more careful testing of chemicals' side effects. In 1970, Congress established the Environmental Protection Agency (EPA) to reduce and control pollution of water, air, and soil.

Rachel Carson did not live to see all of this happen. She died of cancer in 1964.

What about us? Can we avoid the "silent spring" that Carson predicted? In the 31 years since *Silent Spring* first appeared, people have grown far more aware of our impact on the environment. But we still use many potentially deadly chemicals.

A 1993 *New York Times* article says that "68 pesticide ingredients [not in use] have been determined to cause cancer. One out of every 10 community drinking-water wells contains pesticides... Farmers exposed to "herbicides" [weed killers] have a six times greater risk than others of contracting certain cancers. Children in homes using pesticides are seven times as likely to develop childhood leukemia [a form of cancer]."

"There remains, in this space-age universe," wrote Rachel Carson, "the possibility that man's way is not always best." We would do well to remember her warning.

Post-Assessment

Resource Conservation Audit Model

Purpose: To audit one or more areas in the school by collecting data, assessing resource usage, determining capacities for improvement, implementing recommendations and monitoring compliance.

The following Resource Audit Model is divided into segments so that teachers and students may concentrate on one or more of the following areas of resource usage: electrical, solid waste, or water.

General Procedure

Discuss resource issues and identify problems; create a list of questions for the building engineer

Tour school with building engineer

Conduct research

Establish student groups

Develop experimental design

Collect data

Analyze data

Compile information

Develop recommendations

Present information to school community

Implement recommendations

Monitor compliance

Community Outreach

ELECTRICITY

Tour with Building Engineer Sample Questions (It is best to have students generate their own questions.)

What are the main consumers of electricity in the building?
How efficient is the lighting?
How do the outdoor lights work?
What type of lights are in the EXIT signs?
Where are the computers located and how are they used?
Where are other appliances such as vending machines, copiers, etc. located?

Are there any wasteful practices?
How can we change infrastructure and behavior to save electricity?

Electrical Usage – Overview of Teams

One or more of the following areas can be assessed:

1. Lighting
    - Lighting Audit Team – Students count light fixtures in specific areas of building, determine wattage of bulbs and hours of usage, calculate electrical usage in one school day
    - Lighting Measurement Team – Students use light meters to determine lighting patterns in various areas of the building, make recommendations to use natural light vs. electrical light
    - External & Exit Lighting Team – Students research location, type of lights, and patterns of usage

- Off – Hours Energy Usage Team – Students research how lighting is used after school and on weekends; make recommendations

2. Computers
   - Computer Team – Students count computers and investigate patterns of usage; use wattage meters to determine volts used when computer are on and in sleep mode

3. Appliances
   - Vending machines, copiers, etc. - Students use wattage meters to determine how much electricity appliances consume; make recommendations for energy reduction

4. Energy Star Data Team
   - Electrical usage can be tracked through the Energy Star Portfolio Manager Account. Students can use the data to create graphs, analyze data, interpret usage patterns and determine usage reductions over time.

5. Presentation Team
   - Teachers and students are encouraged to develop a presentation that will communicate information to the faculty, student body, and community. This presentation will educate various groups on usage patterns and recommendations for resource reduction.

Electrical Usage – Detail of Teams

Lighting Audit Team

Students count light fixtures and number of bulbs in each fixture, determine wattages and hours of usage and calculate the amount kilowatt hours consumed in one school day.

- ✓ Divide the school into various areas:
  a. classrooms
  b. hallways and stairwells
  c. auditorium
  d. gymnasium
  e. cafeteria
  f. library
- ✓ The electrical consumed by lighting during one school day can be determined after all light bulbs are counted and the wattage of each bulb is recorded. In a 24-hour period, an estimate of how long the lights are on should be determined.
- ✓ Send a survey to each classroom teacher (see sample)
- ✓ Use formula to determine kilowatt hours
- ✓ Add individual classroom totals to determine total classroom kilowatt hours consumed
- ✓ Audit other areas listed above

Optional:

- ✓ Flicker-Checkers can be used to determine if ballasts are magnetic or electronic

Sample Data Tables

Room Number	Number of light fixtures	Number of bulbs in each fixture	Watts per bulb	Number of usage hours in 24 hours	Notes

Number of Kilowatt Hours Used by the Building Per Day

Rooms / Area	Hours Lights are Used	Number of Kilowatt Hours (KWH) per day
Total Hallways	12	151.296
Total Classrooms	11	278.784
Gym	11	5324
Library	11	32.384
Office / Speech	12	16.384
Cafe	8	15.36

Calculation:

# of fixtures X # of bulbs in each fixture X wattage/ bulb X # of hours in use per day ÷ 1000 = KWH/day

Sample Calculation

$$20 \times 4 \times 32 \text{ Watts} \times \frac{8 \text{ Hours}}{\text{Day}} \times \frac{1 \text{ Kilowatt}}{1000 \text{ Watts}} = 20.48 \frac{\text{Kilowatt Hours}}{\text{Day}}$$

# of fixtures | **# of bulbs in each fixture** | **watts per bulb** | **conversion factors**

Lighting Measurement Team

Students use light meters to determine lighting patterns in various areas of the building and make recommendations to encourage the use of natural light vs. electrical light.

- ✓ Students use light meters to measure the amount of footcandles emitted when all lights are on. Use 4 light meters in random areas of the room and calculate the average number of footcandles.
- ✓ Try various configurations by using as much natural light as possible and as little electrical lighting as possible. The recommended amount of light by the health department is 40-45 footcandles of light in classrooms.
- ✓ Take notes on how switches control lights.

Sample data table

Room Number	Footcandle readings with all lights	Average footcandles	Footcandle reading with blinds open	Average footcandles	Notes

External Lighting and Exit Sign Team

Students learn about the type of outdoor lighting and where each fixture is located. They determine the usage patterns and reasons for the location of each fixture.

- ✓ Conduct a tour of the outdoor lighting with the building engineer.
- ✓ Determine where outdoor lights are located.

- ✓ Record the type of lighting and how each fixture is operated.
- ✓ Count the number of EXIT signs determine what types of light bulbs are in them.

Sample data table

Location	Type of Light	Wattage	Hours of Usage	Notes

Off-Hours Lighting Usage Team

Students determine what lights are used after school hours and on weekends.

- ✓ Interview building engineer to determine how lighting is used during off-hours and in what locations; take notes on usage patterns

Sample data table

Location	Type of Light	Wattage	Hours of Usage	Notes

Computer Team

Students audit computer usage in the building.

- ✓ Count the number of computers.
- ✓ Determine the type and location of each computer.
- ✓ Use wattage meters to compare the amount of electricity consumed when the computer is on and when it is on sleep mode.
- ✓ Use wattage meters to determine amount of electricity consumed over time.

Sample data table

Location	Computer type and number	Kilowatt Hours consumed	Notes

Appliance Team

Students audit appliance usage in the building such as vending machines, copiers, televisions, etc.

- ✓ A wattage meter is used to show how many watts each appliance is using.
- ✓ Attention should be given to “phantom power” (power consumed when appliance is turned off).

Sample data table

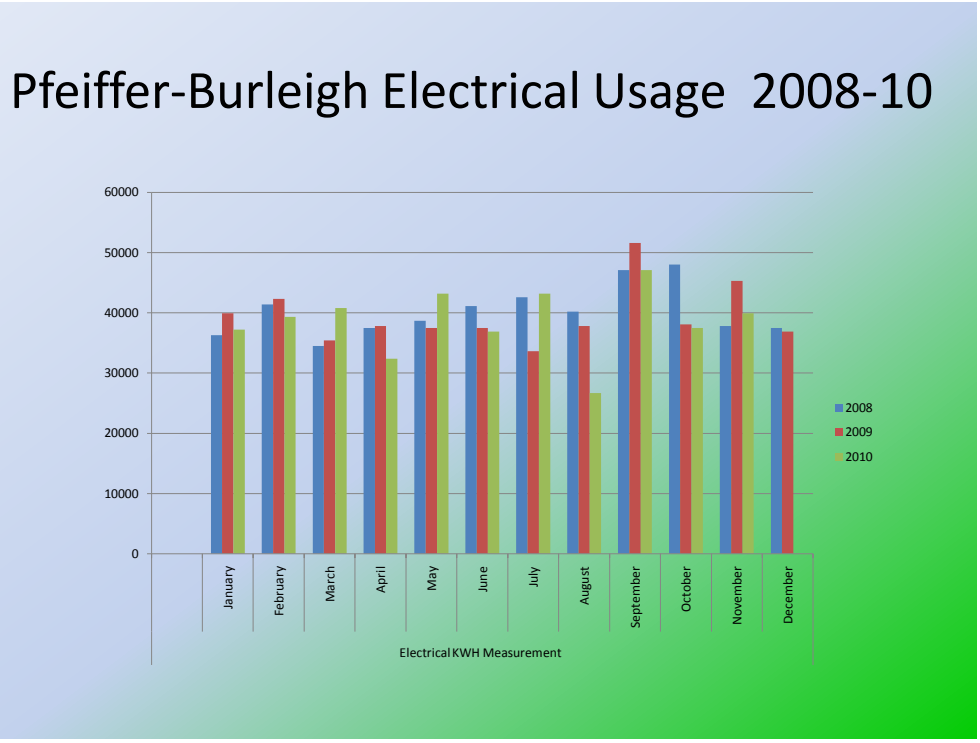
Location	Appliance	Kilowatt	Notes

		Hours consumed	

Energy Star Portfolio Manager Team

Students use the data for electrical and heating usage to construct graphs over time.
User name and password for the account can be obtained from Doreen Petri.

- ✓ Construct four graphs for the 3 most recent years:
  Electrical usage (KWH) vs time (months)
  Electrical cost (dollars) vs time (months)
  Heating usage (ccf) vs time (months)
  Heating cost (dollars) vs time (months)
- ✓ Determine usage patterns by interpreting data



Presentation Team

Students assemble information from all teams to develop a presentation. Information (audit results, data collected; information analysis, recommendations) can be presented to the faculty, student body, school board, community organizations, etc.

- ✓ Science students may choose to conduct research on topics such as: renewable and nonrenewable resources; global warming; climate change; energy usage in other countries; International conferences on climate change; energy consumption by the United States; Where does the electricity for our school come from?; suggestions on how to reduce energy usage in the home; etc.
- ✓ Interview each team and create slides with information, data, analyses, and recommendations
- ✓ Presentation of information can take many forms: posters, announcement, displays, powerpoints, etc.

SOLID WASTE

GOALS

Students will

- Sort items into recyclable and reusable, compostable, and trash categories.
- Investigate the benefits of recycling.
- Learn persuasive techniques to present their case for a school recycling program.
- Describe the impact of the wasteful use of resources and production of waste on the environment
- Identify responsible parties (stakeholders) in the recycling process.
- Identify sources of waste in their school, conduct an audit to identify usage patterns, and recommend reduction strategies for school and home.

Background Information:
School waste is made up of food, paper and packaging, candy wrappers, as well as other materials such as glass, plastics, aluminum and metals. So where does it all go? In industrialized countries, for instance, about 70% of waste is land filled, which means it's buried in the ground, while about 8% is incinerated, which means it's burnt. Land filling and incineration can harm the environment if not properly managed.

There are three valid alternatives, which can help restraining this problem.

(economic, social and environmental) for the community. As consumers, we have the possibility to reverse this trend, for example buying only what we really need, choosing long lasting products, and avoiding those over-packaged.

- REUSING: We can cut down on the amount of rubbish we have to get rid off by reusing our materials. Furniture and clothes, for instance, could easily be refreshed, passed on to others, or donated to collection centers such as the Salvation Army.

- RECYCLING: Putting materials aside for recycling saves valuable materials and energy. New technologies are fostering our ability to recycle what was previously waste and turn it back into the resources we need. Single stream recycling has made the process much less complicated and easier to convince people to participate in the program.

"Sort the Trash"
(The three "R's" Reduce, Reuse, Recycle)
Is it really trash?

By Steve Wasiesky/Andrea Platz

Lesson Summary: In this lesson the students will determine if items can be recycled, reused or if packaged differently could less materials be used to reduce the amount and type of materials needed. Also, they will determine what items can be composted.

Purpose: The purpose of this activity is to teach the concepts of the three "R"'s Reduce, Reuse and Recycle. By finding out what is trash and what is not, the students will understand how they can easily help the environment, save money, and our natural resources by "Living Green", following the three "R" principles. They will see that one person can make a difference.

Objective: After this activity the student will be able to:

1. Give examples and/or separate items that can be reduced, reused, recycled, and composted.
2. Explain how by practicing the "Three R's" can save materials, energy, and money needed to make these items.
3. Explain how the environment is helped by practicing the "Three R's"

Time: 30 minutes

PA Environment & Ecology Standards Addressed with this lesson:

4.2 Renewable and Non-Renewable Resources
4.3 Environmental Health
4.8 Humans and the Environment

Materials for "Sort the Trash" Activity:

A. Have 4 of each of the following examples and place them in 4 clean trash bags to represent the bags of " trash" for the students to sort.

There are 3 categories, (*reuse and recycle, trash, or compost*). This sample list also serves as the answer key. (Note: All items are empty, cleaned items that can be reused over and over)

B. " Sort the Trash" Data Sheet for each group of students that will work with one of the four bags of trash.
C. Clipboards and pencils.

1. Recycle and or Reuse

blue wegmann's grocery bag **(could also be reused)**
aluminum pop can
Examples of #1 thru #7 plastic containers
glass bottles
newspaper
ziplock sandwich bag **(could also be reused**)
paper
papertowel

2. Trash

paper bag **(could also be reused)**
paper napkin
paper plate
styrofoam cup **(mention bad for environment, does not easily degrade unless made) Note: If made from the new non CFC made foam it can be recycled in some areas, not here in Erie)**
insulated paper cup **(could also reuse, for a while**)
coffee stirrer **(could use a spoon that could be washed**)
plastic wrap
aluminum foil **(could also reuse for a while**)

3. Compost

Realistic fake plastic apple, banana for an example

Procedure:

1. Review the importance of renewable verses non-renewable resources.

2. Background Information to go over with the students.
   To prepare them for the trash sorting activity, tell them the importance of reusing items, recycling, composting to reduce the amount of trash that is taken to the landfill, and save our resources and energy to make new items.

   Tell them that the LakeView Landfill is the one of tallest points in elevation in Erie County. This is a pile of trash with dirt on it.

   Because our natural resources need to be used wisely so we do not run out, reducing what we use, reusing, recycling, and composting is very important. You might not think that one person can make a difference but you would be wrong.

3. Tell the students that there is something they can do every day that can not only help the environment, save energy, save resources, and save their parents money at the same time. Reduce, Reuse and Recycle, (The Three "R's") and Compost
   a. Review and give examples of each. Show them the triangle symbol for recycling.
   b. Note: For plastic, only containers with the # 1 through #7 found in the triangle on the bottom of the container can be recycled in our area.
   c. Note: aluminum foil cannot be recycled.
   d. Note: paper bags, Tupperware® type containers, zipper type plastic bags can be cleaned and reused again. Do not throw them away until they are damaged.

4. Tell them they are going to do an activity to see if they can determine what is trash and what is not trash. Divide them into four groups and give them each a bag of "trash", a clip board and Data Sheet.

Instructions: Given a bag of "trash" see what items can be reused and recycled, or put in the compost bin to reduce the amount of trash that has to be taken to the land fill and to reduce the amount of energy and natural resources that are needed to make new items. Have your group get in a circle on the floor or use a table top and dump the items in the bag on the floor or table top so all can see them. Write the name of the items from the bag of "trash" in the appropriate category; either recycle and/or reuse, compost, or trash. Also, answer the two questions.

a. Give the students about 10 minutes to do the activity.
b. Review the items with them to see if they are correct.
c. Have them answer the questions and discuss their answers.

"Sort the Trash"
INSTRUCTIONS AND DATA SHEET

Instructions: Given a bag of "trash" determine what items can be reused, recycled, or put in the compost bin to reduce the amount of trash that has to be taken to the land fill and to reduce the amount of energy and natural resources that are needed to make new items) Have your group get in a circle on the floor or use a table top and dump the items in the bag on the floor or table top so all can see them.

Write the name of the items from the bag of "trash" in the appropriate category; either recycle and/or reuse, compost, or trash. Also, answer the two questions.

A. RECYCLE AND OR REUSE

B. COMPOST BIN

C. TRASH

Questions: Answer the following questions. Review the answers in a class discussion.

1. Are there any items that you can see that could have been packaged differently to reduce the amount of materials and energy used to package the item? Describe below.

2. If your Reduce, Reuse, or Recycle and Compost every day, how does that also save you money?

"Sort the Trash"
Answer Sheet

Bag # 1:

Trash	Recycle / Reuse	Compost
Paper Cup	Ziploc Container	Apple
Paper Foam Cup	Plastic Bottle	(Represents real fruit)
Plastic Spoon	Rechargeable Battery	
Potato Chip Bag	Yogurt Container	
Aluminum Foil	Plastic Bowl	
	Bottle	
	Newspaper	
	Baby Food Jar	
	Store Plastic Bag	
	Shirt	
	Notebook	

Aluminum Pop Can

Bag # 2:

Trash	Recycle / Reuse	Compost
Sandals	Fruit Cup Container	Apple
Paper Plate	Owl Babies Book	Banana
Aluminum Foil	Grocery Bag	(Represents real fruit)
Plastic Fork	Old Shirt	
	Plastic Jar	
	Juice Box (can be made into other items)	
	Ziploc Bag Box	
	Plastic Container with lid	
	Aluminum Pop Can	

Answers to the following questions. Review the answers in a group discussion.

1. Are there any items that you can see that could have been packaged differently to reduce the amount of materials and energy used to package the item? Describe below.
2. *Potato Chips could have been packaged in large bag. When you want to pack some for lunch put some in a reusable Ziploc type bag. This reduces waste.*
   This could be done with a lot of the items in the bag.

2. If you Reduce, Reuse, or Recycle and Compost every day, how does that also save you money?
It saves your parents from having to buy new items as often.

Sample Questions for Tour with Building Engineer (It is best if students generate their own questions.)

How and where is trash generated?
Where is the trash collected?
Are any materials reused; recycled?
How are the trash and recyclables disposed of?

How can we help people to think about reusing and recycling materials?

Performing a School Waste Audit
Students may want to begin with a survey of school–wide attitudes towards Reducing, Reusing, Recycling and Rotting waste. Some of the questions may be: Do you recycle everything that you can? Would you recycle an aluminum can in a recycling bin if it was located a few feet away, or would you put it in the trash can, which might be closer? If you are not recycling, why not? What would it take to get you to recycle more? Do you make double–sided copies? Compile the result of your survey and share it with your classmates.

General Instructions:

1. An audit of the trash that is generated in one school day can be done by collecting all of the trash, sorting it and categorizing it. In this way, the percentage of each type of waste (paper, plastic, food, utensils, etc.) can be determined.
2. If this is not possible, concentrating on paper waste is a very valuable project. Start out by finding out where paper is used and how it is wasted.
3. Brainstorm ways that the number of copies can be reduced, paper can be copied on both sides, and the increased use of electronic communication can reduce paper use also.
4. You may want to start a recycling program in your school. Here are some questions you may want to answer before you develop a plan of action:

   a. What is difficult about placing materials in the proper containers?
   b. What would be the best way to educate the school population on how to recycle?
   c. What steps would need to be taken to reduce waste generation?
   d. What steps would need to be taken to start a recycling program in our school?

   Consider:

   - Types of containers and locations
   - Who will pick up the recyclables?
   - Where would they be disposed of?
   - How will we check for compliance?

WATER

GOALS

Students will

- Investigate the availability and importance of water to living organisms.
- Describe the characteristics of a watershed and the effects of human activities on them
- Name and describe different kinds of pollution that can affect water as well as animals and plants that live in water.
- Observe water quality changes and the impact of land use on them.
- Investigate the processes of water and sewage treatment.
- Identify sources of water in their school, conduct an audit to identify usage patterns, and recommend reduction strategies for school and home.

BACKGROUND INFORMATION

1. The Water Cycle
2. Watersheds
3. The Community Water Environment

4. Water Quality
5. Water Pollution
6. Water Pollution Prevention
7. Wastewater Treatment
8. Alternative Wastewater Treatment Methods
9. Drinking Water
10. Drinking Water Treatment
11. Water Conservation
12. Land Use and Water Quality
13. Water Related Careers

PRE-AUDIT DISCUSSION

Lead a class discussion or have students research the following topics:

1. Why is water important to living organisms?
2. What properties of water make it invaluable to living organisms?
3. What types of human activities have a negative impact on water quality?
4. How do these impacts affect ecosystems?
5. How is water obtained for human consumption?
6. How is water cleaned after human usage?

Tour with Building Engineer

Sample questions (It is best to have students generate the questions.)

1. Where does the water come into the building?
2. Where is it used?
3. Where does it exit the building?
4. Where does it go after it leaves the building?
5. Are there any areas of waste?
6. How can we improve on our water usage?

Planning a Water Audit

http://legacy.ewb.ca/en/whatwedo/canada/projects/hso/students/w4w/audit.html
adapted from Engineers Without Borders Canada – Conduct a Water Audit

Audit Your School's Water Consumption

Follow these 4 steps to learn how water is being used in your school and how it can be reduced.

1. Learn about your school's water system

Ask the building engineer to take you on a school tour and explain current water uses, conservation practices and how the water system works.

Take note of:

- the location of the water meter and the connection to the community water system
- the many ways water is used
- the location of drinking fountains, faucets, washrooms, showers, sinks, sprinklers, kitchens, and pools
- whether there is any special equipment such as automatic dishwashers

Asking these questions will help you gather more information:

1. How is the school attempting to conserve water? Have water-saving devices been installed?
2. Are there additional water systems such as an irrigation system for the athletic field or a sprinkler system for fires?
3. How frequently and for how long are the athletic fields, lawns and gardens watered?
4. What water applications use the most water?

2. Plan your water audit

Plan a strategy for auditing your school's water system.

- Make a list of all the places where water is used at school.
- Organize the water use sites into research areas that can be assigned to Action Groups to audit that particular area. (You might divide the school water system by area - first floor, second floor, outside, or you may organize by sites - classrooms, hallways, maintenance areas, offices, food service areas, washrooms, etc.)
- Find out whether you need permission to conduct your audit and from who, as well as whether some areas are closed to students.

You may want to use a chart such as this one to record your Water Audit Plan:

Water Audit Plan			
Research Area	**Action Group (Student Names)**	**Accessibility Permission Required**	**Audit Due Date**

3. Begin to audit

With your Action Group, research your area by compiling a detailed list of all water outlets (water fountains, showers, toilets) and water use sites (restrooms, kitchens, science labs) in your research area. Decide with your group the best way to conduct your research.

Will you monitor the frequency and length of water use of each site - will someone be stationed there for a given period of time? Consider the best time to conduct your audit at each site accounting for how different times in the day affect use.

You should also discuss how to identify waste or water conservation measures at each site taking note of leaks, unneeded water left running and how these habits can be changed.

You may want to use a chart like this one to record your group's plan:

Action Group Plan				
Water Site	**Numbers and Types of Outlets**	**Date and Time of Audit**	**Method of Monitoring Use**	**Student(s) Responsible for Audit**

4. Complete Your Audit

Work with your group to develop a method for measuring water consumption at the sites in your area. You will need a pitcher or bucket, a 250 mL beaker and a stopwatch.

Here is an easy way to measure the regular water flow for each site:

1. Turn the water onto its normal flow.
2. Hold an empty pitcher under the fixture for 10 seconds
3. Transfer the water from the pitcher to the 250mL beaker, one at a time, counting the number of times it takes to empty the pitcher.
4. Multiply the number of beakers by 6 to give you the number of beakers per minute your faucet uses.
5. Convert beakers to liters (1 beaker = 250mL and 1,000mL = 1L) by multiplying by 4.
6. Record how many liters are used per minute. **Flow Rate in liters/minute**

Once you have calculated the flow rate, determine how long the water runs during each use and the number of times each day it is used. By multiplying these numbers you will get the approximate water consumption per day for that site.

Average Length of Use (add all duration times and divide by the number of observation times)

Flow Rate (Liters/minute) x Average Length of Use (minutes) x Uses per Day = Daily Water Consumption (liters)

Use the same procedure at each site as well as to measure drips and leaks. (2)

You can use a chart like this to measure your findings:

Water Use Chart					
Water Outlet or Site	**Flow (liters per minute)**	**Average Length of Each Use**	**Uses per Day**	**Waste (Total Leaks)**	**Total Daily Water Use**

Discuss with your Action Group the results obtained from your audit of sites in your area.

1. Were you surprised by the results?
2. Did you find clear indications of waste, where and how much?
3. Compile school data.

With your results, you can strategize recommendations for improvement in your school so as to reduce water consumption.

1. Report data, analysis of data and recommendations to principal, teachers, staff, and student body.

A similar procedure can be followed to learn how much water you use at home and how it can be reduced.

Lesson #6: MONITORING ENERGY CONSUMPTION

GOALS

Students will:

- Develop monitoring strategies to maintain energy or resource conservation measures implemented in a previous section of this unit.
- Report progress to school administration and other appropriate personnel on a regular basis

STEPS:

1. Review the energy conservation strategies implemented during the audit process.

2. Develop monitoring strategies to maintain compliance.

Suggestions:

a. Assemble a team(s) of students (e.g. green police; student energy monitors)

Student Energy Monitors make sure lights and other appliances (such as computers or fans) are turned off and unplugged when not in use. Energy Monitors should be assigned to each classroom in the same way that Hall Monitors or Bus Monitors are assigned.

b. Develop a plan that includes goals, a timeline, and an action plan. The plan could include daily checklists, unannounced visits, classroom/homeroom competitions, good/poor performance tickets, classroom report cards, inspections, etc.)

During the staff conferences/meetings at the beginning of the year, all improvements planned for the year should be communicated to the staff. Best practices for utilizing these improvements as well as their environmental and economic importance should be discussed. Additionally, staff members should also be made aware of deficiencies found in the energy audit that they can immediately improve.

Create a checklist specific to each classroom that outlines the end of day activities for both the students and the teachers. This checklist should vary seasonally based on thermal comfort needs of the classroom. These items can include turning off or unplugging appliances, checking the thermostat, ensuring the faucets are not dripping, and closing or opening blinds and windows.

c. Develop reporting procedures that could be posted in a conspicuous area. Progress should be communicated on a regular basis to the building principal, engineer, faculty and staff, and student body. Effectiveness of progress should be evaluated by the analysis of quantifiable data.

EXTENSION ACTIVITIES:

1. A more extensive energy team can be assembled that would include parents and local community partners.

2. Mitigation to offset CO_2 emissions – Examples would be tree planting and/or composting.

3. Community Outreach - Ideally, students could use their energy knowledge at home and to help their neighborhood. A home energy audit process could be implemented and applied to local businesses and be integrated as a service learning or otherwise civic engagement project. There is still a great need for energy awareness locally on the commercial level and perhaps the school can be neighborhood model and leader.

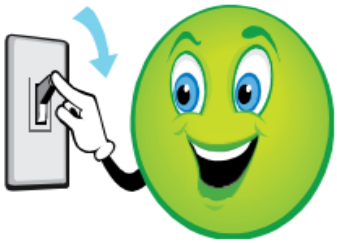
Classroom Energy Monitor Checklist

Week of: _____ _____

This Week's Monitor: _____

- *Morning Checklist:*

  ☐ *Open Curtains or blinds*



- *Recess Checklist:*

  ☐ *Turn off computer monitor(s)*
  ☐ *Turn off Classroom lights*

- *Lunch Checklist (or when leaving classroom for more than 15 minutes):*

  ☐ *Turn off computer monitor(s)*
  ☐ *Turn off Smartboard or projector*
  ☐ *Turn off any personal fans or heaters*
  ☐ *Turn off classroom lights*

- *End of Day Checklist:*

  ☐ *Turn off computers, monitor(s), and printers*
  ☐ *Turn off Smartboard or projector*
  ☐ *Close classroom windows*
  ☐ *Turn off any personal fans or heaters*
  ☐ *Switch off any power bars not in use*
  ☐ *Close curtains or blinds*
  ☐ *Turn off classroom lights*

Note: Classrooms with plenty of natural light may consider turning off the classroom lights on bright, sunny days for even more energy savings.