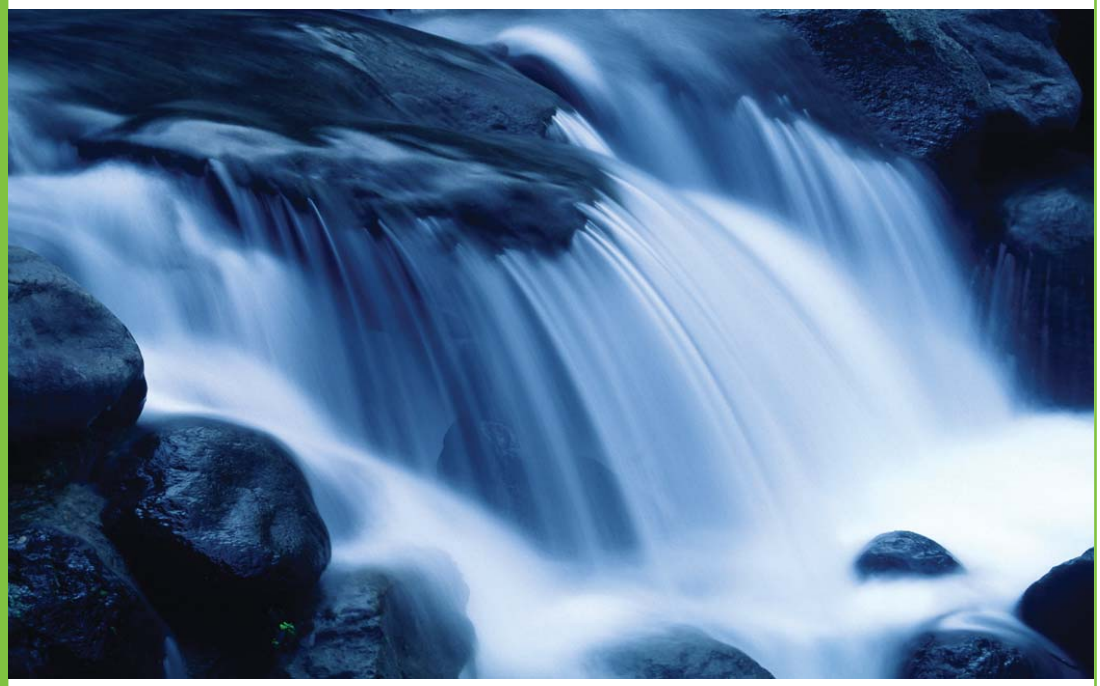
Fall 2009

Educator Guide

Water Quality & Conservation



An Educator Resource for the Washington Green Schools Energy Efficiency Assessment

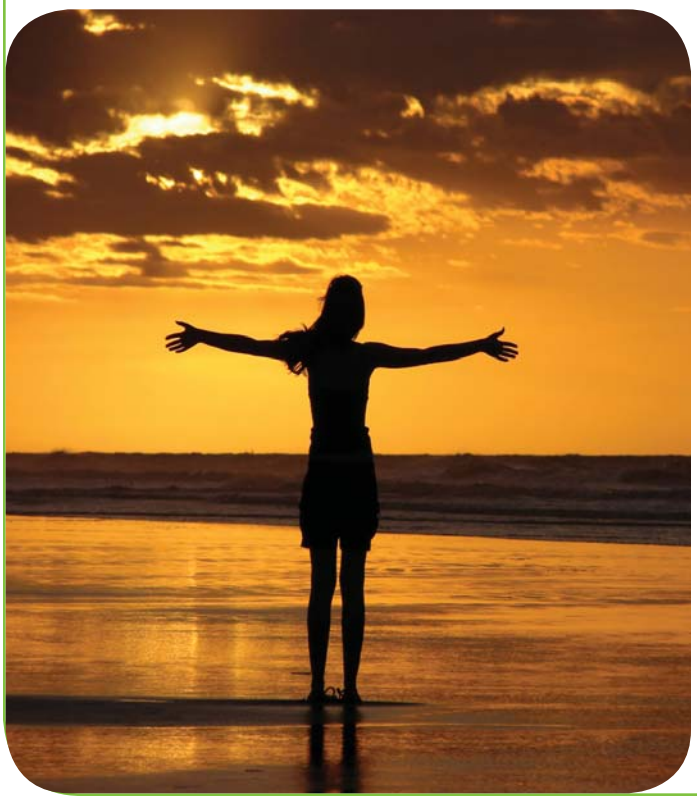
About This Educator Guide

Goal of This Guide

The purpose of this guide is to provide background information and resources so teachers can help students consider the connections between the choices they make every day and the effects those decisions have on the state's water resources —at home, school, work or play.

Teachers will be able to help their students:

- Identify sources and uses of water at school and at home.
- Discuss the impacts daily habits have on water supply (quantity) and water quality.
- Identify behaviors and habits that can be changed to use water efficiently and protect water quality.



How to Use This Guide

This guide includes introductory information on water conservation.

Included are:

- Key Ideas on water quality and conservation
- Key Vocabulary words
- Starter Discussion Questions for overview or enhancing curriculum
- Connections to Other Topics
- Resources and Links

This Guide will support your Green Team's efforts to be educated and effective as catalysts for water conservation.

For in-depth information and classroom activities, take a look at the Ontario EcoSchools Guides available at: *http://ontarioecoschools.org/curriculum_resources/index.htm.*

For additional program information, visit: www.wagreenschools.org

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Introduction

Why Care About Water?

Water is in a constant state of movement. It continually moves through the hydrologic - or water - cycle on, above or below the surface of the Earth. The small amount of fresh water that is available for us to use exists in rivers, streams, lakes, and as groundwater.

Human bodies are made of 60% water, and are in constant need of hydrating with water. Daily tasks to prepare and cook food, wash dishes and clothes, water lawns and gardens, and to flush toilets use water at home and school. Water helps to cool engines and to keep the vehicles clean. Water is also needed to grow food and in most industrial applications that create products for everyday use. Water is also used to generate the majority of electricity (hydroelectric power) in Washington. Needless to say, water is a very precious resource, and a clean, fresh supply is essential to live and function.

Worldwide water consumption has increased dramatically. According to the United Nations, "water use has grown at twice the rate of population during the past century." In 2000, Americans withdrew 408 billion gallons of water per day for thermoelectric power, irrigation, and public use, including what is used in our households and industrial applications. The largest use of withdrawn water after thermoelectric power is for agriculture, as irrigation. No water is withdrawn for hydroelectric power.

Roughly 70% of the Earth's surface is covered in water, but only 3% of that water is fresh water.
Of that 3%, 75% is locked up in glaciers and frozen ice caps

As the population continues to grow, so does demand for this finite resource. Being conscientious of water usage, using it efficiently, and protecting it from pollution are all key to ensuring that future generations will have an adequate supply of clean water.

Key Ideas

The constant flow of water is necessary to live.

- All living things depend on water to survive. *The human body is made up of 60% water*; the average human can survive only 3 days without water.
- Water provides the ability to grow food, move about and do work, and is used for bathing, drinking, washing, and cooking in every day lives.

In nature, the water cycle affects both living things and the earth.

- Water can change states between *liquid, gas, or solid*, sometimes very quickly (within seconds) and other times very slowly (thousands of years).
- The water cycle is driven by the sun. Water from the lakes and the ocean evaporates (water is also released as a vapor from plants through a process called *evapotranspiration*).
- *Water vapor moves higher in the*

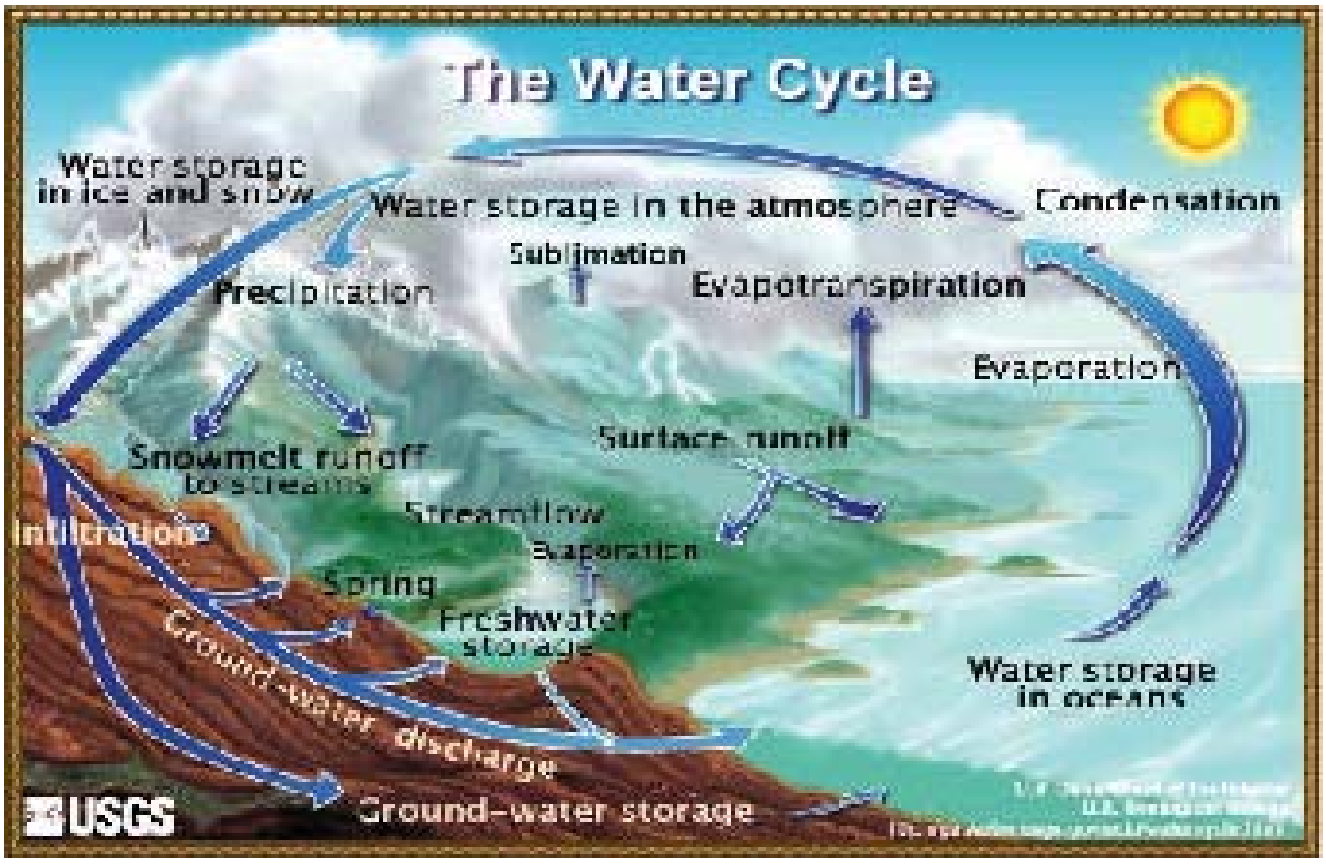
Key Ideas

atmosphere to cooler areas where it then condenses into clouds. Clouds are moved in the atmosphere by air currents, and in cooler areas, some of the water within the clouds falls back to the earth in the form of precipitation—rain, ice, sleet, hail, or snow. Most of this water lands in the ocean or on land, falling into lakes, rivers, and streams.

- Some of the water that hits the ground infiltrates the surface and replenishes aquifers that house groundwater.
- Some precipitation is stored in cold areas, especially mountains, in the form of glaciers, ice caps, and snowpack. When temperatures rise during the warmer seasons, this frozen water melts and flows through rivers, streams, and into the ground before flowing back into the oceans.

Clean freshwater demands are increasing while supplies are decreasing.

- Most of the fresh water on earth (not including frozen) is in the form of *groundwater*, water that is stored in rocks beneath the earth's surface.
- Groundwater is a very important source of fresh water. Water taken from underground reserves will not be replenished in near future; *shallow groundwater* has a renewal rate of about 300 years and *deep groundwater*, over 1000 meters deep, may renew itself in about 4,600 years.
- Currently, there is an increasing drain on the groundwater supply. As groundwater dries up, streams' flows are reduced, ponds and marshes dry up, and plant and animal species suffer.



Source: http://ga.water.usgs.gov/edu/watercycle.html

Key Ideas

- The International Water Management Institute estimates that one third of the human population across the globe does not have access to safe, affordable water.
- The rate of water use has been growing more than twice the rate of population growth in this last century. *http://www.climate.org/topics/water.html*
- Population growth, urbanization, and high consumption rates negatively impact water supplies.

Point and non-point pollution sources threaten streams, lakes, and other waterways.

- *Point sources* are easily identifiable and can therefore be easy to manage.
- *Non-point sources* are not just one source that can be attributed to pollution. This can include runoff from streets, fields, and yards, as well as landfills, sewage overflow, and sites for mining, deforestation, agriculture – crops and livestock, and construction.
- *Pollutants* enter water from agricultural and industrial applications, as well as wastewater treatment plants.
- *Domestic activities* can also contribute to water pollution. Any product used outside on lawns, in yards and for cars, can be carried away by rain as runoff and end up washed into stormwater drains. Stormwater is not treated at a sewage plant before entering nearby waterways such as Puget Sound, streams, lakes, or the ocean.
- *Sources of pollutants* can include chemical pesticides and fertilizers used in yards, detergents from cleaning cars, improper disposal of household chemicals down storm drains, and pet waste not properly disposed of by pet owners.
- Pollution has adverse effects on human health, habitat, and fish and wildlife.

Water is used heavily for agriculture and industrial applications.

- *Roughly 140 billion gallons* of water are used each day in the United States, mostly in arid western states, for irrigation of crops, including corn, wheat, soy, and feed for livestock.
- In the industrial sector, water is used for the *manufacture and production of commodities* such as food, paper, chemicals, refined petroleum, and refined metals.

Water consumption affects plant and animal habitats and communities.

- Engineers have created dams, straightened and diverted rivers, and drained lakes and groundwater supplies in order to meet water needs for all.
- Each time water is drawn from its natural setting or *a modification in the natural path* of water, there are likely negative impacts on plants and animals by altering their natural habitat and depleting the resources they need.

Key Ideas

Climate changes affect Washington's clean water supply.

- Climate changes affect the hydrologic cycle in the following ways:
  - *Changes in the seasonal distribution and amount of precipitation*
  - *Increased plant evapotranspiration and a reduction in soil moisture*
  - *Changes in vegetation cover resulting from changes in temperature and precipitation*
  - *Accelerated melting glacial ice*
  - *Increased fire risk in many areas*
  - *Increased coastal inundation and wetland loss from sea level rise*
  - *The possibility of more intense storms and surges of stormwater*

It takes 25 gallons of water to produce 1 gallon of gasoline. Be sure to carpool, ride your bike, take public transportation or walk when possible- these are all ways to save gas, and therefore water.

- *Western Washington* receives large amounts of rainfall during the fall, winter, and spring. Much of that precipitation is in the form of snow that freezes on the mountains during the colder seasons, and that melts during the spring and summer providing a constant supply of fresh water during summer's typically dry season.
- In *eastern Washington*, summers are typically slightly drier than in western Washington receiving four to five times less rainfall in the winter. Temperatures in eastern Washington are usually warmer in the summer and colder in the winter.
- In years when precipitation is lower, both eastern and western Washington face the threat of *drought*. With the possibility

Water Use & Pollution Reduction Tips

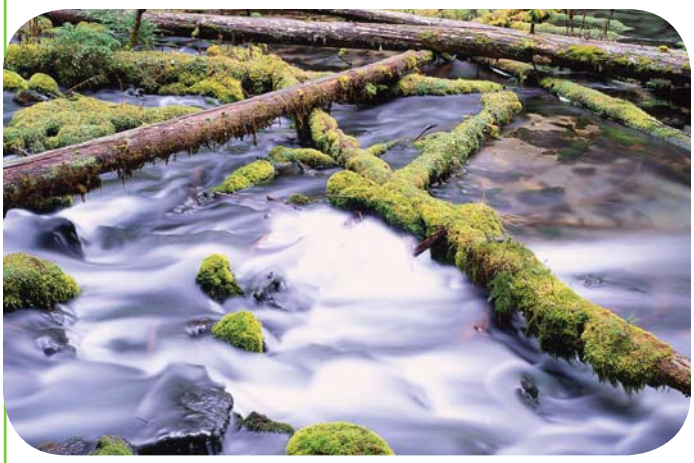
To use water wisely:

- **Turn off the water while brushing your teeth or washing dishes.**
- **Make sure laundry and the dishwasher loads are full—small loads waste water.**
- **Take showers instead of baths. And when showering, take a shorter one! Five minutes is all that is needed to get clean.**

To reduce water pollution:

- **Maintain your car properly and properly dispose of oil – never down the drain.**
- **Use natural methods of pest control in the yard and at school. Use compost rather than chemicals to reduce weeds and to retain moisture in the soil, so you won't have to water as often.**
- **Incorporate drought resistant plants on school grounds and in your yard or garden.**
- **Dispose of pet waste properly. Check with the local Health Department to find out the proper disposal method for your area.**
- **Use household cleaners that are safe and gentle on the environment. They should not contain organic solvents, ammonia, or chlorine bleach.**
- **Read labels carefully. The words "danger" and "poison" signal highly toxic chemicals, "warning" indicates they are moderately toxic, and "caution" means mildly toxic.**

Key Ideas



of rising temperatures and other global changes, these will ultimately negatively affect our supply of clean water.

- Water is used in almost every application of daily life so it's extremely important to conserve and protect this vital resource.

The water that is used becomes wastewater that is treated and returned to the water table.

- *Wastewater* is used water that can contain substances such as human waste, food scraps, oils, soaps and chemicals. Wastewater comes from our sinks, showers, bathtubs, toilets, washing machines and dishwashers. Schools, businesses, and industries also contribute their share of wastewater that needs to be cleaned.
- Wastewater is transferred through underground water pipes to a treatment facility where it is treated to remove *suspended particles* and *aerated* before it is discharged back into the environment.
- *Wastewater treatment* is important for fish and wildlife, recreation, and human health.

Recycling saves water.

- Creating paper, plastic, glass, and metal products from *recycled material* uses less water than creating those same products from virgin materials.
- It takes large amounts of water to *manufacture* items. Recycling saves water— making one ton of paper from recycled paper not only saves the equivalent of 17 trees, but also requires 50% less water than making paper from raw materials. A total of 3.5 gallons of water are saved for each edition of the New York Times printed on recycled-content paper.

Fixing leaky pipes and faucets can quickly save large amounts of water. If 50 homes each have one faucet that leaks just one drop per minute, the total waste equals 285 gallons of water per day!

Wise management of water delivery devices leads to water conservation.

- *Controlling water* usage is very important because it allowsthe use of only the amount really needed. Up to seven gallons of water is used per minute with a standard faucet, five gallons per minute with a standard shower head, and seven gallons of water with each flush of a toilet.
- Install *low-flow shower heads* and water saving devices for the faucet and toilet.
- Control water usage by manually *turning faucets off* and automating some systems like outdoor sprinklers and hoses.
- Adopt *water-friendly gardening* and yard care techniques at home. Work with the school maintenance staff to do the same at school.

Vocabulary

Aquifer
A geologic formation(s) that is water bearing. A geological formation or structure that stores and/or transmits water, such as to wells and springs. Use of the term is usually restricted to those water-bearing formations capable of yielding water in sufficient quantity to constitute a usable supply for people's uses.

Condensation
The process of water vapor turning into liquid water. Water drops on the outside of a cold glass of water are condensed water. Condensation is the opposite process of evaporation.

Evaporation
The process of liquid water becoming water vapor, including vaporization from water surfaces, land surfaces, and snow fields.

Evapotranspiration
The sum of evaporation and transpiration.

Groundwater
1. Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table.
2. Water stored underground in rock crevices and in the pores of geologic materials that make up the Earth's crust.

Hydrologic Water Cycle
The cyclic transfer of water vapor from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to earth, and through runoff into streams, rivers, and lakes, and into oceans.

Irrigation
The controlled application of water for agricultural purposes through manmade systems to supply water requirements not satisfied by rainfall.

Non-point Source Pollution
Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff. Non-point source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides.

Point Source Pollution
Water pollution coming from a single point, such as a sewage-outflow pipe.

Surface Water
Water that is on the Earth's surface, such as in a stream, river, lake, or reservoir.

Thermoelectric power water use
Water used in the process of the generation of thermoelectric power. Power plants that burn coal and oil are examples of thermoelectric-power facilities.

Transpiration
Process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface, such as leaf pores.

Watershed
The land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Mississippi River basin contain thousands of smaller watersheds.

Water Table
The top of the water surface in the saturated part of an aquifer.

Water Quality
A term used to describe the chemical, physical, and biological characteristics of water, usually regarding its suitability for a particular purpose.

Water Use
Water used for a specific purpose, such as for homes, irrigation, or industrial processing. Water use pertains to human interaction with and influence on the hydrologic cycle, and includes elements such as water withdrawal from surface- and ground-water sources, water delivery to homes and businesses, consumptive use of water, water released from wastewater-treatment plants, water returned to the environment, and in-stream uses, such as using water to produce hydroelectric power.

Discussion Questions

Below are five sample discussion prompts to use in your classroom. For more ideas on classroom activities, please see the list of resources at the end of this Guide.

1. What activities require you to use water at home? At school? How would your life be different if you had to collect the water you used daily and carry it home? How many gallons of water do you use in a day? Would you be able to carry a one-day's supply of water for your family?

- Answers can include brushing your teeth, taking a shower, flushing the toilet, washing dishes and clothes or the car, cooking food, drinking, and swimming.
- Indirect water use can include using products that required water use in the manufacturing of it, such as paper, and for sports field irrigation.

2. What is the difference between point and non-point source pollution? Why is non-point source pollution more difficult to control?

- Point source pollution can be traced back to an exact location whereas non-point pollution comes from a general area and cannot be pinpointed.
- If the source of a pollutant is known, prevention is easier. However, it's difficult to address non-point source pollution and to prevent it since we it is coming from multiple, indistinguishable sources in an area.

3. How can you conserve water at home and at school? What is one "water hog" habit that you can change from now on?

- Students can turn off water spouts and faucets when not in use, take shorter showers, install water-saving aerators for sinks and water-saving showerheads, fix leaks, use less pesticides and herbicides on the lawn, and dispose of trash in the garbage and food waste in compost bins rather than down garbage disposals or toilets. Other choices can include to water lawns less or at more efficient times, eat less meat, and run dishwashers and clothes washers only when there is a full load.
- Conserve water by protecting it from pollutants—using fewer or no chemicals in yards, washing cars at a car wash where wash water is treated, picking up and properly disposing of pet waste (students can check with the local Health Department to find out), and properly disposing of motor oil and other hazardous wastes.

4. How does buying less "stuff" save water?

- The creation and transportation of stuff requires the use of water. Purchasing items based on want rather than need contributes to overconsumption of our water resources.
- Making choices to buy fewer things, use the things more efficiently, and share things with friends, family and neighbors can help conserve resources.

5. How can the small amount of fresh water we have available on earth be protected?

- Keep pollutants out of waterways by not using toxic products in the first place.
- Buy fewer material goods.
- Use water more efficiently, for example, by turning off water sources when not needed.
- Plant plants that are suitable for the area. These plants, once established, will typically require less water and care.
- Drive less.

Connections to Other Topics

Water and Energy Efficiency

- In Washington, much of the power comes from water. When it rains, some water is dropped at higher elevations – often as snow, which eventually flows to lower elevations due to gravity. Hydroelectric energy comes from this river water moving through dam turbines. Please see the *Washington Green Schools Educator's Guide—Energy Efficiency* for more information.
- Coal-fired power plants emit sulfur dioxide and nitrogen dioxides, which contribute to acid rain containing sulfuric and nitric acids. Acid rain can change the pH of soil, negatively impacting plants and animals that rely on a healthy soil system. In our region, acid rain can harm forest ecosystems and well as fish, other aquatic wildlife, and aquatic plants.

Water and Transportation & Outdoor Air Quality

- Cars and buses not only pollute the air, they can leak oils and grease in parking lots which wash into storm drains and lead directly to waterways.

Water and Toxics Reduction & Indoor Air Quality

- Water leaking into a building can cause mold which not only ruins parts of the building but can make people sick.
- Fertilizers and pesticides used on lawns and yards can wash into storm drains, which lead directly to rivers, lakes, and bays.

Water and Recycling & Waste Reduction

- Creating consumer goods from recycled materials uses less water than creating consumer goods from virgin materials.
- Waste that is disposed of through garbage disposals and toilets is sent to the local wastewater treatment plant. Disposing of trash this way uses water that would not be needed if items were thrown into a trash receptacle in the first place. Food scraps can be composted.
- Buying less "stuff" saves water through avoided production and transportation.

Water and Climate Change

- Changes in temperature, precipitation, and evapotranspiration greatly affect the water cycle.
- Extreme weather occurrences may increase, and some areas will receive more precipitation while others receive less, impacting agriculture.
- Evaporation can lower river levels, and warmer temperatures can thaw water stored in glaciers and ice packs.
- The combination of increased evapotranspiration, shorter bursts of intense rainfall, and heavier demands for irrigation threaten to deplete groundwater sources. Water from melted glaciers can raise sea levels and coastal communities may eventually be submerged in water over time.

Connections to Other Topics

Water and Sense of Place

- Water plays a key role in Washington's energy production, as hydroelectric dams account for most of the state's electricity production.
- Washingtonians kept 8,000 pollutants out of our water sources in the year 2000 just by recycling.
- In Washington, large amounts of rainfall during the fall, winter, and spring. Much of that precipitation is in the form of snow that freezes on the mountains during the colder seasons, and melts during the spring and summer giving us a constant supply of fresh water during dry seasons. In years when precipitation is lower, there is the threat of drought.
- Consider the watershed your community is in and how it affects your animal and plant life. Do people use it for fishing, swimming, boating, or other recreation? How does the natural water in your area affect your enjoyment of where you live?

Water and Food

- Irrigation accounts for about a third of total water use and is currently the largest use of fresh water in the United States.
- It takes 1,000 tons of water to grow one ton of grain and 15,000 gallons to produce one ton of beef. It takes approximately 1,300 gallons of water to produce just one hamburger.
- Processed foods and drinks require more water use. For instance, it takes 2.7 liters of water to create one liter of soft drink. The industrial process to create the packaging for processed foods also requires water.

Resources And Links

Educator Resources:

Powerful Choices for the Environment program (for middle school) and other educational programs: *http://www.pse.com/community/educationalprograms/Pages/Default.aspx*

Cool School Challenge: *http://www.coolschoolchallenge.org*

Office of the Superintendent of Public Instruction, Education for Environment and Sustainability: *http://www.k12.wa.us/curriculumInstruct/EnvironmentSustainability/default.aspx*

Ontario Ecoschools "Energy" Ecological Literacy Guide and all guides are downloadable free of charge at: *www.yorku.ca/fes/envedu/ecoschools.asp*

Facing the Future: *www.facingthefuture.org*

Project WET: The mission of Project WET is to reach children, parents, educators, and communities of the world with water education: *http://www.projectwet.org*

Aquatic Project WILD is an interdisciplinary environmental education program for K-12 educators: *http://www.projectwild.org/ProjectWILDK-12AquaticCurriculumActivityGuide.htm*

Clean Water. By Karen Barss. Discusses the problems of maintaining a clean water supply and relates this issue to such topics as pollution, depletion of resources, and other environmental concerns.

E2: Environment and Education: Water Conservation Teachers Resource Guide is one of 6 modules Environmental ACTION created to address sustainability issues and the role that humans play.

Resources And Links

Green Teacher's Teaching About Climate Change – Cool Schools Tackle Global Warming: *www.greenteacher.com* Classroom activities created by teachers for K-12. This resource also includes good background information for teachers.

Common Ground: The Water, Earth, and Air We Share. By Molly Garrett Bang. Explains how everyone in the world depends on each of us individually to protect resources and maintain respect for the environment.

The Drop in My Drink. (9-12 years) By Meredity Hooper and Chris Coady. Water takes on fascinating new significance as readers discover the amazing complexity of a substance we take for granted. Includes a detailed depiction of water cycles, amazing facts and important environmental information.

National Science Teacher Association has resources for teachers: *www.nsta.org*

Environmental Protection Agency's website includes many water resources (and other topics too) for K-12 teachers and students: *http://www.epa.gov/epahome/students.htm*

A Drop of Water: A Book of Science and Wonder. By Walter Wick. Shows the different forms of water in amazingly detailed photographs; explains water's properties.

The National Oceanic and Atmospheric Administration (NOAA) has a water-cycle game that teachers can use to have their students get actively involved in simulating the journey water molecules may take as they travel within the water cycle. *http://response.restoration.noaa.gov/*

Ground Water and Surface Water: A Single Resource. U.S. Geological Survey Circular 1139. Presents an overview of the interaction of ground water and surface water, in terms of both quantity and quality, as applied to a variety of terrains across the country. Discusses the firm scientific foundation for policies governing the management and protection of aquifers and watersheds.

Water Conservation: Student Edition. By Leslie Crawford, Jeri Hayes (Editor), Cathy Anderson (Editor) Shows students different ways to analyze, consider options, and take action on issues such as sources of water pollution, community water supply, the school water system, reading a water bill, conservation technologies and practices, and assessing costs and benefits.

Facing the Future. This nonprofit organization provides K-12 curriculum on many topics including population growth, diversity, and consumption.

Sources Used to Develop this Guide

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