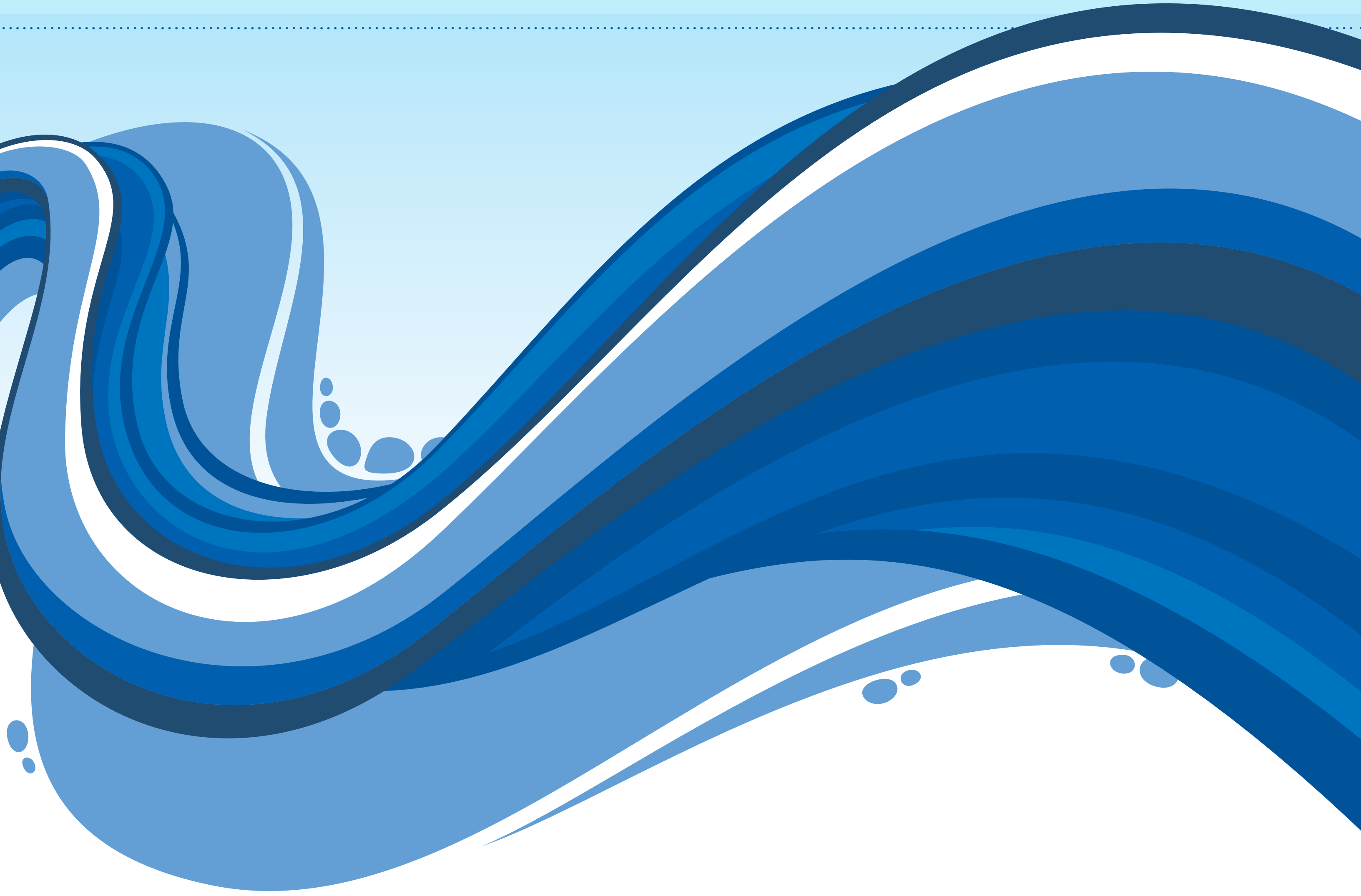
GLOBAL WATER SUPPLY
HIGH SCHOOL CURRICULUM



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INTERNATIONAL
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• Funding for this project was provided by the Open Square Foundation •

GLOBAL WATER SUPPLY HIGH SCHOOL CURRICULUM TABLE OF CONTENTS

WATERPARTNERS CURRICULUM ALIGNMENT: U.S. EDUCATION STANDARDS MASTER LIST

:: **Middle and High School**
:: http://www.education-world.com/national/standards

English/Language Arts

NL-ENG.K-12.1
Reading for Perspective: Students read a wide range of print and non-print documents to build an understanding of texts, of themselves, and of the cultures of the United States and the world.

NL-ENG.K-12.3
Evaluation Strategies: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts.

NL-ENG.K-12.4
Communication Skills: Students adjust their use of spoken, written, and visual language to communicate effectively with a variety of audiences and for different purposes.

NL-ENG.K-12.5
Communication Strategies: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

NL-ENG.K-12.6
Applying Knowledge: Students apply knowledge of language structure, language conventions, media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

NL-ENG.K-12.7
Evaluating Data: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources to communicate their discoveries in ways that suit their purpose and audience.

NL-ENG.K-12.8
Developing Research Skills: Students use a variety of technological and information resources to gather and synthesize information and to create and communicate knowledge.

NL-ENG.K-12.11
Participating in Society

NL-ENG.K-12.12
Applying Language Skills: Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

WATERPARTNERS CURRICULUM ALIGNMENT: U.S. EDUCATION STANDARDS MASTER LIST

Science

NS.9-12.1
Science as Inquiry: Abilities necessary to do scientific inquiry/ Understanding about scientific inquiry

NS.9-12.3
Life Science: Populations and ecosystems/ Diversity and adaptations of organisms/ Interdependence of organisms

NS.9-12.5
Science and Technology: Abilities of technological design/ Understandings about science and technology

NS.9-12.6
Science in Personal and Social Perspectives: Personal health/Populations, resources, and environments/Risks and benefits

Social Sciences

Geography

NSS-G.K-12.1
The World in Spatial Terms: Understand how to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

NSS-G.K-12.2
Places and Regions: Understand the physical and human characteristics of places/ Understand that people create regions to interpret Earth's complexity/ Understand how culture and experience influence people's perceptions of places and regions.

NSS-G.K-12.3
Physical Systems: Understand the physical processes that shape the patterns of Earth's surface/ Understand the characteristics and spatial distribution of ecosystems on Earth's surface.

NSS-G.K-12.4
Human Systems: Understand the characteristics, distribution, and migration of human populations on Earth's surface/ Understand the characteristics, distribution, and complexity of Earth's cultural mosaics/ Understand the patterns and networks of economic interdependence on Earth's surface/ Understand the processes, patterns, and functions of human settlement/ Understand how the forces of cooperation and conflict among people influence the division and control of Earth's surface.

NSS-G.K-12.5
Environment and Society: Understand how human actions modify the physical environment/ Understand how physical systems affect human systems/ Understand the changes that occur in the meaning, use, distribution, and importance of resources.

NSS-G.K-12.6
Uses of Geography: Understand how to apply geography to interpret the present and plan for the future.

Civics

NSS-C.9-12.1
Civic Life, Politics, and Government: What is government? Why are government and politics necessary? What purposes should government serve?

NSS-C.9-12.4
Other Nations and World Affairs: What is the Relationship of the United States to Other Nations and to World Affairs?/ How is the world organized politically?/ How has the United States influenced other nations and how have other nations influenced American politics and society?

NSS-C.9-12.5
Roles of the Citizen: What are the responsibilities of citizens?/ How can citizens take part in civic life?

NSS-WH.5-12.1
Era 1: The Beginnings of Human Society

NSS-WH.5-12.2
Era 2: Early Civilizations and the Emergence of Pastoral People

Technology

NT.K-12.1
Basic Technology Operations and Concepts: Students demonstrate a sound understanding of the nature and operation of technology systems/ Students are proficient in the use of technology.

NT.K-12.2
Social, Ethical, and Human Issues: Students understand the ethical, cultural, and societal issues related to technology/ Students practice responsible use of technology systems, information, and software/Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

NT.K-12.3
Technology Productivity Tools: Students use technology tools to enhance learning, increase productivity, and promote creativity/ Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.

NT.K-12.4
Technology Communications Tools: Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences/ Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

NT.K-12.5
Technology Research Tools: Students use technology to locate, evaluate and collect information from a variety of sources/ Students use technology tools to process data and report results/ Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

Economics

NSS-EC.9-12.1
Productive Resources: Scarcity

NSS-EC.9-12.3
Allocating Goods and Services: Comparing the benefits and costs of different allocation methods in order to choose the method that is most appropriate for some specific problem can result in more effective allocations and a more effective overall allocation system.

NSS-EC.9-12.4
Positive and Negative Incentives: Acting as consumers, producers, workers, savers, investors, and citizens, people respond to incentives in order to allocate their scarce resources in ways that provide the highest possible returns to them. Responses to incentives are predictable because people usually pursue their self-interest/ Changes in incentives cause people to change their behavior in predictable ways/ Incentives can be monetary or non-monetary.

NSS-EC.9-12.6
Gain from Trade: A nation pays for its imports with is exports/When imports are restricted by public policies, consumers pay higher prices and job opportunities and profits in exporting firms decrease.

12.0 (MIDDLE AND HIGH SCHOOL) WATER-AWARE PORTFOLIO INSTRUCTIONS

WATER-AWARENESS PORTFOLIO INSTRUCTIONS

A portfolio is a record demonstrating what students learn over an extended period of time for a specific unit such as a “global water crisis” unit or “water-awareness” unit. The introduction of a water portfolio is an effective technique teachers can use to interface water curriculum with ongoing assignments and activities in any subject including economics, geography, biology, language arts, social studies, and environmental science.

- The participation and completion of a global water crisis or water-awareness portfolio will give students access to knowledge and awareness of current water conditions in developing nations, an increased awareness of the need for conservation practices and the value of water as a shared global resource.
- Students who are involved in creating the portfolio gain valuable experience in setting their own goals and standards of excellence. The process of creating many entries over time gives students a sense of ownership and control over their own learning.
- Portfolios that have depth, duration, and complexity will challenge students and motivate them towards construction of knowledge. They will acquire problem-solving, planning, and self- evaluation skills. Students will process and generalize information to make predictions about, and generate solutions for, the global water crisis. The written components of a portfolio also strengthen reading comprehension and writing skills that benefit students in standardized testing conditions.

Materials needed:
A three-ring notebook or a folder with pockets
Instructor prompts (see sample portfolio entry prompts below)

A portfolio may include a variety of written assignments: journal entries, poetic responses to a piece of art or journalism, letters, essays, reports, stories, timelines, creative writing, book summaries, article summaries and/or WebQuests.

Non-written entries may include: drawings, original artwork, photos, brochures, maps, charts, computer-generated graphics, maps and/or illustrations, etc. Students should demonstrate correct grammar, punctuation, spelling, and vocabulary usage in all entries.

Sample prompts for a water-awareness portfolio:
Students will visit a broad collection of websites to raise water awareness. Students will create a chart and briefly describe water crisis information found of each of the following websites:

National Geographic: (http://www.nationalgeographic.com)
Environmental Protection Agency: (http://www.epa.gov)
American Museum of Natural History: (http://www.amnh.org)
Discovery Education: (http://www.discoveryeducation.com)

- Students will create a proposal to convince the U.S. Congress to take a more active role in assisting developing nations with water and sanitation infrastructures.
- Students will write a letter to inspire and challenge family members to conserve water. Students will read the letter to their family and discuss family reactions the next day in class.
- Students will visit (http://www.water.org) and create a Venn Diagram comparing water and sanitation conditions in two of the five following countries: Bangladesh, Ethiopia, Honduras, India, Kenya.
- Students will read the article "Dangerous Waters" by Sharon P. Nappier, Robert S. Lawrence, and Kellogg J. Schwab. Students will identify and describe five infectious pathogens posing serious threats to freshwater sources around the world. Students may research images of infectious pathogens and create visual representations of pathogens such as Norovirus, Plasmodium, Giardia, E. coli, and Cryptosporidium parvum.
- Students will create a timeline that demonstrates the evolution of significant water and sanitation inventions and discoveries since the time of Roman aquifers through the present.
- Students will read the document "Early History of Water Sanitation Technology" and create an invention to assist with the collection, distribution, sanitation or any other aspect of the global water crisis.
- Students will analyze a variety of economic plans to assist water-deprived third-world nations. Students will visit (http://www.water.org) to research micro-finance example: WaterCredit and other sources to research oil-for-water programs.

13.0 (HIGH SCHOOL) "MOCK MUCK" MINI-UNIT

National Curriculum Alignment:
(The following National Curriculum Standards are addressed by completing all of the activities associated with the Water-Aware mini-unit. See http://www.educationworld.com/standards/national for a corresponding key to standards.)

NL-ENG.K-12.1
Reading for Perspective: Students read a wide range of print and non-print documents to build an understanding of texts, of themselves, and of the cultures of the United States and the world.

NL-ENG.K-12.3
Evaluation Strategies: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts.

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NL-ENG.K-12.8
Developing Research Skills: Students use a variety of technological and information resources to gather and synthesize information and to create and communicate knowledge

NL-ENG.K-12.12
Applying Language Skills: Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

Science Grades 6 - 12

NS.9-12.1
Science as Inquiry: Abilities necessary to do scientific inquiry/ Understanding about scientific inquiry

NS.9-12.3
Life Science: Populations and ecosystems/ Diversity and adaptations of organisms/ Interdependence of organisms

NS.9-12.5
Science and Technology: Abilities of technological design/ Understandings about science and technology

NS.9-12.6
Science in Personal and Social Perspectives: Personal health/Populations, resources, and environments/Risks and benefits

Technology Grades 6 - 12

NT.K-12.4
Technology Communications Tools: Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences/ Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

NT.K-12.5
Technology Research Tools: Students use technology to locate, evaluate and collect information from a variety of sources/ Students use technology tools to process data and report results/ Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

:: **High School**
:: **"Mock Muck": A Water Treatment Simulation**
:: **Level of difficulty and duration**: ***

Pre-activities:

Whiteboard brainstorm

1:: As a class, list as many chemicals and other items you can think of that are poured down drains or emptied into water sources such as lakes, rivers, groundwater or kitchen and bathroom drains.
2:: Read "Water-Aware Fact Sheet" to raise student awareness of the global water crisis water.
3:: Students will record answers to pre-lab questions.

Pre-lab Questions:

1:: What three water purification techniques will you use?
2:: Define filtration-
3:: What will you use to measure the volume of your foul water sample?
4:: Why should sand be pre-moistened for use during sand filtration?
5:: How will you determine whether or not your sample is clean? (Do not test the purity of the water by drinking it.)

Objective:
The "Mock Muck" activity will simulate the water treatment and purification process. The purpose of the activity is to purify a sample of foul water, producing as much "clean" water as possible. The three major techniques used should be oil-water separation, sand filtration and charcoal absorption/filtration. Students will compete in groups to produce the cleanest sample of water at the end of a pre-determined time period such as 30-45 minutes.

Lesson:
Students will develop strategies to create the most effective filtration/treatment system with materials provided. The winning group will produce both the greatest amount of water (retained water from the original sample) as well as the cleanest sample of treated water. Students will write a detailed procedure of how each group plans to purify their water sample. Students will complete the "Mock Muck" Data Worksheet

Materials:
Students will collect a mock sample of polluted/untreated/waste water from the instructor. Instructors will mix a large enough sample to provide each student group with 3 cups of the "mock muck" sample. Suggested items include cooking oil, tuna fish water, chocolate milk (preferably sour), coffee grounds, soy sauce, tomato sauce, etc.

Per student group:
3 cup sample of mock wastewater, 1 coffee filter, ¾ cup of sand and 1 charcoal brick (such as found in a bag of charcoal for grilling). Each student group will need two containers that each hold 3 cups of liquid.

Post-activities:
Students, as a class, will discuss their expectations and experience "treating" the polluted sample. Students, as a class, will generate solutions for people living without access to safe water who are forced to collect it from polluted sources like rivers, ponds and ditches.

MOCK MUCK DATA WORKSHEET DATA TABLE

	Color	Clarity	Odor	Presence of oil	Presence of solids	Volume
Before treatment						
After step one						
After step two						
Final sample						

Analysis:

1:: What percent of the original foul water sample was recovered as "clean water"? (% of water=volume of purified water/ (over the) volume of foul water X 100)

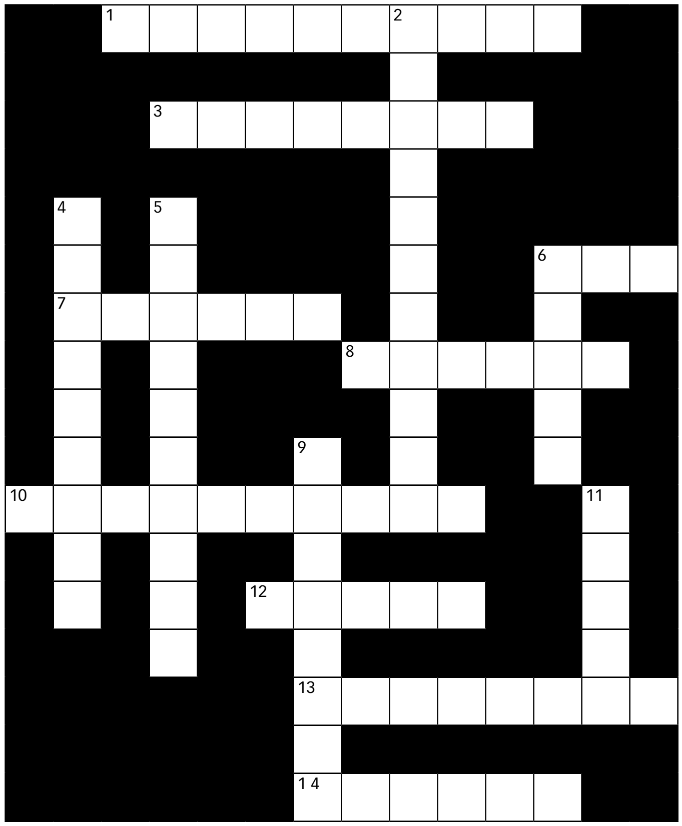
2:: What volume of liquid did you lose during purification?

3:: Compare your purification experiences and data with those from other groups. How should the success of various groups be judged? Write a description of the results from your group and those of your classmates.

Group #	Volume of "clean" water	Clarity ranking
1		
2		
3		
4		
5		
6		

WATER-AWARE FACT PUZZLE

Read the Water-Aware Fact Sheet to help you solve this puzzle,



Across

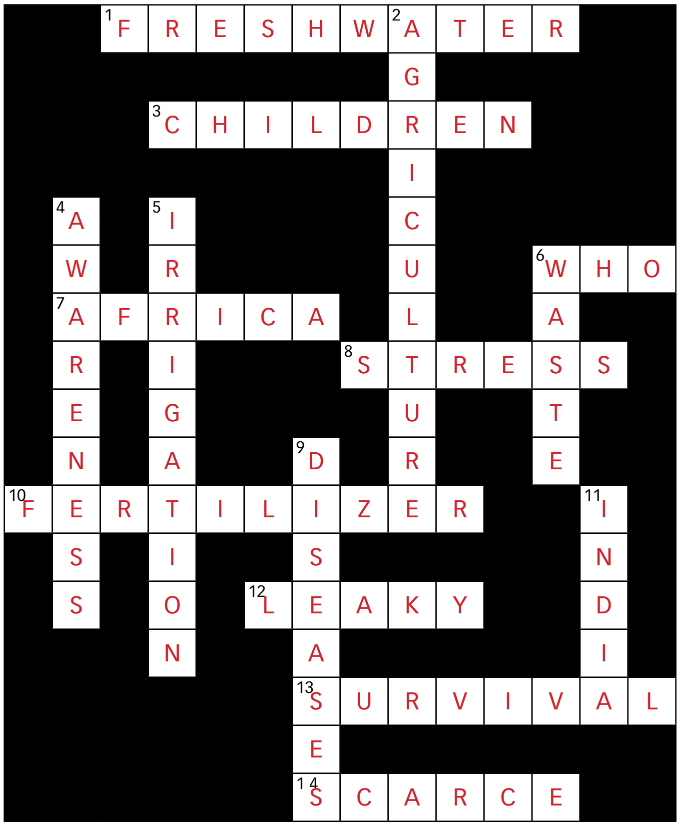
1 used faster than it can be replaced
3 15 million die a year from water related illness
6 World Health Organization (acronym)
7 continent with minimal percentage of water treatment
8 one-third of world population suffers from water ________
10 farming containment along with pesticide
12 Large cities waste water because of these type of systems
13 more than 1 gallon a day is the bare minimum for ______
14 “value groundwater like any other ______ resource”

Down

2 responsable for 80% of world water consumption
4 increase public and government ______
5 60% of this water is wasted
6 two million tons a day are disposed in freshwater resources
9 diarrhea, typhoid, cholera
11 home to the Ganges River

WATER-AWARE FACT PUZZLE

Read the Water-Aware Fact Sheet to help you solve this puzzle,



Across

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9 diarrhea, typhoid, cholera
11 home to the Ganges River

14.0 (HIGH SCHOOL) "HYDRO-TECHNOLOGY" MINI-UNIT

National Curriculum Alignment:
(The following National Curriculum Standards are addressed by completing all of the activities associated with the Hydro-Technology mini-unit. See http://www.educationworld.com/standards/national for a corresponding key to standards.)

NL-ENG.K-12.1
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NL-ENG.K-12.8
Developing Research Skills: Students use a variety of technological and information resources to gather and synthesize information and to create and communicate knowledge.

NL-ENG.K-12.11
Participating in Society

NL-ENG.K-12.12
Applying Language Skills: Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).
Science Grades 6 - 12

NS.9-12.1
Science as Inquiry: Abilities necessary to do scientific inquiry/ Understanding about scientific inquiry.

NS.9-12.3
Life Science: Populations and ecosystems/ Diversity and adaptations of organisms/ Interdependence of organisms

NS.9-12.5
Science and Technology: Abilities of technological design/ Understandings about science and technology

NS.9-12.6
Science in Personal and Social Perspectives: Personal health/Populations, resources, and environments/Risks and benefits

Geography Grades K - 12

NSS-G.K-12.2
Places and Regions: Understand the physical and human characteristics of places/ Understand that people create regions to interpret Earth's complexity/ Understand how culture and experience influence people's perceptions of places and regions.

NSS-G.K-12.3
Physical Systems: Understand the physical processes that shape the patterns of Earth's surface/ Understand the characteristics and spatial distribution of ecosystems on Earth's surface.

NSS-G.K-12.4
Human Systems: Understand the characteristics, distribution, and migration of human populations on Earth's surface/ Understand the characteristics, distribution, and complexity of Earth's cultural mosaics/ Understand the patterns and networks of economic interdependence on Earth's surface/ Understand the processes, patterns, and functions of human settlement/ Understand how the forces of cooperation and conflict among people influence the division and control of Earth's surface.

NSS-G.K-12.5
Environment and Society: Understand how human actions modify the physical environment/ Understand how physical systems affect human systems/ Understand the changes that occur in the meaning, use, distribution, and importance of resources.

NSS-G.K-12.6
Uses of Geography: Understand how to apply geography to interpret the present and plan for the future.

Technology Grades 6 - 12

NT.K-12.2
Social, Ethical, and Human Issues: Students understand the ethical, cultural, and societal issues related to technology/ Students practice responsible use of technology systems, information, and software/Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.

NT.K-12.4
Technology Communications Tools: Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences/ Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.

NT.K-12.5
Technology Research Tools: Students use technology to locate, evaluate and collect information from a variety of sources/ Students use technology tools to process data and report results/ Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.

:: **Hydro-Technology Lesson Plan**
:: **High School**
:: **Difficulty and duration**: ***

Objective:
Students will gain insights into the global water crisis through a variety of sources. Students will research, analyze, interpret and apply information to invent and design new water supply, collection and/or sanitation technology. Students groups will present their original concept for a design, an illustration and description of the working parts of the technology, as well as a detailed rationale or explanation for the necessity of the design. Student groups will submit the collection of their work in the form of a "patent application" to the peer group operating as an "international patent office" for constructive feedback.

Lesson:
Students will read the articles "Blue Planet Blues" and "Dangerous Waters" and complete "Blue Planet Blues" and "Dangerous Waters" Reading for Comprehension Questions. Students will consult the documents "Examples of Water Collection Hydro-Technology" and "Early History of Water Sanitation Technology". Students will work in groups of 3 or 4 to create a new design for a water supply, collection, or sanitation devise. One student group will serve as a mock "international patent review board" and will be responsible for creating review criteria, reviewing the designs, rationales and illustrations of the other peer groups and producing objective, constructive feedback for each group submitting designs.

Materials:
Internet access, copies of necessary articles and documents, access to design software, if applicable, or pencils and paper and other materials for creating illustrations.

Assessment:
The student group functioning as the international patent review board will create a review criteria (rubric) while other groups are designing new hydro-technology. The international patent review board will present the pre-determined criteria (rubric) to each group and provide each group with a copy of the rubric. Students groups do not have to be assessed competitively such as being awarded 1st -4th or 5th places by the patent review board. The review board may simply comment on each of the components of the rubric for each group providing constructive feedback.

Sample criteria for a rubric:
Level of implementation: (easy/simple to extremely difficult)

Level of Implementation					
	5 Excellent	4 Great	3 Good	2 Average	1 Poor
Expense: How likely are developing nations to adopt the new technology considering the price to design, construct and implement on a large scale?					
Range of application: (can this new technology be applied to a variety of climates/countries or is it very limited in its scope to offer a solution to a water-deprived region)					
Feasibility: Do the products necessary to build the technology exist? How readily available are materials? How long could the technology be expected to produce results? How many would be served by the design?					
Effectiveness: How likely is the new technology to positively impact global water conditions?					

Demand for freshwater threatens to outstrip supply. How can we meet the needs of all of Earth's species? *- Natural History, Nov, 2007 by Eleanor J. Sterling*

> **Water: evolving life-forms crawled out of it hundreds of millions of years ago, yet it still envelops us in our fetal state, suffuses every tissue of our body, and surrounds our drifting continents. From ancient origin myths and ritual baths, to Handel's Water Music and the play of ornate fountains, to water parks and water slides, we celebrate it. Water molecules move through the years and across the globe, from rivulets to rivers to oceans, rising into the atmosphere and falling back to land, connecting each of us to the rest of the world. In this global cycle, each of us is always downstream from someone else.**

Despite all the water in the world, only a small fraction is available to us and other species that depend on freshwater. Salty seas account for more than 97 percent of the water on Earth. Of the remaining 3 percent or so, at least two-thirds is tied up in glaciers, ice caps, and permafrost, or else lie deep underground, of little use to those of us living on the land above.

[That last 1 percent, that precious supply that keeps us alive… freshwater] is not evenly distributed across the globe. The Americas have the largest amount and Oceania (Australia, New Zealand, and the Pacific islands) the smallest. Thinly inhabited Oceania, however, has the greatest per capita supply, more than 9.5 million gallons per person per year. Asia has the lowest. By country, Brazil, Canada, China, Colombia, Indonesia, and Russia together have half the world's supply of freshwater; northern Africa and the Middle East are the water-poorest. The United Nations defines water scarcity as less than 500 cubic meters (132,000 gallons) per person per year. Kuwait has a natural supply only one-fiftieth that amount, but given its huge supply of oil, it can afford to run desalination plants.

At the individual level, further inequities emerge. Although a person can manage for a few days on a gallon or two a day, an adequate supply of clean water is about thirteen gallons per person per day. Ten percent of it is needed for drinking, the rest for sanitation and hygiene (40 percent), bathing (30 percent), and cooking (20 percent). In 2006 the UN estimated that more than a billion people--one-sixth of the world's population--lack even the bare minimum gallon-plus per day of safe drinking water, and 2.6 billion lack access to basic sanitation. In contrast, those of us who live in the United States and Canada each consume, on average, more than 150 gallons a day for domestic and municipal purposes (not including agricultural and industrial usage). In the United Kingdom people do fine with about a fifth as much.

People appropriate more than half the world's available surface freshwater. Globally, 70 percent of withdrawals from rivers and groundwater are used for agriculture, 22 percent for industry, and the remaining 8 percent for homes and municipal use. As demand increases, driven by both population growth and soaring consumption rates, water appropriation is projected to rise to 70 percent by 2025. In many ways, we are already damaging the systems that provide us with this critical natural resource.

Groundwater is one of the major systems being stressed. Overpumping, or extracting water faster than the underground systems recharge, has led to plummeting water tables, not only in the Middle East and northern Africa, but also in China, India, Iran, Mexico, and the U.S. The Ogallala aquifer, one of the world's largest, stretches under parts of eight states in the High Plains of the central U.S., from South Dakota to Texas. Water began collecting in porous sediments there some 5 million years ago; a geologically slow rate of recharge means that deep wells still bring up water from the end of the last Ice Age, more than 10,000 years ago, making it truly "fossil water." But the aquifer is being pumped out many times faster than it can be replenished. Between the early 1900s, when the Ogallala was first tapped for irrigation, and 2005, the water table dropped by more than 150 feet in some parts of Texas, Oklahoma, and Kansas. The raising of crops has become uneconomical for some Great Plains farmers, and further depletions could have substantial ripple effects on billions of people around the world who depend on American farm products.

As more land is paved over, rainwater can no longer soak into the ground or evaporate slowly to recharge the system. In coastal areas, a falling water table may open an aquifer to an influx of saltwater, impairing or even ruining it as a freshwater source.

Human activities are affecting other aquatic systems as well. Canals, dams, and levees that impede the natural flow of water can change not only the absolute quantity but the quality of water downstream: its concentration of pollutants, its sediment load, its temperature, and so on. People on both sides of the barrier are affected, whether they are growing crops or fishing for sport. Those changes can also severely alter or destroy the habitats of other species. More than half the wetlands in parts of Australia, Europe, New Zealand, and North America were destroyed during the twentieth century. When people divert water into desert regions to maintain thirsty crops, luxurious green lawns, and golf courses--instead of growing drought-adapted crops and native and ornamental plants--water resources are decimated. Even high-volume rivers such as the Colorado, the Ganges, and the Nile have been reduced, in some places, to polluted trickles.

In water-rich regions, people may wonder how their actions could have any effect on how people use water in water-deprived areas. But consumer choices obviously help drive what agriculture and industry produce and how they produce it. If agriculture and industry account for more than 90 percent of water usage, our closets, cupboards, desks, and refrigerators are filled with what has been termed “virtual water”: products that require water for their growth, manufacture, and packaging. Those products now come from all over the world, including from places with limited water resources.

More than 700 gallons of water are needed to grow enough cotton to make a T-shirt. Your choice to buy the shirt could lead farmers in arid Central Asia to divert water to irrigate a cotton crop. Although poor farmers may welcome the cash, such diversions have led, for instance, to a 75 percent loss of volume in the Aral Sea. Once the fourth-largest inland body of water by area, the Aral has now shrunk so much that its former lakebed is littered with rusty ships, rimmed with abandoned fishing villages miles from the water’s edge, and scoured by storms of toxic dust.

Conserving water helps not only to preserve irreplaceable natural resources such as the Aral, but also to reduce the strain on urban wastewater management systems. Wastewater is costly to treat, and requires continuous investment to ensure that the water we return to our waterways is as clean as possible. During storms, rainwater runs off the pavement, collecting pollutants as it goes. Where storm sewers and sanitary sewers are connected, the influx of storm water can overwhelm sewage treatment facilities, leading to the release of untreated sewage and polluted storm water directly into local waterways. Forty billion gallons of such a toxic cocktail flow into the Hudson River and its estuary each year. Several towns and cities around the world are installing innovative solutions to such problems that also benefit surrounding ecosystems. Rainwater overflow, for instance, can be channeled into wetland systems instead of into storm sewers.

Human activities affect water quality in other ways as well. Particularly in large cities, once water has disappeared down the drain or into a storm sewer, it is rarely thought of again. But what becomes of the household chemicals poured daily into the water supply--cleansers, antibacterial soaps, medicines? Ecologists are just now learning about their downstream effects. One that is well documented is the disruption of growth and reproduction in frogs and fish. Cities with sophisticated treatment systems can filter out many chemicals, but antibiotics, hormones, and antibacterial compounds remain hard to handle.

The UN estimates that by 2025, forty-eight nations, with a combined population of 2.8 billion, will face freshwater “stress” or “scarcity.” Water shortages already impede development, perpetuate poverty, and damage health in low- and middle-income countries. As populations grow and the demand for water increases, problems will intensify and will not be contained within national borders. Population displacements and conflict over shared surface and groundwater resources are bound to exacerbate international turmoil. It is no coincidence that the word “rival” derives from the Latin word for “one living on an opposite bank of a stream from another.”

The world also faces the uncertain effects of global warming. The loss of mountain ice caps and glaciers, for instance, may alter the quantity and reliability of water for drinking, agriculture, and power generation. California's Central Valley, which produces a quarter of the food sold in the U.S., depends on timely seasonal snowmelt from surrounding mountains; farmers could face failing or lower-yielding crops as the climate warms and less water is available in the growing season.

Water policy makers have focused on technological solutions to increase water supplies--diverting surface water, pumping up groundwater, extracting the salt from seawater. Such solutions often have high costs, both monetary and environmental. And so the focus has shifted to reducing demand. Hydrologists estimate that as much as 60 percent of the water extracted from aquatic systems for human use is simply wasted--lost to leakage, evaporation, inefficient appliances, and human carelessness. Changes in various technologies and in everyday behavior could slash that number in half. Saving water in the home calls for installing water-efficient appliances and fixtures, fixing leaks, refilling water bottles from the tap, landscaping with native plants, and generally being more conscious about water use. Municipalities could construct wetlands or, better yet, refrain from destroying existing ones. Towns and businesses could pave with a permeable material that enables water to seep back into aquifers. Industries and municipalities can reuse water that has been treated but does not reach drinking-water standards. A bounty of choices is available, once we decide to stop taking water for granted.

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“Blue Planet Blues”
Reading for Comprehension Questions

1:: Use the information in the Eleanor J. Sterling Blue Planet Blues article to create a chart or graphic representation of the distribution of freshwater across the globe.

2:: Create a chart or graphic representation of the recommended percentages of water--out of a total of thirteen gallons per day-- for the following purposes: drinking, bathing, cooking, and sanitation and hygiene.

3:: Define and/or describe the meaning of the term “virtual water”

4:: According to Sterling, in what ways do the actions of people living in water-rich locations affect how people use water in water-deprived areas?

5:: What meaning is Sterling attempting to convey in the following statement: “It is no coincidence that the word “rival” derives from the Latin word for “one living on an opposite bank of a stream from another.”

6:: List examples of technological solutions water policy makers have focused on to increase water supplies to water-deprived areas.

7:: List examples of what a person living in a water-rich area can do to help alleviate the problems experienced by those living in water-deprived areas?

Examples of water collection hydro-technology

Fine mesh "fog catching" nets, stretched between poles, collect usable water from fog.
Pipe directs rain from rooftop into cistern in "rooftop harvesting."

An iceberg towed from Antarctica to Saudi Arabia or Australia would alleviate the country's water shortage, but would cost billions and wreak environmental havoc.

Filtration straws trap disease-causing bacteria, enabling people to safely drink untreated water. Two million people use the straws, which cost $3 each.

Desalination cone placed over saltwater in the sun evaporates the water, which condenses on the cone's inner wall and trickles down into a collection channel around the bottom edge.

A bamboo treadle pump, made of inexpensive local materials, helps farmers tap groundwater to irrigate small plots of land.

A wind-powered spray turbine mounted on an anchored platform in the ocean sucks water up through pipes, then filters and sprays it in fine droplets into the sky. The humidified air produces clouds and rain.
The fine weave of woman's old saris, folded four times, can filter out cholera-causing bacteria.
Hydro Tech

Natural History, Nov, 2007

Research other examples of hydro-technology such as the Q-Drum. The Q-Drum is made of tough plastic, holds 13 gallons of water—and it rolls! The Q-Drum is a significant yet simple new technology that will help people who must travel long distances to collect water. The only extra equipment needed is a piece of rope.

Twenty percent of the people on Earth lack access to clean water. And even that dismal number is likely to grow. *- Natural History, Nov, 2007 by Sharon P. Nappier, Robert S. Lawrence, Kellogg J. Schwab*

Drought in Australia. Water shortages in northern China. The desertification of western Africa. Almost daily, such headlines roll off the presses and issue from the airwaves.

Undoubtedly, diminished access to freshwater is a dire threat to people around the world. But consider the condition of the water when it finally trickles down people's throats. Infectious pathogens and harmful chemicals--from parasites to poisons--contaminate the world's freshwater and contribute to the deaths of millions of people worldwide every year. Understanding the effects of those contaminants holds the key to protecting our drinking water. And figuring out how we are exposed to harmful agents is the first order of business in choosing proper water-treatment techniques.

The burden of those agents weighs heavily on communities around the world. Nearly 2 million people -most of them children under five--die every year from diarrheal diseases. That statistic is not surprising when you realize just how much dirty water flows, or in many cases lies stagnant, across the continents. Nearly 20 percent of the 6.6 billion people in the world lack access to a supply of clean water, and 40 percent lack safe sanitation facilities. No new headlines there: as far back as 1981 the United Nations recognized the need for improved water supplies and sponsored a water-themed decade through 1990, in hopes of rallying international aid. Yet the percentage of people who have sufficient access to clean water supplies has remained fairly static.

Arguably, the battle is uphill. As quickly as innovative filters and water-transport systems enter the market, new contaminants and diseases arise, populations grow, and competing demands for water increase. Certain microorganisms can be elusive, causing severe illness at doses as low as one infectious organism per drink of water. And those disease-causing organisms don't stand still while we figure out how to combat them: dirty water can lead to increased virulence, as in the case of antibiotic-resistant bacteria. Battling, let alone eliminating, those ever-changing organisms, along with the plethora of synthetic contaminants, seems only to be getting more difficult.

One thing will never change: people need water for survival. Circulating inside, outside, and across our cells, water constitutes as much as 70 percent of our body weight. Although we may survive four weeks without food, our bodies last, at best, only a few days without water. Furthermore, we use water for the most basic daily activities: drinking, cooking, bathing, washing, and sanitation.

For at least the past six thousand years, civilizations have understood the need to engineer water treatment techniques. Greek and Sanskrit texts discuss approaches to water sanitation that include boiling, straining, exposing to sunlight, and charcoal filtering. The ancient Egyptians employed coagulants--chemicals that are frequently used even today to remove suspended particles in drinking water--and other methods of purification. The earliest large-scale water treatment plants, such as the one built in 1804 to serve the city of Paisley, Scotland, used slow-sand filtration. By the 1850s London was sending all of its city water through sand filters and saw a dramatic reduction in cholera cases.

The discovery of chlorine as a microbicide in the early 1900s was a turning point in drinking-water engineering. That, in turn, led to a major advance in public health. Chlorination was initiated in the United States around 1910, and during the next several decades change was evident: the previously high mortality rate from typhoid fever--twenty-five deaths per 100,000-plummeted to almost zero. Although chlorine readily inactivates viruses and bacteria, its killing power flags when faced with hardy protozoan oocysts (developing cells), such as those of Cryptosporidium parvum--an agent of diarrheal disease. Another, and perhaps even nastier, drawback is that chlorine and organic matter may create carcinogenic by-products when they mix in the treatment plant. Nevertheless, chlorine is still one of the cheapest and most effective disinfectants in use today.

No panacea for water disinfection exists, however. To ensure that the water supply is clean enough to drink, most modern drinking-water plants amass an arsenal of treatment options. A multibarrier approach might include physical processes such as coagulation and flocculation (creating clumps of particles), sedimentation, and filtration, in conjunction with disinfectants such as chlorine, chlorine dioxide, chloramines, or ozone.

Such systems for cleansing community water are public investments that pay dividends. Clean water improves general health and reduces health-care costs, thereby enabling greater productivity among community members and redirection of public funds to other pressing needs. Unfortunately, rural and low-income localities cannot afford the infrastructure required for large, centralized drinking-water facilities.

On a global scale, of course, an ideal filter is natural vegetation. Protecting entire watersheds could vastly improve water quality worldwide; benefits could come from actions as simple as maintaining hillside growth to prevent soil erosion and flooding. But because many watersheds span several states or even countries, most management plans are politically complex. A comprehensive watershed-management plan must incorporate multiple stakeholders' needs and conflicting interests.

Water scarcity goes hand in hand with disease. As renewable freshwater becomes a dearer commodity worldwide, waterborne disease agents and other contaminants become harder to control. When dealing with diarrheal diseases, for instance, the quantity of available water often matters more than the quality, both to fend off the disease and to foil its spread. Then there's trachoma, a condition that can cause blindness; today it affects 6 million people and is associated with poor personal hygiene, often resulting from a dearth of water.

Every person, every day, needs at least thirteen gallons of water for drinking, cooking, bathing, and sanitation. In 1990 more than a billion of the world's people used less than that. By contrast, average per-capita water usage in the U.S. now exceeds 150 gallons a day. That discrepancy illustrates how the level of personal use correlates not only with the economic development of a region, but also with the degree of urbanization and with the overall public health in the region.

All that water filling swimming pools and soaking gardens might seem extraordinarily wasteful, but only 8 percent of the planet's freshwater supply goes toward personal, household, and municipal water use. Agriculture accounts for 70 percent, and industry for 22 percent, of current freshwater use. It takes more than fifty gallons of water to produce a single cup of milk. That's modest as virtual water content goes: consider a quarter-pound hamburger (470 gallons) or a cotton T-shirt (520 gallons). Then consider how many cotton T-shirts are tucked away in your closets. It's no surprise that demand is exceeding supply.

Daily water needs are exceedingly hard to meet in areas where rapid urbanization is taking place. Antiquated water-supply systems are simply not equipped to provide enough water and sanitation to people living in progressively crowded shantytowns or on the urban fringe. About half the world's people are now city dwellers. This new urban majority puts great stress on infrastructure, increasing the likelihood that illegal connections will be inserted into existing water systems and that, as a result, the piped drinking water will become contaminated.

Countries undergoing urban population booms often face acute microbial hazards. In countries where per-capita-income is low, roughly 200 children under the age of five die every hour from a water-associated microbial infection. Many of the infections derive from the ingestion of water contaminated with human or animal feces that carry pathogenic bacteria, viruses, protozoa, or helminthes. That's the classic, but not the only, pathway for waterborne disease spread.

Exposure to contaminated water extends beyond the drinking fountain. Many diseases, once introduced into a population, can spread via person-to-person contact, in aerosol droplets, or through food preparation, rather than direct consumption of contaminated water. For example, malaria-carrying mosquitoes use stagnant water as a breeding ground; Giardia can be acquired during a swim in a local lake; clothing or bedding may carry scabies mites; noroviruses can be transmitted by eating oysters [see photomicrographs on these two pages].

Emerging infectious diseases (the ones whose incidence in humans has increased in the past two decades or threatens to increase soon) have recently caused some public-health scares. Noroviruses--headlined for causing cruise ship infections--are already on the rise. Cryptosporidium parvum sickened some 400,000 residents of Milwaukee, Wisconsin in 1993, when the local water-treatment process was changed in what had seemed to be a minor way. E. coli O157:H7 is another of the more common emerging infectious pathogens in the U.S. joining the hefty ranks of dangerous bacteria, many of which are becoming resistant to multiple standard antibiotics.

But pathogenic microorganisms are not the sole cause of water-associated illnesses. Chemicals, too, pose serious risks. About a thousand new synthetic compounds are introduced every year, joining the ranks of tens of thousands more that are already in widespread use--dioxins, PCBs, and halogenated hydrocarbons included. Many inevitably seep into the water system and accumulate in the food chain. In the United States, for instance, some 700 chemicals have been detected in drinking water sources, and more than a hundred of those chemicals are considered highly toxic.

Advanced technologies enable investigators to detect harmful chemicals in the water supply, even in low concentrations--a critical step, since their effects on human health are often unknown. Several emerging chemicals of utmost concern are fuel additives, such as methyl tertiary-butyl ether, or MTBE; by-products of disinfection; antibiotics, hormones, and psychoactive drugs; the antibacterial soap ingredients triclocarban and triclosan; and persistent organic pollutants, such as perfluorinated chemicals and phthalates.

Most people have a sufficiently robust immune system to handle exposure to a certain amount of water pollutants. But some--infants, the elderly, people living with cancer or AIDS--are immunocompromised. Elderly adults often sicken on exposure to only a small fraction of the infectious dose that others require--an issue for the U.S. as it baby boomer population ages.

Just as an aging population poses a concern for public health, so too does an aging infrastructure pose a concern for water delivery. U.S. water infrastructure is outdated and deficient. In the next few decades, measures must be taken to reinforce or restore our water delivery pipes and systems, equipping them for both natural disasters and terrorist threats.

Once again the United Nations has declared a water decade: 2005 through 2015 will be the Water for Life Decade. Among the UN's Millennium Development Goals outlined for the decade are reducing the number of people worldwide who lack adequate water and sanitation by half. Additional efforts will concentrate on curbing the unsustainable exploitation of water. As with the UN's approach to increasing literacy, facilitating income generation, and curbing population growth, the focus will be on empowering women as a means of achieving its goals.

Certainly the goals are challenging. Achieving them will require cooperation among many stakeholders who are committed to expanding investments in water and wastewater infrastructure. New management strategies must embody conservation and efficiency for people everywhere, lest we find ourselves changing too slowly to quench the world's thirst.

“Dangerous Waters”
Reading for Comprehension Questions

1:: What are the four major uses of water for humans?

2:: How much water does a human need each day to survive? What percentage of the human body is water?

3:: Describe early attempts to supply and sanitize water.

4:: Explain the following statement: “Disease-causing organisms don’t stand still while we figure out how to combat them.”

5:: Only 8% of the planet’s freshwater supply goes toward personal, household, and municipal water use while agriculture accounts for 70%. How can/should the issue of agricultural water waste be addressed?

6:: Give examples of diseases that, once introduced into a population, can spread via person-to-person contact rather than through direct consumption of contaminated water.

Water-Aware Portfolio Entry:
The United Nations has declared: 2005 through 2015 the Water for Life Decade. Among the UN’s goals are reducing the number of people worldwide who lack adequate water and sanitation by half, concentrating on curbing the unsustainable exploitation of water, facilitating income generation, curbing population growth and empowering women as a means of achieving its goals. Address one of the UN’s goals and create a one to two paragraph recommendation for a course of action.

Answers

1:: drinking, cooking, bathing, washing and sanitation/hygiene

2:: (sources vary from 3, 13, and up) about 70%

3:: answers will vary

4:: dirty/infected/contaminated water can lead to increased disease spreading capability, as in the case of mutations: antibiotic-resistant bacteria. Scientists are trying to battle organisms that can change in a short period of time.

5:: answers will vary

6:: Malaria-carrying mosquitoes use stagnant water as a breeding ground, Giardia can be acquired during a swim in a local lake, clothing or bedding may carry scabies mites, and noroviruses can be transmitted by eating oysters.

EARLY HISTORY OF WATER SANITATION TECHNOLOGY

A safe water supply has always been a critical need of humankind. Throughout history, villages in every region of the world were purposely located near good water supplies. Ancient heavily-travelled trails were often routed past natural springs. However, most early freshwater sources were streams, ponds and springs that were subject to droughts, contamination, and ownership struggles.

Water supply sources with high clarity, good taste, and reliable flows were prized by the ancients. Where reliable sources were found, facilities were constructed to allow for easier access. Investment in a water supply source often consisted of simply digging a well or building a structure around a spring to make water collection easier. In a few cases, a much more significant investment was made, such as in the Roman aqueducts in Europe. These aqueducts were open channels that used gravity flow to bring desirable water from distant locations to major cities. Closed piping, that allowed pressurized water, was extremely limited and consisted of clay, wood or hammered lead; all of small diameter.

For at least the past six thousand years, civilizations have not only understood the necessity of fresh water supply sources, but also understood the need to engineer water treatment techniques. Greek and Sanskrit texts discuss approaches to water sanitation that include boiling, straining, exposing to sunlight, and charcoal filtering. The ancient Egyptians employed coagulants--chemicals that are frequently used even today to remove suspended particles in drinking water--and other methods of purification.

The Greeks and Romans also practiced certain water purification methods, even though they may not have fully understand the scientific principles behind their actions. Purification techniques included settling of water, filtering water through sand, and storing water in copper pots. From the Greek and Roman periods through the early 1800s, there was relatively little progress made relative to purification techniques, or the design or construction of water work facilities. In terms of water sanitation technology, much of that period truly was the dark ages.

Modern water treatment science was spearheaded in England, Scotland, and France in the early and mid-1800s. Probably the most important single breakthrough was the understanding of how certain diseases were capable of being transmitted by drinking water. The earliest large-scale water treatment plants, such as the one built in 1804 to serve the city of Paisley, Scotland, used slow-sand filtration. By the 1850s London was sending all of its city water through sand filters and saw a dramatic reduction in cholera cases. Notable health related developments included the recognition of the benefits associated with regular sand filtration and disinfection using chlorine.

The discovery of chlorine as a microbicide in the early 1900s was a turning point in drinking-water engineering as well. Chlorination was initiated in the United States around 1910, and during the next several decades change was evident: the previously high mortality rate from typhoid fever--twenty-five deaths per 100,000-plummeted to almost zero. Although chlorine readily inactivates viruses and bacteria, its killing power flags when faced with hardy protozoan oocysts (developing cells), such as those of Cryptosporidium parvum--an agent of diarrheal disease. Another, and perhaps even nastier, drawback is that chlorine and organic matter may create carcinogenic by-products when they mix in the treatment plant. Nevertheless, chlorine is still one of the cheapest and most effective disinfectants in use today.

The critical need humankind has for safe, reliable drinking water will never diminish. Many factors currently impact the availability of safe drinking water sources across the globe. Such factors as lack of access in water-deprived regions, global warming, the inefficiency of agricultural practices and runoff, the presence of pollutants and other chemical contaminants in freshwater sources such as rivers and lakes, inequity in economies, and the presence of microorganisms that are responsible for the deaths of millions of children and adults each year, all play a role in our current global water crisis.

Past discoveries in Egypt, Greece, Rome, Scotland, England, France, the United States, and other nations and civilizations as well have made tremendous advances in not only supplying water to large numbers of citizens in heavily populated areas, but also in creating safer water. Current discoveries are being applied to assist water-deprived regions around the world to help even the "water-playing field". Still, new discoveries are needed to protect the precious, finite resource everyone on earth shares in common.

Adolfo Esquivel, an Argentine activist and Nobel Peace Prize laureate stated, "… it is clear that humans can live without oil, gold, and diamonds but not water. The real wars will be over water, not oil." If Esquivel is correct then the people who invent new hydro-technology may also, simultaneously, be creating a cure for future wars.

The above information is excerpted from:

- Sources: 58th United Nations Rally, 23 October 2003, Minneapolis, Minnesota
- "Challenges in Freshwater Management" Keynote address by Marcia Brewster
- The New Hampshire Department of Environmental Services
- "Dangerous Waters" Natural History, Nov, 2007 by Sharon P. Nappier, Robert S. Lawrence, Kellogg J. Schwab

15.0 (HIGH SCHOOL) "RISING TENSIONS OVER THE NILE RIVER BASIN" MINI-UNIT

National Curriculum Alignment:
The following National Curriculum Standards are addressed by completing all of the activities associated with the Rising Tensions over the Nile River Basin mini-unit

NL-ENG.K-12.1
Reading for Perspective: Students read a wide range of print and non-print documents to build an understanding of texts, of themselves, and of the cultures of the United States and the world.

NL-ENG.K-12.3
Evaluation Strategies: Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts.

NL-ENG.K-12.5
Communication Strategies: Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

NL-ENG.K-12.6
Applying Knowledge: Students apply knowledge of language structure, language conventions, media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

NL-ENG.K-12.7
Evaluating Data: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources to communicate their discoveries in ways that suit their purpose and audience.

Science Grades 6 - 12

NS.9-12.6
Science in Personal and Social Perspectives: Personal health/Populations, resources, and environments/Risks and benefits

Social Sciences Grades 6-12

Geography Grades K - 12

NSS-G.K-12.1
The World in Spatial Terms: Understand how to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.

NSS-G.K-12.2
Places and Regions: Understand the physical and human characteristics of places/ Understand that people create regions to interpret Earth's complexity/ Understand how culture and experience influence people's perceptions of places and regions.
NSS-G.K-12.3
Physical Systems: Understand the physical processes that shape the patterns of Earth's surface/ Understand the characteristics and spatial distribution of ecosystems on Earth's surface.

NSS-G.K-12.4
Human Systems: Understand the characteristics, distribution, and migration of human populations on Earth's surface/ Understand the characteristics, distribution, and complexity of Earth's cultural mosaics/ Understand the patterns and networks of economic interdependence on Earth's surface/ Understand the processes, patterns, and functions of human settlement/ Understand how the forces of cooperation and conflict among people influence the division and control of Earth's surface.

NSS-G.K-12.5
Environment and Society: Understand how human actions modify the physical environment/ Understand how physical systems affect human systems/ Understand the changes that occur in the meaning, use, distribution, and importance of resources.

NSS-G.K-12.6
Uses of Geography: Understand how to apply geography to interpret the present and plan for the future.

Civics Grades 9-12

NSS-C.9-12.1
Civic Life, Politics, and Government: What is government? Why are government and politics necessary? What purposes should government serve?

NSS-C.9-12.4
Other Nations and World Affairs: What is the Relationship of the United States to Other Nations and to World Affairs?/ How is the world organized politically?/ How has the United States influenced other nations and how have other nations influenced American politics and society?

NSS-C.9-12.5
Roles of the Citizen: What are the responsibilities of citizens?/ How can citizens take part in civic life?

NSS-WH.5-12.1
Era 1: The Beginnings of Human Society

NSS-WH.5-12.2
Era 2: Early Civilizations and the Emergence of Pastoral People

Economics Grades 6-12

NSS-EC.9-12.1
Productive Resources: Scarcity

NSS-EC.9-12.3
Allocating Goods and Services: Comparing the benefits and costs of different allocation methods in order to choose the method that is most appropriate for some specific problem can result in more effective allocations and a more effective overall allocation system.

NSS-EC.9-12.4
Positive and Negative Incentives: Acting as consumers, producers, workers, savers, investors, and citizens, people respond to incentives in order to allocate their scarce resources in ways that provide the highest possible returns to them. Responses to incentives are predictable because people usually pursue their self-interest/ Changes in incentives cause people to change their behavior in predictable ways/ Incentives can be monetary or non-monetary.

NSS-EC.9-12.6
Gain from Trade: A nation pays for its imports with is exports/When imports are restricted by public policies, consumers pay higher prices and job opportunities and profits in exporting firms decrease.

:: **High School**
:: **Rising Tensions over the Nile River Basin**: **A Global Commons Case Study**
:: **Level of difficulty and duration**: **

Objective
Students will analyze the concept of a global commons dilemma through an evaluation of a primary source document.

Lesson
Students will read The Middle East Media Research Institute Inquiry and Analysis Series –No. 165 February 27, 2004: Rising Tensions over the Nile River Basin by Dr. Nimrod Raphaeli and respond in writing to the Reading for Comprehension questions that follow.

Materials
The Middle East Media Research Institute article

Post Activities
Reading for Comprehension questions and "Tragedy of the Water Commons" Lesson Plan

The article "Rising Tensions over the Nile River Basin" illustrates a global commons dilemma specifically as it relates to water. The article communicates why several African nations are in conflict regarding the use of the Nile River as a water source. Read the article carefully and complete the Reading for Comprehension questions.

"RISING TENSIONS OVER THE NILE RIVER BASIN"

Source: The Middle East Media Research Institute
Inquiry and Analysis Series - No. 165 February 27, 2004

Introduction
The Nile River is the longest river in the world. From its major source, Lake Victoria in east central Africa, the White Nile flows generally north through Uganda and into Sudan where it meets the Blue Nile in Khartoum, which rises in the Ethiopian highlands. The Nile traverses almost 6,700 kilometers (4,169 miles) from its farthest sources of the headwaters of the Kagera River in Burundi and Rwanda to its delta in Egypt on the Mediterranean Sea. [1]

The Nile is shared by ten countries – Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda –- with a combined population of about 300 million, about 160 million of whom live within the boundaries of the Nile Basin. The ten countries that share the Nile waters include some of the world's poorest, with annual per capital income of less than $250. [2]

In recent months, tensions have been rising over the waters of the Nile. In preparation for the African summit meeting of African heads of state to be held in Libya next week, the ministers of water representing the riparian countries have decided to put the subject of the 1929 Nile Water Agreement on the summit's agenda.

President Hosni Mubarak chaired a cabinet meeting in Cairo to discuss the issues. The communiqué issued after the meeting did not say what Egypt would do in the face of a persistent demand for reallocating the Nile waters, and whether Mubarak himself would attend the summit meeting. It vaguely referred to Egypt's readiness to provide training, technical assistance, "and help in procuring funding for projects that benefit all the countries of the Basin," in the framework of respecting the shares established by the existing agreement. [3] A couple of days earlier, the Egyptian government daily Al-Gomhouriya wrote that the demands by some of the Nile Basin countries for reallocating water shares is a matter of concern to Egypt which requires quick intervention to kill any initiative that would reduce the water supply to Egypt. [4]

The following is an overview of tensions regarding the Nile River:

The Nile Water Agreement of 1929
The Nile Waters Agreement (NWA) over the allocation of its waters between Egypt and Great Britain (which represented Uganda, Kenya, Tanganyika [now Tanzania] and the Sudan) was concluded on November 7, 1929 in Cairo by an exchange of letters between the Egyptian Prime Minister and the British High Commissioner in Egypt. The agreement allocated 48 billion cubic meters per year to Egypt as its acquired right and 4 billion cubic meters per year to the Sudan. These allocations were later increased to 55.5 billion cu. meters and 18 billion cu., respectively, under a 1959 bilateral agreement between these two countries that allowed for the construction of the Aswan Dam. Apart from Ethiopia, which had a government in place, the NWA was made before the other Nile Basin countries gained their independence.

The agreement stated that no works would be undertaken on the Nile, its tributaries, and the Lake Basin that would reduce the volume of the water reaching Egypt. It also gave Egypt the right to "inspect and investigate" the whole length of the Nile to the remote sources of its tributaries in the Basin.

This right "to inspect and investigate," which was tantamount to a veto power over any water or power project, has in recent years become moot, as all the former colonies on the Nile Basin have become independent nations and are not likely to readily agree to such encroachment on their sovereignty by Egypt. Indeed, some of them have begun to nibble on the NWA by initiating water projects that threaten to reduce the volume of water available to Egypt. Egypt considers any change in the agreement as a strategic threat and has repeatedly threatened to use all means at its disposal to prevent the violations of the agreement. The other Nile Basin African countries consider the agreement as a relic of a colonial era which no longer reflects their needs and aspirations and hence it should be annulled. Countering this argument, Sherif Al-Mousa, head of the Middle East Program at the American University in Cairo, argues that the Nile water agreement should be treated the same way as the boundaries of most Nile Basin countries which were established by colonial powers, and are recognized under international law. [5]

The Pressures for Change

Population pressures, frequent draughts, and increasing soil salinity have intensified the demands by the Nile Basin countries to renegotiate the 1929 agreement. Not deterred by Egyptian reluctance to negotiate the 1929 agreement, or even Egyptian threats, and constrained by financial hardships, some Nile Basin countries are determined to implement projects that would tap into the sources of the Nile.

The 1959 agreement between Egypt and Sudan, which increased the water allocations to themselves while completely ignoring the interests of the other riparian countries such as Tanzania, Kenya and Ethiopia has, in retrospect, weakened the Egyptian argument about inviolability of the NWA.

The Nile Basin Initiative

To reduce the potential for conflict, and with the help of the World Bank, the Nile Basin Initiative was launched in 1999 as a transitional arrangement until a permanent framework is in place. It is guided by a shared vision "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources."

The Nile Basin Initiative notwithstanding, member countries are forging ahead with their own projects and challenges. Droughts are difficult to forecast, even in the beginning of the crop season. Building dams to store water is not unlike a bank savings account, to be used at a time of need. While Egypt has secured its agriculture with the building of the Aswan Dam, it has been reluctant, if not belligerent, when other countries on the Nile Basin sought similar solutions.

Ethiopia Asserts Rights to the Blue Nile

The **Ethiopian Minister of Water Resources** announced his country's intentions to develop close to 200,000 hectares (ha.) of land though irrigation projects and construction of two dams in the Blue Nile Sub-basin. He further stated that these projects would be the first phase of forty-six projects which Ethiopia proposed to execute along with ten joint projects which Egypt and Sudan proposed. The Egyptian Ambassador to Ethiopia confirmed.

Egypt's commitment is to the utilization of the Nile waters for the benefit of all riparian countries. However, the Egyptian commitment was conditional. All projects must benefit both upstream and downstream countries, provided these projects do not lead to a reduction of the waters reaching Egypt.

The Ethiopian Minister of Water Resources retorted that the agreement to participate in the Nile Basin Initiative reserves Ethiopia's right to implement any project in the Blue Nile Sub-basin unilaterally, at any given time. He charged that the 1959 agreement between Egypt and Sudan impedes sustainable development in the basin and called for its nullification. [6]

From the Egyptian perspective, any change in the volume of its water could have devastating effects on Egypt. The vast majority of Egyptians live in a valley which is about 4 percent of the Egyptian territory, and 95 percent of Egypt's water resources are derived from the Nile.

Tanzania Challenges Egypt

In early February 2004, Tanzania launched a project to draw water from Lake Victoria to supply the Shinyanga region. The project calls for the construction of about a 100 mile long inland pipeline at an initial cost of $27.6 million, to be constructed by a Chinese engineering company. To mitigate the anticipated Egyptian reaction, Tanzania announced that the pipleline was designed to provide drinking water to its thirsty population rather than irrigate agricultural land. Tanzania's population of 35 million has suffered from frequent droughts, desertification, and soil erosion. In fact, Tanzania was the first riparian country which, upon its independence in 1961, declared the 1929 agreement invalid. [7]

Nevertheless, Egypt expressed its irritation with the Tanzanian project, arguing that under the 1929 agreement it has the right to veto any project - agricultural, industrial, or power - that could threaten its vital interests in guaranteeing its annual share of the river waters. While Egypt is handling the issue diplomatically, Egyptian officials stressed that "the diplomatic dialogue does not mean that Cairo does not consider any number of other options, if necessary." [8] In diplomatic parlance, "other options" do not exclude the use of force. Tanzania has not budged. The Deputy Permanent Secretary in the Tanzanian Ministry of Water and Livestock Development, Dr. C. Nyamurunda, said that Tanzania's sentiments about the legality of the water agreement are well known. He emphasized that "other countries also believe that the treaties [NWA] were illegal but they are to cooperate in negotiations, although they are not restricted from using the waters of the Nile." [9]

Another Challenge from Kenya

Similarly, in response to a threat from Kenya that it was considering withdrawing from the 1929 agreement, the **Egyptian Minister of Irrigation and Water Resources Mahmoud Abu Zeid** said: "Egypt considers the withdrawal of Kenya from this agreement as tantamount to official declaration of war [emphasis added] and a threat to its vital interests and national security." A Kenyan weekly quoted the Egyptian minister declaring in Addis Ababa that Kenya could be subject to sanctions by Egypt and the other eight members of the Nile River Basin Agreement. He said Kenya's position violates international law and customs "and we will not agree to it." [10]

The **Kenyan deputy foreign minister M. Watangola** repeated his country's demand for a revision of this historic agreement because Kenya was not consulted prior to its being signed. He said eight Kenyan rivers flow into Lake Victoria, which is the main source of the Nile waters. [11]

Water for Oil

A senior Kenyan parliamentarian suggested that the Nile water should be sold to Egypt and Sudan for oil. He said that the time has come to replace the Nile agreement with a new agreement to allow the members to benefit from the Nile's waters. He added: "We have presented our natural resources to Egypt and Sudan free without them doing anything in return. We need to sell to them as they sell to us." The Egyptian treated the idea as "stupid" because the two countries have vested rights, rather than customers who would buy the water. [12]

Egypt Accuses Hidden Fingers

In addition to Tanzania and Kenya, Ethiopia and Uganda are also demanding the abrogation of the 1929 agreement and a bigger share of the Nile waters. Egypt accuses "hidden fingers known to the Egyptian side [which] are openly inciting the traditional allies of Egypt in the Nile Basin to annul the agreement, arguing that it is incompatible with the population and political developments that have transpired in the last 75 years." [13] The anonymous senior Egyptian official who has made the allegation about the "hidden fingers" stressed that any change in the agreement was inconceivable and warned that "any infringement of the agreement would suggest that the African countries do not respect regional obligations." [14]

Egypt's Alternatives

To deal with the threat to its vital oil supply Egypt has four alternatives. Some are not mutually exclusive:

- Reduce waste through improved irrigation system.
- Price water at market rates.
- Maintain the status quo as long as feasible.
- Resort to the use of force.

Reduce Waste Through Improved Irrigation System

According to a study by the World Bank, 96.44 per cent of the economically active population in Egypt is engaged in agriculture. It is the highest percentage in the Middle East, with Morocco in second place with 92.61 percent of active population in agriculture. By contrast, the corresponding ratios for Tunisia and Lebanon are 60.87 and 10.35 percent, respectively. As a result, much of the water is used in agriculture, which contributes proportionately a small percentage to GDP. In Egypt, 88% of the water is consumed in agriculture which, as a sector, contributes only 14 percent to GDP, while 8 percent of water used in industry contributes 34 per cent of GDP. The report suggests that "from a narrow macroeconomic perspective, rationale of justifying the allocation of water to agriculture over industrial and other sectors is weak." [15]

Price Water at Market Rates

While the region remains one of the most water-scarce regions in the world, the cost of water for irrigation is set at below cost recovery levels. Egyptian agriculture is entirely dependent on irrigated land. The government provides irrigation water free, except of cost recovery of on-farm investment projects. Annual irrigation subsidies are estimated at $5 billion. In Egypt, irrigation subsidies are often rationalized as a means of offsetting low farm prices controlled to keep down urban food prices. [16] Water pricing and subsidies are such that they lead to waste in agriculture and provide little incentive for conservation techniques.

Maintain the Status Quo

Egypt's third option is to seek a status quo while tolerating some changes on the margin. To do so, Egypt must continue to maintain a pro-American and pro-Western orientation to discourage them and organizations controlled by them, such as the World Bank, from financing costly water projects such as dams or power projects in any of the riparian countries, which they themselves cannot finance through internally-generated resources.

Resort to the Use of Force

The last and least likely alternative is to resort to the use of force to uphold Egypt's right to exercise the veto power on activities that it deems dangerous to its national interests. Egypt's saber rattling cannot be taken too seriously, certainly not by the African countries themselves. Indeed, as one Egypt daily pointed out, "the harsh language adopted by Abou Zeid … might not be working…" [17] Not only does Egypt lack the military capacity to strike at countries two thousand miles outside its borders, but it will be hard pressed to justify a military action to enforce the provision of a 75-year old agreement concluded to satisfy colonialist considerations and priorities but dissatisfy the needs of the countries upstream. A Kenyan father of two, who owns eight ponds for fish farming, was quoted as saying: "If the Egyptians try to invade Kenya for the sake of its water we are ready to die for our rights. Kenya must forget the Nile agreement and return to the commercial consumption of the Lake Victoria Lake." [18]

Reading for Comprehension Questions:

1:: Which ten African nations share access to the Nile River?

2:: What issue, regarding the Nile, was put on the African Summit agenda in February of 2004?

3:: In what ways did the Nile Water Agreement of 1929 give Egypt an advantage over other African nations?

4:: What pressures intensified the demand for the Nile Basin countries to re-negotiate the 1929 agreement?

5:: Identify and explain the four suggested alternatives for Egypt.

6:: Why would Egypt been considering or threatening the use of force against other African nations? Why was Egypt's use of force unlikely?

7:: Ethiopia and Tanzania announced plans to construct dams and pipelines. According to the article, the Egyptian perspective at that time was, "any change in the volume of its water could have devastating effects on Egypt". Describe the position of the leaders of Ethiopia and Tanzania.

8:: If you were an Ethiopian Minister of Water how would you have responded to threats from Egypt designed to prevent you from accessing Nile water?

Answers:

1:: Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda

2:: The Nile Water Agreement of 1929

3:: Other countries could not build structures that would reduce the amount of water flowing into Egypt. Also, the agreement gave Egypt the right to "inspect and investigate" the entire river.

4:: Population, frequent droughts and increasing soil salinity

5:: (see article for descriptions/descriptions may vary)
1. Reduce waste through an improved irrigation system
2. Begin charging market rates for water
3. Maintain the status quo
4. Resort to the use of force

6:: Egypt wanted to maintain the dominant access to the Nile provided by The Nile Water Agreement of 1929. Egypt was unlikely to use force because it did not have the military capability to take on such a large effort and ultimately would not be able to justify the validity of the 1929 agreement.

7:: The Ethiopian Minister of Water Resources stated that Ethiopia has the right to implement any project in the Blue Nile Sub-basin at any time. The Deputy Permanent Secretary in the Tanzanian Ministry of Water and Livestock Development questioned the legality of the water agreement and stated that Tanzania is not restricted from using Nile waters.

8:: Answers will vary.

:: **High School**
:: **"Tragedy of the Water Commons"**
:: **Difficulty and duration:** ***

Objective

Introduce students to the concept of The Tragedy of the Commons and apply the concept to address the global water crisis. Student will gain insight into the global water crisis and interpret information illustrating the lack of access to freshwater in many developing nations.

Lesson

At tables of four, students will review materials that will help them better understand the global water crisis.

Background

In 1968, environmentalists coined a term or concept called the Tragedy of the Commons. The tragedy being the notion that any resource that is open to everyone – such as the air, rivers and lakes, or the ocean – will eventually be destroyed because everyone can use the resource but no one is responsible or fully accountable for preserving it. When people are not compelled to preserve resources for the welfare for future generations, the Tragedy of the Commons occurs.

Materials

Before the activity begins you must set-up the room so that four students can each sit around a table. In the middle of the table, for each group, the teacher will place a dish (this represents the lake) containing varying numbers of orange goldfish crackers. Eighteen crackers are suggested for one of the groups. Sixteen crackers are suggested for two or three of the groups. Ten crackers are suggested for one of the groups. Eight crackers are suggested for one of the groups. Place four sets of chopsticks (they represent the fishing apparatus) at the table.

1:: Read the following to students: Each one of you represents the head of a family that is starving. In order for your family to survive, you must catch enough fish for them to eat. The only food source is a small local lake which can hold up to 16 fish. Each group will be given a predetermined, differing number of fish to represent access to, or the lack of access, to water as a resource.

Once a "year" you will get a chance to fish and each time you fish you may take 0, 1, 2, 3, or 4 fish from the lake. It is your choice how many fish you take, however, if you only take one fish, your family will starve. If you take more than 2 fish, you can sell them for a profit. The fish in your lake will reproduce once a year. Keep the fish that you "catch" in front of you. (You will be able to eat them later.)

2:: At the end of each year, the teacher will visit each table and add more fish to the lake when they reproduce. They simply double each year. If any family has starved then they obviously cannot fish the next year.

3:: Instruct students not to communicate while fishing

4:: Have the student fish for 5 "years" and make sure that they fill in the Data Table for 1st game after each round. You should control each and every round telling them when to start and stop.

5:: After the first game have students answer questions 1 and 2 in the discussion questions.

6:: The students have still been unable to talk to each other during fishing so now you begin game #2. Remind students not to communicate with each other.

7:: Once the game is complete, have students answer the discussion questions.

8:: Facilitate a class discussion focusing on the questions provided. Extend this to have students look at how the U.S and other countries use water as a global common.

FISH DATA TABLE
1st game

NAME OF LAKE: ______________________ BEGINNING # OF FISH: __________

	Number of fish in the lake [after reproduction]	Number of fish caught per person	Number of fish caught per year [by everyone]
YEAR ONE			
YEAR TWO			
YEAR THREE			
YEAR FOUR			
YEAR FIVE			
TOTAL			

FISH DATA TABLE
2nd game

NAME OF LAKE: ______________________ BEGINNING # OF FISH: __________

	Number of fish in the lake [after reproduction]	Number of fish caught per person	Number of fish caught per year [by everyone]
YEAR ONE			
YEAR TWO			
YEAR THREE			
YEAR FOUR			
YEAR FIVE			
TOTAL			

Tragedy of the Water Commons" Discussion Questions

1:: Did anyone in your group take too many fish? How did that make you feel? Did everyone try to take as many as possible? Why or Why not? Does society reward those with the "most" or greatest access to resources?

2:: Did your group start out at a disadvantage with fewer fish or with an advantage of more fish than other groups? How did the number of fish your group started with affect the team's strategy?

3:: How might a lack of access to safe, clean drinking water place individuals and communities at a disadvantage in their daily lives?

4:: Is it possible to maximize the number of fish caught/person AND the number of fish remaining in the pond at the same time? Why or Why not?

5:: The game is structured to illustrate why many people/corporations/farms/governments, etc. have abused their privilege of access to common natural resources such as freshwater. Does the game successfully demonstrate this principle? Why or why not?

6:: In Game two how did your strategy change, if at all? Does it make a difference to know what the rewards are?

7:: What can people do to create access to safe, clean drinking water for countries or regions who "begin the game with fewer fish" or are at an apparent disadvantage to other more developed regions?

8:: Did anyone sacrifice the # of fish, for the good of the community? Why or why not? Does society ever reward that type of person?

9:: What infrastructures are in place to protect water as a global common?

10:: How might nations reward one another for protecting water as a valuable global commons resource?

ABOUT WATERPARTNERS INTERNATIONAL

WaterPartners International is a U.S.-based non-profit organization that provides safe drinking water and sanitation to people in developing countries. Since its inception in 1990, WaterPartners has transformed more than 200 communities in Bangladesh, El Salvador, Ethiopia, Honduras, Guatemala, India, Kenya, and the Philippines with access to safe water and sanitation.

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