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
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-12.6
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).
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.

“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