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Green Chemistry: Is Water, Water?

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Overview

Water is everywhere. Water is essential for all living organisms. Man can survive without food for weeks or even months, but without water perhaps only for days. Even the human body consists of three quarters water. [1] The significant body parts are composed of water. The brain is composed of 70 percent water. The lungs are about 90 percent water. [2] There is water in the air, water in the ground, and in food and liquids that man consumes. Basically water is one of the most important sources of life.

All living organisms need water to survive. However, we forget that fresh water will eventually be depleted if not conserved. Man is misusing water and abusing its sources. The manufacturing companies and industrial plants have poisoned the water sources such as the brooks, streams, lakes, seas and oceans. In Southeast Asia, unscrupulous fisherman use illegal means to catch fish which destroy the schools of fish and the coral reef environments. The waterfronts are no longer safe for swimming. People buy water in plastic bottles instead of drinking from tap water. The plastic bottles are discarded improperly which pollutes both land and water ways. As the human population increases, nations will face water shortages. In some communities, the use of water is restricted. We need to undo our mistakes and do something to sustain our one and only planet, Earth. Green chemistry will teach us how to use our water sources wisely.

Green Chemistry, also known as Sustainable Chemistry, is the design of chemical products and processes that reduce hazardous substances. It applies across the life cycle, including the design, manufacture, and use of chemical products. The technologies used in green chemistry provide waste reduction, safer products, less use of energy and resources, and improve competitiveness of chemical manufacturers.

When I teach science concepts to my students, I use literature to get my students engaged. Science terminologies are abstract to them. Using children's literature for each lesson makes the challenging science concepts meaningful. For instance, the book "S is for Save the Earth" is relevant to green chemistry, one of the letters in the alphabet is the letter O. The book describes the letter O in poetry form, "Letter O is for the lovely oceans " and states scientific facts on how important the ocean waters are on the Earth's surface. [3] It explains how plastic and toxic chemicals contaminate the rivers, lakes and oceans. The simple suggestion of bringing a trash bag with you the next time you get to the beach is doable for readers.

After reading one of the most interesting children's books, S is for Save the Planet: A How to be Green

Alphabet written by Brad Herzog, you would appreciate the small things that people take for granted. It teaches children as well as adults the environmental issues that we encounter and gives simple suggestions that anyone can understand. Its goal is to teach the readers how they can be a force of nature in protecting the Earth for generations to come.

The curriculum unit is designed for second language learners in the fourth/fifth grade level. The learners are about 8-9 years old. The class consists of 75 percent Hispanic and 25 percent native speakers of English. The unit could also be modified for students in the mainstreamed class. The learners will be taught in English in reading, science, math and social studies. The unit will take about three to four teaching weeks. Reading will be integrated to teach science content. It will also include the four proficiency skills in listening, speaking, reading and writing. Children's literature will be used to introduce the science concepts when teaching the unit. It is my hope that the curriculum unit will increase social awareness and responsibility of my students to be stronger forces of nature that will sustain and protect the Earth's resources (specifically water) and the environment. They will do simple actions that set examples and understand how to use the principles of green chemistry for their own future.

The unit will focus on the importance of water. The objective of my unit is for the students to understand the value of water in all living organisms and how green chemistry keeps our water clean and sustainable. The state standard objective is for the students to demonstrate an understanding of life science.

Strategies

Since I am integrating reading and science in my unit, I will choose four books to introduce my science concepts namely: The Story of Water on Our Planet (history of water), The Lorax (green chemistry), and Song of the Water Boatman & Other Pond Poems, (The Drop in my Drink: The Story of Water on Our Planet, and S is for Save the Planet: A How to be Green Alphabet (green chemistry). To introduce the topic about water, I will use The Drop in my Drink: The Story of Water on Our Planet.

Before, During and After reading strategies will be integrated in the science lesson. Prior to reading the books I have chosen for my unit, I will set a purpose for reading the story. For example in "The Lorax", each student will take the role of a junior scientist who will investigate why the Trufulla Forest disappeared. They will have to find out what happened to all the plants and animals before and after the Once-ler arrived in the Trufulla forest. The book will be previewed by pointing to the title, pictures and captions, headings and bold-faced prints, and other graphics. Then I will activate students' background knowledge by asking them to think about what they already know and write their ideas on sticky notes provided by the teacher.

This strategy is called the Herringbone strategy. It is used for fiction, non-fiction and expository text. I find this strategy applicable for the science content of my unit. The Herringbone strategy helps students summarize and synthesize what they have learned in the text. Students make decisions for selecting the main idea, significant details and its relationship to science. Using a K-W-L chart (What I Know, What I Want to Learn and What I Learned From the Story), I will post the sticky notes. The first two, K-W- columns will be filled out with sticky notes; then after reading the story, students will put their replies to lessons learned in the L- column.

While I am reading aloud, I will check for students' understanding by asking Comprehension Purpose

Questions (CPQ) that have been prepared in advance and written on sticky notes. The Comprehension Purpose Questions are asked from concrete to abstract using the Bloom's Taxonomy concept. The CPQ will be posted on the board or on the walls for the students to see. When teachers read with a question in mind, we help readers cut through the dense text and zero in on important information. Remember that we, the teachers have to plan in depth and read ahead. CPQ questions help students review content and relate what they have learned to what they already know. [4]

When some students do not understand a sentence or a paragraph, rereading helps. Whenever there is a vocabulary word that is not understood, I can skip it and read to the end of the paragraph and tell the students to think about what would make sense. I will use the context clue, go back and tell the students to guess what the word is.

I will teach the students how to connect background knowledge to the information in the text. Since students have brainstormed prior to reading the text, I will tell them to think how the information is similar to what they already know about the topic, event or person. I will ask the students to find the direct information in the text. If I am reading a longer text, I will stop and review what has happened in the story or what information has already been given.

After reading aloud, I will tell students to work in groups of four. Each group will do the Think-Pair-and-Share strategy. The four students in the group will pair up, think and discuss the story. As a group, they will share their ideas and one student in the group will be chosen to summarize the story orally. After doing this activity, each group will come up with a written summary. I will give students a Venn diagram handout. The students to use graphic organizers like the Venn diagram to visualize their ideas. Finally, I will go back to the posted CPQs, tell the students to write their answers to the questions and discuss them with the whole class.

Each student must have a science/reading journal notebook to write and record their reading and science activities. In their journal notebooks, I will teach key words using semantic maps. Semantic maps are used to teach vocabulary development. Schirmer states that new knowledge is gained from finding new relationships in old knowledge and from relating new information to old knowledge. That means students use a semantic map as a visual aid to help them think of other words related to the new word. I will write one vocabulary word or a key concept and ask the students to think of words related to the vocabulary word or the key concept. The teacher and the students group the words in categories. I will suggest new words and encourage the students to find where the words would fit into the semantic map.

The Gist strategy will be used to check students' understanding. I will use seven prompts before, during and after reading. Before reading, ask the students these questions: What do you think this text is all about? What makes you think so? The next three prompts will be used during reading are as follows: Did you find evidence that supports your prediction? Explain your answer. Did you find evidence that does not support your prediction? If yes, explain your answer. Do you want to change your prediction at this point? Why or why not? The last two prompts to ask students are: Do you want to make changes of what it is all about. If yes, why do you want to make these changes? Finally, what did you learn that you did not know before reading?

Remember to tell the students to write their responses and reactions to what they are reading in their science/reading journal notebook. These are some of the strategies that I will use in integrating reading with science content. The seven prompts or questions can be displayed on sentence strips around the room, or on a transparency, or a smart board or on the chalk/white board or copies are provided for each group of students. Thus, students will be able to monitor their own comprehension.

Research studies have shown that reading and science education develop similar types of skills such as problem solving and sequencing. Armbruster explains that, "the study of science helps develop language and reading skills and strengthens the logical processes necessary for effective content reading". [5] Student achievement will increase in both areas when integrating science and reading. Hands on activities or science experiments help students learn better because they are solving problems, engaging in direct investigation, interacting, and promoting the use of real language. Students create meaning by listening science, talking science, reading science and writing science. Therefore, using these strategies in my unit will entice my students to learn meaningfully and effectively.

Unit Background

Why is water important?

When you see Earth's image from an astronaut's window overlooking space, Earth is covered mostly with water. It is the only planet that has liquid water on it. History tells us that even the early man learned the he could not live without water. Man's thirst led him to live close to water. Water was also his source of food. He knew that water was important to every living organism. Man, plants and animals needed water for food. Where there is water, life exists.

Man knows that water is needed for life. Every living organism contains water. The human body is composed of 75 percent water, which is also true for animals and trees. [6] The main part of the blood is mostly water. The brain, muscles, skin and all body tissues contain water. As the saying goes, man can live without food for many weeks, but he can live only for a few days without water.

What is water?

In chemistry, water is made up of two invisible gases, hydrogen and oxygen. There are two parts of hydrogen and one part of oxygen. Hydrogen is the simplest and lightest of all elements. It is a nonmetallic element. Hydrogen is the most abundant element in the world. Hopefully it will become important in the study of fuel cells to generate electricity because it is a clean and efficient element. Oxygen, on the other hand, is also a non-metallic element. It is colorless, odorless and tasteless. It is one of the most significant elements behind most chemical reactions because it is important to life processes. When we inhale, oxygen gets into our bloodstream and our blood cells carry oxygen to sustain chemical reactions in our body.

There are three states of matter namely solid, liquid and gas. Water has three different forms. When the water is frozen, it is in its solid state. The freezing point of water is 32 degrees Fahrenheit and 0 degrees Celsius. When you put water in the freezer, ice forms. Ice also forms during cold winter time on ponds, rivers and lakes. When water freezes it expands. A cubic foot of water makes more that a cubic foot of ice. That makes ice lighter than the same amount of water. In winter, ponds are only frozen on the top. Fish and other living organisms swim and feed in the water below. If ice were heavier than water, then ponds would freeze from the bottom to the top. All living creatures would also freeze. The fish would all die.

When ice melts, water turns to its liquid state. Water boils at 212 degrees Fahrenheit and 100 degrees Celsius. When water boils it turns into a gas called steam. The steam is invisible and, as it cools down, tiny drops of

water formed. We would see tiny clouds. Clouds are water vapors. They are formed when warm, moist air rises and is cooled. There are billions and billions of droplets of water which create moisture. Air is never entirely dry because of the moisture that surrounds the Earth.

Water has three classes of characteristics namely physical, biological and chemical. The physical characteristics of water are temperature, taste, odor, and turbidity. Water is a colorless substance. The sea waters look blue because of the sun's light. The colored light rays are reflected by water molecules. This is also true for the ocean waters that look green.

The biological characteristics of water refer to different organisms found in it. These organisms are microscopic viruses, bacteria, protozoa, and phytoplankton, zooplankton which are the tiny water animals, insects, worms, large plants and fish. Humans are affected by the disease causing bacteria and viruses which could be present in water. These species that infect humans and animals are called pathogens. Pathogens can enter the water system through the sewage. Scientists conduct tests to determine contaminated water. They measure a certain bacteria called fecal coliforms. Coliforms are found in the intestines of mammals. The presence of coliforms in water indicates that sewage is present and there may be other disease causing organisms.

The Alberta Environment research states that water has many chemical characteristics. [7] Substances that dissolve in water also contribute to chemical water characteristics. The chemicals found in water include the gases oxygen and carbon dioxide, salts, substances that stimulate plant growth (nitrates and phosphorus) and other man-made substances. Due to the plumbing fixtures, iron and manganese are found in ground water. Dioxins and furans are only tested after an investigation has been made from the source of these chemicals. Water testing for these two chemicals is costly. Dissolved Oxygen is an important factor that determines the types of organisms that can survive. Trout will survive in the right amount of dissolve oxygen found in clean water, that is without the presence of toxic chemicals. Chemical testing is routinely done for dissolved oxygen, pH and phosphorous values.

The quality of water changes depending on the nature or human activities. On average, each person uses about 80-100 gallons per day in the United States. [8] Water consumption is high when we use it for flushing the toilets, washing and bathing ourselves, our clothes, dishes, cars, and our homes. It takes 4-6 gallons to flush the toilet, 6-12 gallons to wash dishes, 25-30 gallons to take a shower, 30-40 gallons to take a bath, 30-50 gallons per load to wash clothes, 60 gallons to wash the car, 150 gallons to produce one Sunday newspaper, and 100-200 gallons to water the lawn. [9] Two gallons per person per day are used for drinking and cooking. If we multiply the amount of water for the whole population, we will come up with billions of gallons water used daily. That figure does not even include the water usage in farm irrigation, and operation of factories. For instance, according to research, it takes 63 gallons of water to produce one egg. [10] Count the amount needed to grow food for the hen, and the water that the hen drinks. To produce one-quarter pound of hamburger, it would take 625 gallons of water. [11] A pound of beefsteak would take 1200 gallons of water. [12] It takes a gallon of water to equal a gallon of gasoline by volume. [13] To manufacture a ton of steel, it would take almost 62,600 gallons. [14] Put all these figures together and that would approximately give a total of almost 500 billion gallons every day.

We are so fortunate that in our country, water supply is abundant. There is so much water that flows out of the faucet and it seems like our water will never run out. Canada and Europe also have abundant water supplies. However, in other parts of the world, the people are experiencing water shortages, drought, and

people have to walk hours to get drinking water from wells which are contaminated with pathogens. In some places, bacteria and coliforms are present. Their water supply causes illnesses and diseases for humans and animals.

Water supply for our daily needs comes from rivers, lakes and reservoirs. Reservoirs are man-made lakes. Water is also found under the ground. Ground water is stored in layers of rocks, sand and soil. Humans and animals need fresh water which is free of salt, chemicals and pathogens. Water can only be purified and renewed through the water cycle. The water cycle goes from precipitation, evaporation, condensation and the cycle goes on and on. Precipitation is when rain falls into lakes and stream. Used water goes underground or into a sewage system. Then the water flows back to the lakes, streams and rivers and some of it evaporates into the air. Water evaporates from the oceans, from trees and plants, from animals and humans. This is when water becomes water vapor which is a gas.

During condensation the water vapor cools. One drop of water contains about 100,000 water droplets. Clouds are made up of water droplets. The wind blows the clouds to different places. When the water droplets become heavy, they fall as rain or snow. Although some water impurities are picked up during evaporation, water remains clean. Water is useful again for our homes, farms and industries.

Drinking water today is the same water that was here when the dinosaurs roamed the Earth. Water is still made of the same molecules. Water evaporates, condenses and precipitates in the form of rain or snow. That is the same water that was present millions of years ago. We depend on the water cycle because it renews and purifies our water supply. There are times when there is no rain, which decreases the water level in our rivers and lakes. When drought happens, people are asked to conserve water or take the risk of running out.

I have mentioned earlier that humans, plants and animals need water. However, there are other organisms that need water too. The way we live affects the quality of water as well as the health of the organisms. For example, toxic chemicals that are not Earth friendly reduce the amount of oxygen available for the organisms. Bacteria consume a lot of oxygen when organic waste is broken down. Oxidation occurs when some of the compounds in the waste change chemically because oxygen is present in the water. Therefore, the organisms that can live in lower quality of water survive and those organisms that cannot tolerate the reduced level of oxygen will die or move away.

Branley describes one of the issues of water emergencies that occur in northern New Jersey. [15] There are few lakes and reservoirs in that area. During the winter, water in the form of rain and snow is collected in the reservoirs. When droughts occur, the water in reservoirs is not enough for its people, plants, animals and industry. Water must be taken from other resources. In the year 1980 - 1981, there was a drought in New Jersey. Water pipes carried water from other lakes in the northern states to New Jersey reservoirs. The water was taken from other places where people were living in summer cottages, called recreational centers, and residents who needed water for their own use. This was not a good solution because water from the lakes was drained. Residents in the area did not have enough water for their own use.

When a problem like this occurs, the solution is to build more reservoirs and to build long pipelines to carry water from faraway lakes. New York City has built long pipes to provide water to everyone. In 2006, the city consumed about 1.086 billion gallons of water average per day. [16] Aqueducts carry the water to as far as 100 miles from different lakes and reservoirs in upper New York State. This is also true for California. The Colorado River and reservoirs located in the mountain east of the state supply California with water. The residents of New Jersey, New York City, and California hope for heavy snows in the winter. When snow melts the water will

fill the reservoir.

According to statistics, the human population is increasing every year. So whenever population increases, the consumption of water also increases. Farmers have to grow more crops and use water to irrigate their farms. The acre foot is the common measure for large quantities of water and is approximately 325,851 gallons. [17] So a 60 acre farm requires thousands of gallons of water each planting season. [18] The demand of water has increased remarkably. People use water at a very high level. There are about two million dams built to store water. Millions and millions of well have been dug to bring ground water to the surface. [19] For instance in Houston, Texas, there is a place where the ground has sunk because the pumping of so much water affected the land. As a result, many houses sank in sink holes and the residents had to find new homes.

Water is very important to us and it should not be taken for granted. When water becomes scarce we realize that life cannot go on. Humans, plants and animals need good water. The effect of not having enough water will be disastrous. The entire place will just be a wasteland. I could not imagine what life will be like when I turn on my faucet and not a drop of water comes out. There is one place in the world where the cleanest water is found. Russia has many lakes. One of the famous lakes is Lake Baikal. It is the deepest lake found in the world and also known as the largest fresh water lake. It has the purest water and that is why one will find 1700 species of plants and animals. [20] Two thirds of these flora and fauna are not found anywhere else. Baikal is considered as the oldest lake in the world. The lake is isolated and surrounded with mountains. The water in the lake is well-mixed and well oxygenated. The lake supplies water to the local population.

The Principles of Green Chemistry

In my unit, students will learn the 12 principles of Green Chemistry. [21] Since I am teaching reading and science to my second language learners, I will only focus on Principles One, Two, Three, Four, and Six. These principles will help them understand the importance of water to all living organisms and how to keep drinking water clean and safe. Most of my students live in apartment dwellings. The cost of water bottles in plastic containers is too expensive for them. Using tap water will lessen the cost of buying drinking water and will minimize the use of plastic bottles which contains chemicals that are hazardous to their health.

First Principle

Green chemistry's first principle states that it is better to prevent waste than to treat or clean up waste after it is formed. To integrate reading with science content, the students will read "The Lorax" written by Dr. Seuss. The Lorax warned the Once-ler to stop cutting down the truffula trees but the Once-ler refused to listen. As a result of his greed, the beautiful place where the trufulla trees grew, where the swomee-swans lived, where the barbaloots played and ate trufulla seeds, and where the humming fish swam became so polluted that everyone left.

Water pollution is caused when humans add chemicals into water that cannot be filtered out. There are many chemicals on the market and the government has identified the toxic chemicals. They are harmful to humans, plants and animals. There are two popular manmade products, namely the detergent and softener, which many people use to keep their clothes clean. These products contain phosphates, neurotoxins and carcinogens that contribute to groundwater pollution. Detergents contain phosphates. Phosphates cause the

water foaming action every time we do our laundry. Washing and rinsing clothes using detergents allow chemicals to go into the water supply.

Even the fabric softener that makes our clothes smell like pine, jasmine, and lavender contains chemicals that have high toxicity. Every time we rinse our clothes, water goes through the pipes and the sewage. Fabric softeners change the detergent's negative electrical charge back into a positive charge thereby reducing static. The film coats, fluffs and scents the fiber. Liquid softener contains neurotoxins and carcinogens. These toxic chemicals are dangerous to human health because they affect our nervous systems. Neurotoxins and carcinogens are slowly released when we wear our clothes and use our towels and our sheets. Every time we tumble dry our laundry, we release the toxins into our environment through the dryer vents. When we use fabric softeners, the clothes increase their flammability because the materials become thinner. The softener slowly takes away the fabrics' layers. The unit will teach the students that although some chemicals smell good, they are hazardous to human health and to our water. Our clothes will still smell clean if we use an alternative to fabric softener, such as dryer balls.

The use of chemicals in the industry is high. The American Chemistry Council tabulates yearly the United States top 100 basic chemicals. In 2000, the amount of the top 100 chemicals produced was a total of 502 million tons as compared to the 1990 figure of 397 million tons. [22] These chemicals are necessary to make all kinds of medicines, plastics for making good soap/detergent, clothing, and other consumer products that will improve the quality of life. However, there is no place to dispose of waste products. For many years, people have been disposing waste products away into rivers and lakes. As a result, many water sources have become polluted. There are thousands of man-made lagoons where waste is disposed of. During the water cycle, the water evaporates from these lagoons, and the chemicals become more and more concentrated. Since the bottoms of the lagoons are sand and dirt, these chemicals are absorbed slowly into the ground water.

The EPA informs us of drinking water contaminants. [23] Cryptosporidium comes from human and animal fecal waste. When a person ingests water that contains this contaminant, he/she gets gastrointestinal diseases. Coliforms are naturally present in the environment as well as in feces. Viruses are found in human and animal fecal waste. One can get gastrointestinal diseases from them. When the water gets cloudy, turbidity is tested. It indicates water filtration effectiveness. Parasites, bacteria and some microorganisms cause nausea, cramps and headaches. There are other contaminants such as disinfectants, inorganic chemicals, organic chemicals and radionuclides. All of these contaminants affect the health of humans who ingest water.

Chemicals that get into the ground water cannot be removed easily. If groundwater moves, the water is purified naturally by the soil; if it does not, the toxic chemicals stay. The impurities remain underground. Sometimes impure water can be purified by pumping it to the surface, treating it and putting the water back in the ground. This water purification process is very expensive. The best thing to do is not to pollute groundwater.

What are the different sources of water?

The source of water is not known to everyone. Water that flows from the faucet, have two sources. Surface water comes from the water in rivers and lakes. Groundwater comes from wells. Most water in the United States comes from ground water. The agency that provides us information online is the Environmental Protection Agency. A large percentage of the US population get their water from the groundwater community supply and the rest of the population gets water from private wells, camp grounds and resorts. s. About a large number or percentage of the water sources come from the surface and the other percentage is from

wells. The taste of ground water is different from surface water. There is a taste of metal in ground water and it contains minerals. In some places, the surface water has a musty taste and looks cloudy. The look and taste of water depends on where it is coming from.

The next green chemistry principle will be a combination of principles two and three: synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product; and wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment. The children's literature applicable to this science

content lesson is S is for Save the Planet. The book contains 26 poems and practical ways to keep the Earth green. The solution given for the environmental issues is suitable for children of all ages.

I can incorporate in this lesson the different ways of purifying drinking water from the tap. One way of doing it is by simply boiling it. Drinking water in the US is the safest water supply in the world. Water is frequently tested for human consumption. In most places tap water is safe to drink. The water source is well tested. The public is informed of their water supply and when there are contaminants in the water suggestions are given on how to purify it or not to drink the water at all. When water flows through the rivers and gets collected in aquifers, the contaminants are low and not hazardous to human health. The US Environmental Protection Agency (EPA) explains that the public water suppliers and well owners must monitor their water supply. There are standards for keeping the water supply safe. EPA has named 90 contaminants to set their standards and these contaminants are monitored in drinking water. Therefore, drinking tap water is safe.

There are only a few instances when water is unsafe. This happens when there are treatment problems or weather conditions are bad. For example, during a hurricane the flood water is most likely to contaminated water that flows to the rivers and the wells. The contaminants are not a threat to the public health. Water will be treated to remove those contaminants. Bacteria and viruses may also contaminate the water. It might cause the following illness: vomiting and diarrhea for some people. If the water treatment does not meet standards, the water supplier must inform the public. The water suppliers are required by the law to notify the consumers. EPA water standards protect children and adults from drinking or using unsafe water.

The fourth principle of green chemistry is all about designing chemical products to preserve efficacy of function while reducing toxicity. The book that I will use to integrate reading and science is Song of the Water Boatman & Other Pond Poems. The students will read this book to find out what would happen to a drying pond and its inhabitants. To sustain Earth's water, we must avoid chemicals that affect humans, plants and animals. In this story, when the pond dries out the living organisms will perish or disappear.

Arsenic, fluoride, and water are toxic to human health. When we drink water with these contaminants we are taking water into our system with poisonous chemicals that will affect some parts of our body like the colon. Arsenic is a heavy metal. It is gray or yellowish. Arsenic is a deadly and poisonous element. When it enters our blood stream arsenic is difficult to detect. Arsenic is considered as a metal and a non-metal. When industrial sections dispose of arsenic improperly it goes into the water-ways. Arsenic is so toxic that it causes cancer. Poisoning takes place in the body and results in death. Multiple organs in the body fail. The affects are lethal. A large amount of arsenic is dangerous for humans as well as animals. The human body can ingest a small amount of arsenic because it is essential. Seafood such as shrimps and crabs are sources of arsenic.

Fluoride is classified as a non-metallic element. Its color is pale yellow or green. Fluoride is added to water for teeth protection. Some think that it prevents tooth decay. That's why fluoride is commercially found in baby

formula, bottled water, tooth paste, aluminum foil and many more. Another form of fluoride is Teflon. Teflon is known for its non-stick coating to pots and pans. Fluoride is an element that could take an electron from almost any atom and form other compounds. However, a pollutant is created when fluoride is in CFC (chlorofluorocarbons). CFCs are used in sprays which have done so much damage to the ozone layer. This chemical could be toxic to human, plants and animals health.

Chlorine is a green and nonmetallic element. It is a toxic gas. According to history, chlorine was used as a weapon in World War I. People that inhaled this toxic chemical died. These days, chlorine is often used in household cleaners. It is a popular chemical because it kills bacteria, especially those found in toilet bowls. It could also be used to fight cholera and typhoid fever when added to purify drinking water. Chlorine is used to treat our drinking water supply. In doing so, our water supple becomes potable and safe. Swimming pools use chlorine to keep their water bacteria free. However, it becomes toxic to humans, plants and animals when the element is added to the pesticide DDT and also when used in CFC products.

Water Purification

How is water purified?

Water purification is the process of removing chemicals or water contaminants. It is necessary to purify water because humans need to drink and use it. Pharmacology, chemicals and industry need purified water too. There are three ways of purifying water namely: physical, biological and chemical process. Filtration and sedimentation methods are used for the physical purification of water. During filtration, the solids are separated from the liquid by using a medium that can let the fluid through; however, the solids are retained. The separation depends on the pore size of the medium as well as the mechanisms that occur during filtration.

Sedimentation is another way to purify water. It is used in a waste-water treatment plant. Sedimentation reduces the content of suspended solids and the contaminants in the water. During the biological process, water is filtered through slow sand filters or active sludge. In the chemical process, the purification occurs by flocculation, chlorination and by the use of electromagnetic radiation. Water purification reduces suspended particles, parasites, bacteria, algae, virus and fungi. In this unit, I will briefly discuss the simple ways of water purification that are boiling water and using activated carbon.

To keep drinking water safe, there are a few tips to keep in mind. When outdoors, avoid filtering water in places where human and animal activity is always present. For example, when you are in an open field or farm, do not filter water where it is close to the cows' or chickens' shed. Indoors, boil drinking water for at least one minute. According to an environmentalist, when water boils it kills bacteria, viruses and parasites. To remove water's after taste, leave the boiled water container and pour the water several times back and forth to another clean container. Another way to purify water is by adding iodine. This could only be done three times a week in order to avoid health issues. Iodine should not be taken by pregnant women. A person should wait 40 minutes before drinking water with iodine in it.

There are also water filters that are manufactured and sold in different stores. When using commercial water filters make sure that the filter is the best option for you. There are four different kinds of water filters namely: distiller, reverse osmosis, activated carbon water filters and backwash. Distillation is boiling water until it

evaporates. As water vaporizes the contaminants are left behind. The water condenses into pure water. Dissolved oxygen is lost during this process. This process is not effective for chemicals like ammonia, trihaclomethanes, chloroform, trichloroethylene and phenol. The reverse osmosis process involves letting water pass through the membrane towards the more concentrated solution. Dissolved oxygen is not lost during this process and that is why the water has no after taste. Carbon filters are used to treat the taste and removes odors. Carbon absorbs the water contaminants.

Water Conservation

When we conserve water, we sustain and help reduce the demand for water supply. We protect our rivers and lakes. We use fewer chemicals to treat our aquifers and use less energy to heat water. We save electricity because we pump less. That would mean savings for our water bills too. We can save water inside and outside of our homes.

At Home

At home use green cleaning chemicals when doing house chores. Put a bottle of pebbles inside the toilet tank to displace the water and use less water when we flush. Turn off the water when brushing your teeth. That saves water about one or more gallons of water per day depending on the number of people in a household. Take quick showers and save 150 gallons per month. Save the cold water in a container while waiting for hot water to reach the shower head. Wash dishes by hand. Avoid leaving the water on when rinsing. Use one sink to soap and the other sink to rinse and save 200 to 500 gallons per month. Use the least amount of detergent because it minimizes the rinse water needed. It saves 50-150 gallons a month. Keep a bottle of drinking water in the refrigerator. When you get drinking water from the tap and store it in a glass pitcher or a jar, one could save hundreds of gallons per month. Rinse fruits or vegetables by using a filled sink or a pan of water.

Outside the Home

Whenever the children want to cool off, use the water sprinkler in an area where the lawn needs it most. Share water saving tips with friends. Do not play with the garden hoses and save 10 gallons of water per minute. Turn faucets off when not in use. Throw left over ice on plants. Collect rain water for the garden with overflow ports and secure the lid for child safety. Children can easily do the water tips to conserve water. There are many other ways to save water. Be smart and use water wisely. Every drop of water that we can save is worth it.

Classroom Activities

I will use the same strategies that are mentioned earlier for teaching reading/science. Before reading aloud the story to the students, I will give a set of vocabulary cards and

using pictures. As the saying goes, a picture is worth a thousand words. I will make a word list on chart paper;

match each word with its meaning. For second language learners, it is important that the words match the pictures. I will also give each student a letter of the alphabet and, as I read the story, I will ask the students to stand up and give a copy of the poem and science information that goes with the letter. To check for student understanding, I will prepare comprehension purpose questions for the students to answer as I read along and write them on small sticky notes.

Activity One: Introduction to the Unit

The purpose of the activity is to engage the student with the given topic, "Water". So introduce the unit in a power point presentation with Question and Answer. Ask: "Did you know..." For example: Did you know that it takes 15-30 gallons of water to take a shower? (15 gallons of milk). Did you know that it takes 180 gallons to water the lawn? (180 gallons of milk). Give about 10 questions. Allow time for the students to process information. Use their prior knowledge and, from the students' responses, explain the important facts.

For the hands on activity, let the students work on density of water. Use different cans of soda and explore which cans sink or float (diet soda will float and non-diet soda will sink. Discuss students' responses and allow time to process their observations. Make a work in progress vocabulary word list. Start with the words water and density. Get students to give their own meaning of density and then explain the concept. Density is the measure of how solid something is. Provide the handout, organize the class in groups of four, read aloud the handout (materials and procedure, discuss, and do a follow-up activity. Create a teacher made assessment at the end the lesson and student/teacher made rubric

Activity Two: The History of Water

This book describes the story of water, its origin, and importance. The story begins with a picture of a boy looking at a glass of water and asking the question where water comes from. As the reader turns the pages of the book, it answers the question with vivid, colorful illustrations and facts about water. It explains the existence of water billions of years ago. The Earth's first plants and animals lived because of water; even the extinct dinosaurs needed water. Presently, a drop in a boy's drink continues to provide water for life from the smallest flowers to the tallest trees in the rain forests. Plants and animals need water to make their food. This book will catch the interest of children.

One of the activities that student will work on will be a story foldable. Use a piece of construction paper, fold it lengthwise and cut it into three equal parts. The student will draw pictures of what happened first, what happened next and what happened last. The students will write in their science journals three reasons why water is important to all living organisms. Create a teacher made assessment at the end the lesson and student/teacher made rubric

Activity Three: S is for Save the Earth

For the book, "S is for Save the Earth". I will use the alphabet activity. Each student will get one letter of the alphabet and as I read aloud they will read the text and the information given. For vocabulary development, I will use the Frayer Model graphic organizer. Students will write the word or key concept, write the meaning using their own words, and write its characteristics; teachers will give an example and a non-example. Each letter of the alphabet is in poetry form. At the end of the lesson, the students who are working in groups of four will create their group's alphabet book. The science facts are given for each letter of the alphabet. Allow the students to explain them with the teachers' guidance. Teachers choose an alphabet and create a larger version, of the poem on chart paper. For handout, make smaller copies of the poem for the students (whole class). Read aloud the poem to the students. For the second reading, students work in pairs and read the poem together. Engage students in a discussion. Teach a mini lesson on how to write a haiku, model it and write teacher's haiku on chart paper. Tell the students to create their own haiku. The next meeting will be a science mini lesson on green chemistry's first principle. Create a teacher made assessment at the end the lesson and student/teacher made rubric.

Activity Four: The Lorax

The Lorax warned the Once-ler to stop cutting down the truffula trees but the Once-ler refused to listen. As a result of his greed, the beautiful place where the trufulla trees grew, where the swomee- swans lived, where the barbaloots played and ate trufulla seeds, and where the humming fish swam became so polluted that everyone left. Using "The Lorax", this activity will focus on the first principle of Green Chemistry, that it is better to prevent waste than to treat or clean up waste after it is formed. Dr. Seuss' powerful message is for readers to be aware of their environmental issues and to create Earth friendly action globally. The Once-ler is one of the characters in the story. He tells the boy about the Lorax who was lifted away using his whisper-ma-phone for the secrets.

Read aloud the story to the students. Ask them CPQ questions and discuss their responses. Readers will understand that the environmental issues in the story are comparable to the environmental concerns of today. Explain that when we misuse our natural resources, that would cause land and water pollution. Compare and contrast why some plants and animals are in the verge of extinction, for the reason that humans are not good keepers of our environment. The Lorax warned the Once-ler to stop cutting down the truffula trees but the Once-ler refused to listen. Explain that as a result of his greed, the beautiful place where the trufulla trees grew, where the swomee-swans lived, where the barbaloots played and ate trufulla seeds, and where the humming fish swam disappeared. Create a teacher made assessment at the end the lesson and student/teacher made rubric.

Activity Five: Water Celebration

This is an optional activity. At the end of the water unit, celebrate the importance of water in children's lives. Let the students plan their Water Celebration with guided instruction. In doing so, students take ownership of their activity and become more involve with it. Invite parents, administrators and other students to culminate the reading/science content area. Make students look into their reading portfolios or science journals to and choose their favorite activity. Listening, speaking, reading and writing skills are meaningful to them when they showcase their own work. Learning science makes meaning as well. Students create or write letters to their parents telling them about their thinking and learning as they were doing the different water activities. Ask for volunteers for the class presentation. Students can read, chant, rap or sing or talk about their favorite green chemistry principle and how they could use the principle at home to help them keep water "green". Make this a part of the writing process which is making invitations for a small gathering that parents come to school and watch each child present. Do revisions for their selected writing pieces such as the haiku or summaries written by the students. Put students' samples on a table for parents viewing and ask a pair of students to act as "science ambassadors" and explain the how each product relate to their learning. As part of the presentation, each student/pair of students will do a one minute class presentation of their favorite piece of work and give an explanation. Invite a speaker from the community who is an expert on drinking water or a parent whose work is related to chemistry or an another expert from the environmental agency. Have the students create play that is a copy changed version of Dr. Seuss, The Lorax. Allow responsible students to choose a producer, director, characters, costume designers, etcetera. All activities are monitored by the teacher(s). Finally, serve snacks prepared by the students like water, lemonade and brownies or cookies. Have fun!

Bibliography

Anastas, Paul T., and John C. Warner. Green Chemistry: Theory and Practice. New York: Oxford University Press, USA, 2000. This book describes explicitly the principles of green chemistry.

Arato, Rona. The World of Water. New York: Crabtree Publishing Company, 2008.

This book describes water as an essential to life.

Berger, Melvin. The New Water Book.. New York: Ty Crowell Co, 1973.

This book describes how amazing water is.

Branley, Franklyn Mansfield. Water for the World. New York: T.Y. Crowell Junior

Books, 1982. This book explains the world's water sources.

Breslow, Ronald. Chemistry Today and Tomorrow: The Central, Useful, and Creative

Science. Washington, DC: American Chemical Society, 1997. This book explains

chemicals in the past and the present.

Brudvig, Gary. PhotosynthesisPower Point. New Haven: Yale University, 2009.

Photosynthesis is the process of plants making their own food.

Burns, Loree Griffin. Tracking Trash: Flotsam, Jetsam, and the Science of Ocean Motion (Scientists in the Field). Boston: Houghton Mifflin, 2007. This book describes the science of ocean currents and how to keep our oceans clean.

Cann, Michael C. Real-world cases in green chemistry. Washington, DC: American Chemical Society, 2000. The book describes realistic studies in green chemistry.

Carona, Philip. Water: A Follett Beginning Science Book. Chicago: Follett, 1966. The book provides easy information about water and water experiments.

Carson, Rachel. Silent Spring. New York: Houghton, 1962. The book describes how Carlson pushed the agency to stop the use of DDT.

Cayne, Bernard S., and Jenny E. Tesar. Food and Water: Threats, Shortages and Solutions (Our Fragile Planet). New York: Facts on File, 1992.This book describe food and water shortages.

Dipper, Frances. Changing World Oceans & Rivers. San Diego: Advanced Global Advanced Mktg, 1996. The book describes the water cycle.

Ditchfield, Christian. Water. Missouri: Scholastic, 2002. The book explains the importance of water.

Editors. Just Add Water Science Experiments you can squirt. New York: Scholastic, 2008. This book is a fun science activity book.

Geisel, Theodor Seuss, and Dr. Seuss. The Lorax (Classic Seuss). New York: Random House Books for Young Readers, 1971. This a a Dr. Seuss classic story about the environment.

Gunter, Veronika Alice, and Joe Rhatigan. Cool Chemistry Concoctions. New York: Sterling, 2007. This book is a good source of cool science experiments (fun!).

Herzog, Brad. S Is for Save the Planet: A How-to-be Green Alphabet (Alphabet-Science & Nature). Missouri: Sleeping Bear Press, 2009. A beautiful picture book that kids will

love. It describes ways of how to keep the Earth green.

Hooper, Meredith. The Drop in My Drink: The Story of Water on Our Planet. London:

Frances Lincoln Children's Books, 2008. The book explains the story of water.

Peterson, Ottis. Junior science book of water (Junior science books). Champaign: Garrard

Pub. Co, 1966. This book explains what water is and its formation.

Prange, Joyce (Author); and Beckie(Illustrator) Sidman. Song of the Water Boatman and

Other Pond Poems [SONG OF THE WATER BOATMAN & OT]. New York, New

York: Houghton Mifflin Harcourt (Hmh), 2005. This is a book of poems.

Schirmer, B.R. Language and Literacy Development in Children Who are Deaf. Macmillan Publishing Company. New York, NY, 1994. This book describes semantic mapping.

Sidman, Joyce. Song of the Water Boatman.2005. Houghton Mifflin Company. New York, NY. This is a collection of poems with informational facts of some living organisms in the pond.

Wyland, Creech. Hold Your Water!. Missouri: Wyland Foundation, 2006. This book

describes how to conserve

Others

Brudvig, Gary. Green Chemistry. Yale University. 2009. Seminar Notes and Handout.

http://www.abheritage.ca/abnature/environmental/water_physical_characteristics.htm. This website provides information on the physical characteristics of water. 7/10/09

http://english.unitecnology.ac.nz/resources/resources/learntolearn/author.html. This website provides Francesca Pouwer's autobiography. 7/14/09.

http://en.wikipedia.org/wiki/Green_Chemistry. The website defines green chemistry. 7/10/09

http://www.seussville.com/games_hb/lorax_trees.html. The website provides Lorax games for children. 5/2/09

http://www.cqs.com/edioxin.htm. This website provides good information on dioxin and ways to avoid it. 7/10/09

http://www.watershed.net/pdf/Purified_Water_and_its_Dangers.pdf. The websites explains the dangers of purified water. 7/14/09

http://ga.water.usgs.gov/edu/qahome.html#HDR3. The website provides information on water usage. 7/10/09

http://www.articlebiz.com/article/130952-1-the-question-is-where-does-water-come-from-/. This website describes the different sources of water. 7/12/09

http://www.epa.gov/safewater/kids/activity_grades_4-8_wherewatercomes.html. This website describes the different activities and games for water. 7/13/09

http://www.epa.gov/safewater/kids/kidshealth/booklet_text.html#whatyou. This website informs the public about the safety of drinking water. 7/13/09

http://www.abheritage.ca/abnature/environmental/water_chemical_characteristics.htm. This websites gives the information of water's chemical characteristics. 7/12/09

http://www.sfenvironmentkids.org/teacher/lesson_plans/wet_appetite6-12.pdf. This website provides information the amount of water for producing eggs, hamburgers etc. 7/13/09

http://www.epa.gov/safewater/kids/kids_4-8.html. Website with drinking water and groundwater games for children. 7/13/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html. The website provides information on how Class V works. 7/13/09

http://www.epa.gov/safewater/kids/pdfs/activity_grades_4-8_plantsinwaterfiltration.pdf. The website provides hands on activities for water. 7/13/09

http://www.epa.gov/safewater/kids/watertreatmentplant/index.html. The website provides visual water source. 7/13/09

http://www.epa.gov/safewater/kids/activity_grades_4-8_wherewatercomes.html. The website provides the source of water. 7/13/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html#one. The website provides information about a Class V well. 7/14/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html#two. The website provides information on the different uses of a Class V well. 7/14/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html#three. The website provides information of the requirements of a Class V well to prevent water contamination. 7/14/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html#four. The website provides information about what we can do to prevent contamination. 7/14/09

http://www.epa.gov/safewater/uic/class5/basicinformation.html#five. The website provides information on water safety. 7/12/09

http://www.epa.gov/greenchemistry/. This website provides green chemistry information.

http://soc.hfac.uh.edu/artman/publish/article_295.shtml. 7/12/09

http://documents.publicworks.houstontx.gov/documents/divisions/utilities/water_quality_report_2006.pdf. This website describes the quality of water in Houston, Texas.

http://www.cleanhouston.org/living/better_world/houston3.htm This website explains the future of Houston water and how she manages the challenges of an environmental crisis. 7/5/09

http://www.khou.com/news/local/stories/khou090309_mp_debris_dumping.1bc1f02d.html This is the website that describes the man

who was caught dumping water in the San Jacinto River. 7/5/09

http://www.allianceforwaterefficiency.org/AWE_Charter_Sponsor_Profile_Houston_Drinking_Water_Operations.aspxac This is the website that informs the readers how to promote and sustain water in Houston. 7/5/09

http://www.allianceforwaterefficiency.org/AWE_Charter_Sponsor_Profile_-_Houston_Drinking_Water_Operations.aspx This website informs drinking water and health basics and much relevant information. 7/5/09

http://www.epa.gov/safewater/dwh/dw-health.pdf This website informs the readers about the things we need to know when we drink water. 7/8/09

http://www.epa.gov/safewater/dwinfo/tx.htm This website tells us about safe drinking water for Texas. 7/5/09

http://www.epa.gov/safewater/arsenic/index.html This website tells us the arsenic in the water system. 7/8/09

http://www.epa.gov/saf7/10ewater/arsenic/basicinformation.7/14/09

http://www.epa.gov/safewater/arsenic/basicinformation.html#one This website describes arsenic contaminants in water. 7/14/09

http://www.epa.gov/safewater/arsenic/basicinformation.html#two This website informs how arsenic gets into our drinking water. 7/14/09

http://www.epa.gov/safewater/arsenic/basicinformation.html#three This website informs the readers the short and long time effects of arsenic. 7/14/09

http://www.epa.gov/safewater/disinfection/gwr/index.html. This website provides information about the Ground Water Rule.7/14/09

http://www.epa.gov/safewater/lcrmr/index.html This website provides information about lead in drinking water.7/14/09

http://ga.water.usgs.gov/edu/qahome.html#HDR3. This website provides clear information about water quality. 7/13/09

http://www.sciencea-z.com/scienceweb/research.do#Integration. This website provides the effectiveness of science and reading integration.7/13/09

http://www.epa.gov/safewater/disinfection/index.html. This website provides information about microbial and disinfection by-products (MDBP).7/13

http://www.survivaltopics.com/survival/how-long-can-you09-survive-without-water/. This website provides information about water survival. 7/14/09

http://www.paec.org/david/reading/general.pdf. This website provides reading strategies.http://www.research-pro.com/2009/03/our-body-comprises-about-75-water-brain.html. This website provides information on the amount of water in the human body. 7/13/09

http://wateruseitwisely.com/100-ways-to-conserve/index.php. The website provides 101 ways to conserve water.7/15/09

http://www.hh-pub.com/book.php3?book=HH1925. This website provides information on integrating children's literature with math, science and social studies. 7/14/09

http://www.sciencea-z.com/scienceweb/research.do#Integration. This website provides information on science and reading

integration. 7/14/09

http://tips.simplygoodstuff.com/fabric-softeners-cuddly-at-any-cost/. This website provides information on water softeners. 7/14/09

http://en.wikipedia.org/wiki/Water_purification. The website provides information on water purification.7/8/09

http://english.unitecnology.ac.nz/resources/resources/learntolearn/module2.html.7/8/09

http://www.niho.com/tipsntales/disinfectingwater.asp. This website informs ways of disinfecting water.7/11/09

http://www.epa.gov/safewater/contaminants/index.html#mcls. This website informs the list of water contaminants.7/11/09

http://www.monolake.org/about/waterconservation#whyconserve. The website includes the figures use for water conservation.7/11/09

http://www.ionizers.org/filter_types.html. The website describes the different types of water filters. 7/11/09

http://internationalstudies.uchicago.edu/outreach/resources/climatechange/3-VocabularyLessons/ClimateChange-3-FrayerModelTemplateforusewithActivity.pdf: This website has an example of the Frayer Model template.7/13/09

Texas Assessment of Knowledge and Skills (TAKS)

State Standards

TAKS Objective 1: The students will demonstrate an understanding of the nature of science.

TAKS Objective 2: The students will demonstrate an understanding of life sciences.

TAKS Objective 3: The students will demonstrate an understanding of the physical sciences.

TAKS Objectice 4: The students will demonstrate an understanding of the Earth sciences.

2003. Texas Education Agency

Endnotes

- [1] Carona, Philip. Water p. 6
- [2] http://www.chemcraft.net/wbody.html; http://ga.water.usgs.gov/edu/propertyyou.html. (Accessed 7/09)
- [3] S is for Save the Planet: A How to-Be- Green Alphabet.
- [4] The University of Texas Health Science Center/Houston/Texas Education Agency/The University of Texas System, 2009. The Texas Reading First Institute in Texas presents effective reading strategies.
- [5] Armbruster, BB.1992Science and Reading. The Reading Teacher 46(4):346-47
- http://en.wikipedia.org/wiki/Lake_Baikal. This website provides reading strategies.

- [6] Carona, Philip. 1966. Water pages 6-7
- [7] http://www.environment.alberta.ca/. This website provides scientific information about the quality of soil in Alberta. Aug. 14, 2009.
- [8] http://ga.water.usgs.gov/edu/qahome.html. (Accessed July 2009)
- [9] http://www.fairwindscommunityassociation.org/Water%20Conservation.htm. The website provides the information on water usage. (Accessed July 2009)
- [10] http://www.sfenvironmentkids.org/teacher/lesson_plans/wet_appetite6-12. The website provides information the number of gallons it takes to produce one egg. (Accessed July 2009)
- [11] http://www.sfenvironmentkids.org/teacher/lesson_plans/wet_appetite6-12. The website provides information the number of gallons it takes to produce one egg.(Accessed 2009)
- [12] http://www.sfenvironmentkids.org/teacher/lesson_plans/wet_appetite6-12. The website provides information the number of gallons it takes to produce one egg.(Accessed 2009)
- [13] http://wiki.answers.com/Q/How_much_water_does_it_take_to_make_1_gallon_of_
- gasoline. This website answers the question of how much water does it take to make 1 gallon of gasoline. (Accessed July 2009)
- [14] http://media.mgbg.com/wkrg/photos/weather/downloads/Water_Facts.pdf. This website is a good source of information for water trivia. (Accessed July 2009)
- [15] Branley, Franklyn, M. Water for the World on page 11. (Accessed July 2009)
- [16] http://en.wikipedia.org/wiki/Environmental_issues_in_New_York_City. The website provides the information about the daily water consumption in NYC. (Accessed July 2009)
- [17] http://www.shsu.edu/~geo_mrl/HydLab1.html. The website provides the information on number of gallons per acre. (Accessed July 2009)
- [18] Branley, Franklyn. M. Water for the World page 11.
- [19] Branley, Franklyn. 1982. Water for the World page 12.
- [20] http://en.wikipedia.org/wiki/Lake_Baikal. Lake Baikal's flora and fauna information are given. (Accessed July 2009)
- [21] Anastas, Paul. 1998. Green Chemistry: Theory and Practice.
- [22] http://en.wikipedia.org/wiki/Chemical_industry. The website provided the information on the top 100 chemicals in the US. (Accessed July 2009)
- [23] http://www.epa.gov/safewater/contaminants/index.html. This website provides information on water contaminants. (Aug. 14, 2009)