Water Pollution and Contamination

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Abstract

Water-related diseases are one of the leading causes of death worldwide. Over three million people die each year, nearly all in developing countries. In the United States there is regulation, such as the Clean Water Act, the Beaches Environmental Assessment and Coastal Heath Act and Comprehensive Environmental Responses, Compensation and Liability Act to protect the population, but point source and nonpoint source pollution are still growing issues. Categories of pollution include microbiological, Eutrophication, chemical, suspended solids, solid wastes, thermal, radionuclides and spills. Water must be carefully treated in order to make it safe to drink. It is the responsibility of all citizens to be aware of the importance of clean water and help preserve it.

When thinking of water pollution and water contamination, the two can easily be mistaken as the same thing. In a sense, they are, when speaking in general terms. Delving more deeply into the subject matter, one discovers that the two have completely different causes (http://www.freedrinkingwater.com/water_quality/quality2/j-15-08-water-pollution-contamination-same-thing.htm).

Where water pollution is caused primarily by humans, contamination can be caused by nature (http://www.freedrinkingwater.com/water_quality/quality2/j-15-08-water-pollution-contamination-same-thing.htm). "Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds" ("Categories of pollution: Point source," 2008). Globally, water pollution is one of the main killers of people. Water can be contaminated from the smallest activities. Throwing plastic into a body of water, throwing trash into a river, dumping oil into streams, improper disposal of wastes—all this leads to water contamination.

When water is contaminated, that water cannot be consumed by humans. In some areas, people suffer from diseases related to water contamination because the only water available to them is the water that has been polluted. Waterborne diseases are diseases contracted from consuming water contaminated with human or animal feces, which takes place often in areas where sewage systems and other filtering technology are limited. Waterborne diseases include diarrhea, cholera, malaria, and dengue ("Waterbourne Diseases," 2011). Even though people may have been treated for these waterborne diseases, they often get the same disease again because they are forced to drink from the same water. In many developing countries, the main cause of death is diarrhea contracted by drinking water. Human and animal

wastes are not the only water pollutants. Sometimes pollution can come from an oil spill or another single source. When this occurs, it is called point-source pollution ("Categories of pollution: Point source," 2008).

> The global picture of water and health has a strong local dimension with some 1.1 billion people still lacking access to improved drinking water sources and some 2.4 billion to adequate sanitation. Today we have strong evidence that water-, sanitation- and hygiene-related diseases account for some 2,213,000 deaths annually and an annual loss of 82,196,000 Disability Adjusted Life Years. ("Waterbourne Diseases," 2011)

In reference to the above quotation, there are several other detrimental factors that result from drinking contaminated water: sky-rocketing death rates, avoidable illness, and different cancers. Several countries, many in Africa and Asia, are decimated by the deadly water their citizens are forced to consume.

The Environmental Protection Agency (EPA) has many regulations and policies put in place to try to minimize the damage cause by water contamination in the United States. The Clean Water Act (CWA) is said to be the, "cornerstone of surface water quality protection in the United States" ("Water: Laws and Executive Orders," 2010). Though the Act does not deal with groundwater or the quantity of water, it does regulate the proper treatment of water. According to the Act, its main purpose is to restore and maintain the integrity of our bodies of water in the United States. The Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 is an amendment to the CWA. This amendment is located in 33 U.S.C. §1251. In essence, it authorizes the EPA to award grants to eligible states. These grants assist

the government in developing and implementing programs to inform the public about the risk of exposure to disease ("Water: Laws and Executive Orders," 2010).

One of the main federal laws related to water, the Safe Drinking Water Act (SDWA) is geared toward water consumed by Americans. Under the SWDA, there are standards set for the quality of drinking water. The Bioterrorism Action, which can be found in Title IV of the Public Health Security and Bioterrorism Preparedness and Response Act of 2002, addresses drinking water security and safety as well: "Title IV requires drinking water systems serving more than 3,300 persons to conduct assessments of their vulnerabilities to terrorist attacks or other intentional acts" ("Water: Laws and Executive Orders," 2010).

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), or "Superfund," was created in 1980 after the discovery of waste dumps in areas such as Love Canal and Times Beach in the 1970s. This Act enabled the EPA to fix problems related to sites such as these across the country. With this Act on hand, the door was opened for people responsible for hazardous acts to be held accountable by cleaning up the sites and reimbursing the government for EPA-led cleanups ("Superfund," 2011).

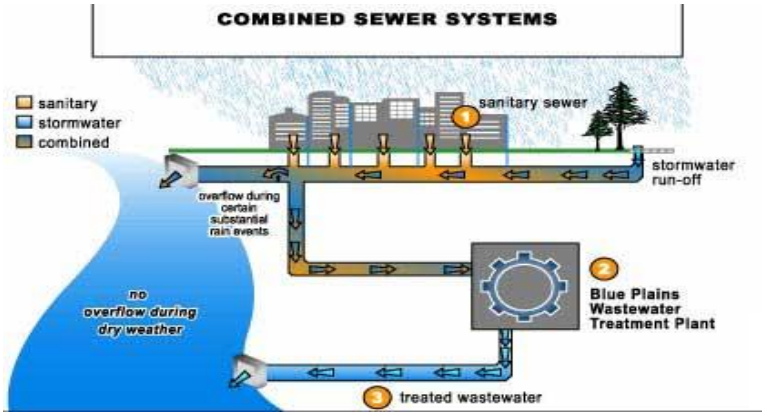
> Responsible parties can be any of the following: past and present site owners; generators of hazardous substances found at the site; or transporters of hazardous substance to the site. If these parties are able and willing to undertake the response task, the USEPA either negotiates a legal agreement with them or unilaterally orders them to do so. Should they be unable due to bankruptcy, or refuse to comply with the order altogether, the USEPA can undertake the response actions itself. ("CERCLA/Superfund," 1998)

CERCLA is, in fact, one of the biggest acts pertaining to this matter. When issues revolving around water contamination come about, CERCLA is usually cited.

There are two general categories of water pollution: point source and non-point source. Point source pollution refers to water contamination entering from a source that can be identified. Common point sources include pipes and sewage. Point source pollution or contamination can be broken down further into two common parts—factories and sewage treatment plants:

> Factories, including oil refineries, pulp and paper mills, and chemical, electronics and automobile manufacturers, typically discharge one or more pollutants in their discharged waters (called effluents). Some factories discharge their effluents directly into a water body. Others treat it themselves before it is released, and still others send their wastes to sewage treatment plants for treatment. Sewage treatment plants treat human wastes and send the treated effluent to a stream or river ("Categories of Pollution: Point Source," 2008).

As an alternative solution, some factories and plants mix the waste material with urban runoff in a combined sewer system. Storm water that flows over surfaces such as driveways and lawns is considered runoff. When the water surfaces, it combines with chemicals and pollutants and flows directly into a sewer system in its untreated, polluted state ("Categories of Pollution: Point Source," 2008). The image in Figure A on the next page shows the difference in a combined sewer system and a separated sewer system.



http://oceanservice.noaa.gov/education/kits/pollution/media/pol03b_240.jpg

http://oceanservice.noaa.gov/education/kits/pollution/media/pol03c_240.jpg

Figure A. Combined vs. separate sewer systems and storm drains

When discharges from point sources go unregulated, the result will be not only water pollution, but unsafe drinking water. The discharges can restrict activities like swimming, fishing, and other extracurricular activities that humans enjoy. While there can be serious problems with point source discharges that threaten people and wildlife, some of the discharge is completely harmless: "Whether the discharge is harmful or not to the aquatic environment depends on a number of factors, including concentration, the timing of its release, weather conditions, and the organisms living in the area" ("Categories of Pollution: Point Source," 2008).

The other category of pollution and contamination is non-point sources. Non-point source pollution or contamination does not have a single source. It is often the cumulative

effect of small pollutants gathered in a small area, usually runoff. It is very difficult to control because it comes from many different sources ("Categories of Pollution: Nonpoint Source," 2008). Figure B below shows several different sites all discharging to the same location.

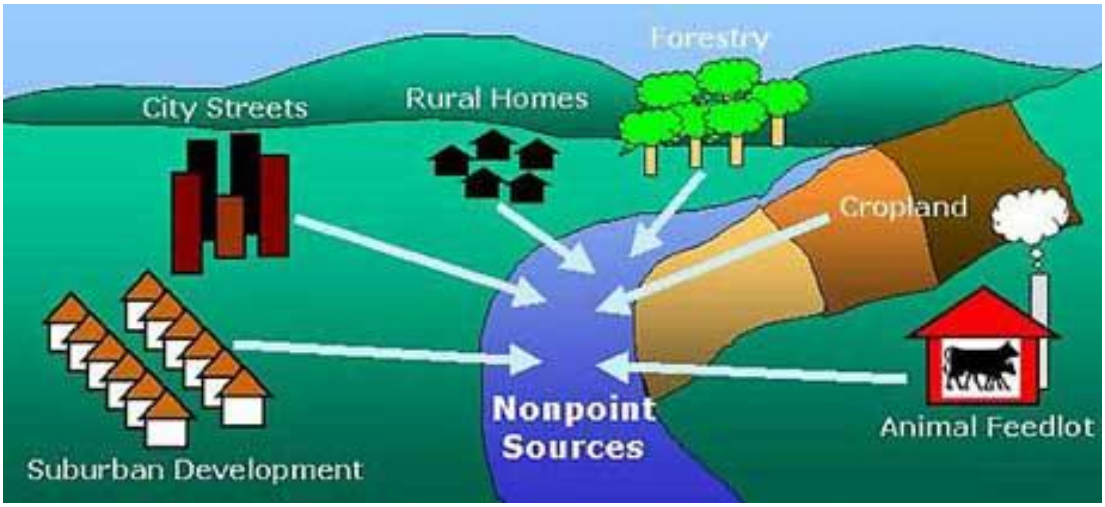


Figure B. Nonpoint sources combining pollution
http://oceanservice.noaa.gov/education/kits/pollution/media/pol04a_460.jpg

Since there are so many different locations and different types of pollutions and contaminations going into one location, this makes the toxicity level of the water even higher.

Non-point pollution is a huge threat to the ecosystem. Not only does it affect ecosystems, but it can have harmful effects on the economy: "U.S. Coastal and marine waters support 28.3 million jobs, generate $54 billion in goods and services through activities like shipping, boating, and tourism, and contribute $30 billion to the U.S. economy through recreational fishing alone" ("Categories of Pollution: Nonpoint Source," 2008). When areas that use fishing, for instance, as a major economic gaining factor are hit by a major non-point source discharge, the fishing is slowed down and sometimes halted, leading to losses in income for that area and other areas around it, thereby decreasing the economic status of the community. Coastal properties are growing at rapid rates. When considering whether to purchase property

in coastal communities, the environmental and aquatic conditions are taken into great consideration by most buyers. Non-point source pollution has an impact on life overall. If non-point pollution continues to grow and affect the areas being sold or leased, the communities will notice a decrease in sales and ultimately, a rapid deterioration ("Categories of Pollution: Nonpoint Source," 2008).

When comparing the two categories, point source and non-point source, it is important to note that the concentration of pollutants from point source locations may be lower than the concentration from non-point source locations. While this is the case, the total amount of a pollutant delivered from nonpoint sources may be higher because pollutants come from many different places. Since point source pollution stems from a location that can be identified, scientists have been able to somewhat control the damage done. The focus has now been put on non-point pollution and how it affects the quality of the environment. The main and most important study is how to control non-point source pollution ("Categories of Pollution: Nonpoint Source," 2008).

In an attempt to control point source discharges, the CWA established the National Pollutant Discharge Elimination System (NPDES). NPDES is said to be the "heart" of the CWA. Under this program, factories, sewage treatment plants, and other point sources must obtain a permit from the state and EPA before they can discharge waste of effluents into a body of water. Before the wastes can be emptied, the latest technology is made available for safety purposes ("Categories of Pollution: Point Source," 2008).

The specific categories of pollution and contamination are microbiological, eutrophication, chemical, suspended solids, solid wastes, thermal, radionuclides, and spills.

Microbiological wastes usually consist of the waste material found in medical wastes. Though there are specific instructions for disposing of this waste material, the pollution comes about when those instructions are not being followed ("Water: Laws and Executive Orders," 2010).

Eutrophication is defined as excessive richness of nutrients in a lake or other body of water. Eutrophication takes place when the runoff of sediment from land enters into a body of water. When this happens, a dense growth of plant life occurs, which depletes the big oxygen demand (BOD), meaning the oxygen available to aquatic life is gone.

> Eutrophication may also be brought about by the drainage of sewage, industrial wastes, or detergents into a body of water. As the overcrowded plants die off, the dead and decaying vegetation depletes the lake's oxygen supply. This, in turn, leads to the death of fish in the lake. The accumulated dead plant and animal material eventually changes a deep lake to a shallow one. The shallow lake then becomes a swamp, and finally it becomes dry land. ("The Environment - What is Eutrophication?," 2011)

Chemical contamination has been a huge problem with drinking water: "Naturally occurring chemicals such as arsenic and fluoride in groundwater has been identified as a problem in six (6) Member States, and various mitigation measures are in progress" ("Chemical Contamination," 2010). Arsenic contamination is usually found in shallow groundwater sites. Since arsenic is a toxic element, exposure to it can cause hyperpigmentation, depigmentation, keratosis, and other skin problems. It could possibly lead to skin cancer ("Chemical Contamination," 2010).

Another type of chemical contamination is nitrate contamination. Although natural nitrate levels are low in groundwater, the nitrate concentration grows because of human activities such as agriculture and other fertilizing tasks. The primary health concern with nitrate is methaemoglobinaemia, better known as "blue-baby syndrome." Methaemoglobinaemia happens when air is unable to be transported to the entire body ("Chemical Contamination," 2010).

The other chemical contaminants are iron contamination, manganese, and heavy metal contamination. They are not extremely harmful to humans, but they are a growing problem in the area of water contamination. If left untreated, iron can clog up waterways, putting a halt to water flow. Manganese is a mineral that occurs mostly in rocks. Sometimes manganese can be found in tap water as well. It is noticeable by the color of the water, the odor it emits, and the taste of it, which is bitter. Heavy metals are detectable, but it is a hard process. Since this is a fairly new problem, technology is being constructed to detect heavy metals in water more easily. The heavy metals usually come from untreated industrial water ("Chemical Contamination," 2010).

The next major category of water contamination is total suspended solids. Total suspended solids (TSS) are solids in water that can be trapped by a filter. TSS includes silt, decaying plant and animal matter, industrial wastes, and sewage. This affects the quality of streams and aquatic life (Zollweg, 2006). Solid wastes are the easiest to dispose of. States require that solid wastes be disposed of in a proper manner.

Besides solid wastes, another form of contamination is thermal contamination. Thermal pollution is large inputs of heated water from a single plant or a number of plants. Sharing the same lake or slow-moving stream can have harmful effects on aquatic life:

> Warmer temperatures lower dissolved oxygen content by decreasing the solubility of oxygen in water. Warmer water also causes aquatic organisms to increase their respiration rates and consume oxygen faster, and it increases their susceptibility to disease, parasites, and toxic chemicals. Discharge of heated water into shallow water near the shore of a lake also may disrupt spawning and kill young fish. (Neeves & Lourenço, 1996)

Most of the water in the United States is affected by thermal contamination. The water is cooled by electrical cooling power plants in many instances. With more and more cooling plants being built, this problem is not going unnoticed and is being fixed (Neeves& Lourenço, 1996).

A radionuclide is an unstable form of a nuclide. They may occur naturally, but can also be artificially produced. Most drinking water sources have very low levels of radionuclides, which are not considered to be a public health concern. Of the small percentage of drinking water systems with radioactive contaminant levels high enough to be of concern, most of the radioactivity is naturally occurring ("Basic Information about the Radionuclides Rule," 2011).

Spills take place more than any other kind of water contamination. Usually, the spills take place in large bodies of water. One of the most infamous recent spills, the British Petroleum Oil Spill, made a boom around the globe. There had never been anything like this kind of turmoil in the Gulf of Mexico. People lost jobs and millions of fish and birds died:

> The BP gulf spill started April 20, 2010 and was first contained July 15, 2010. Oil flowed into the Gulf of Mexico at an estimated rate of 30,000 - 60,000 barrels per day. Some oil was contained by siphoning directly from the cap, some was burned in open waters, some was "dispersed" using chemicals and some was skimmed. ("How Much Oil Has Leaked into the Gulf of Mexico?," 2010)

After a lot of hard work, the Gulf has been restored to habitable conditions. Though it is not the same as it was before, people can make a living, and the seafood is suitable to be consumed by humans.

The chart on the next page (see Figure C) sums up all the categories of contamination and pollution all over the globe. It also shows the level of severity in several different areas. Notice that not all areas are affected the same by the contamination and pollution. This could be because there are more advanced ways of handling the problems in areas where there are better resources and technology. For instance, the bright red block indicates that the impact of microbiological pollution is more severe in the Gulf of Mexico than it is in the Pacific Islands, where the orange block shows that the impact is moderate. Maybe there is better technology in the Pacific Islands for this specific type of problem. If the Gulf of Mexico were to have the same technology as the Pacific Islands, the result could be that the problem it faces with microbiological contamination would be decreased.

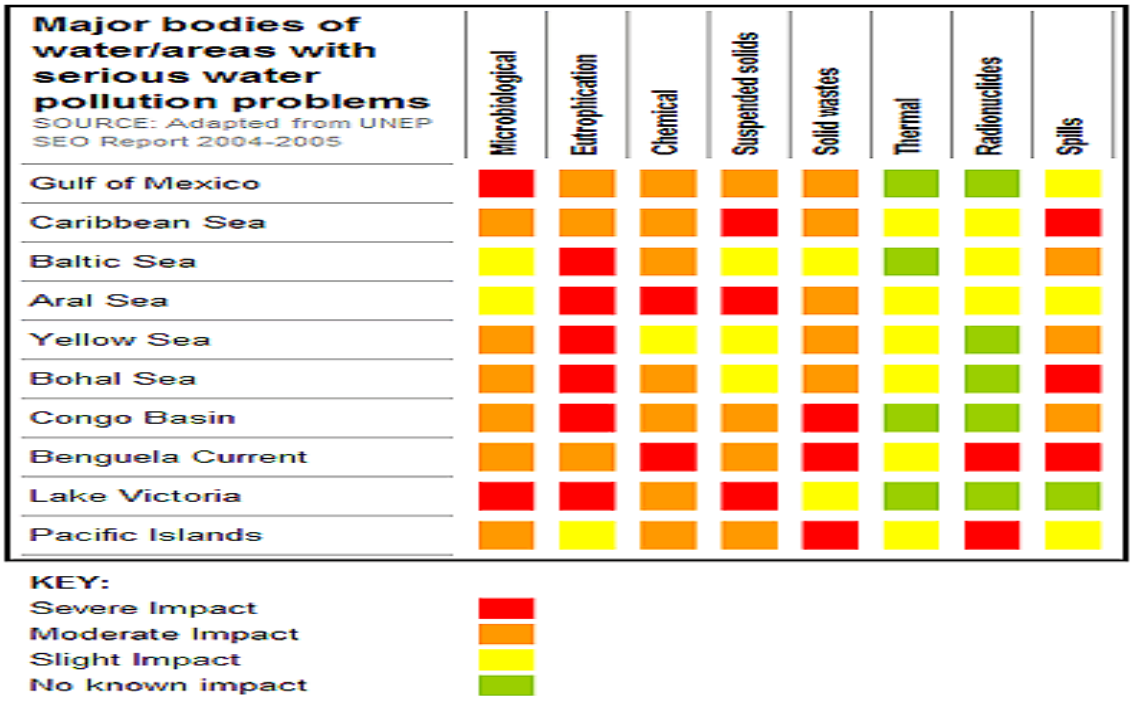


Figure C. Table of worldwide water pollution, © 2005 by Mark Jeantheau
http://www.grinningplanet.com/2005/07-26/water-pollution-table.gif

In the United States, there have been several law suits and tragedies revolving around water contamination. One the biggest suits came out of Woburn, Massachusetts:

> The plaintiffs were a group of eight families that lived in a part of town served by the two municipal wells. The defendants were W.R. Grace & Co., owner of the Cryovac Plant, UniFirst Corporation, owner of Interstate Uniform Services, and Beatrice Foods, Inc., owner of the John Riley Tannery. The plaintiffs alleged that ingestion of toxic chemicals used at these industries, which were measured in water samples from the municipal wells, were responsible for severe health effects. Children of seven of the plaintiffs contracted leukemia. Five of the children died from leukemia or complications of having leukemia. The spouse of one plaintiff contracted acute myelocytic leukemia and died ("Case Summary," 2008).

All of these injuries were a result of drinking water that had been contaminated. The residents were seeking damages for personal injury and wrongful death. They asked the court to require the companies to clean up the contaminated groundwater and to enjoin future unauthorized discharges of toxic substances ("805 F.2d 1," n.d.).

Another infamous case involving water contamination is the Love Canal case. Love Canal is located in Niagara Falls, New York. In the late 1940s through the 1950s, the site was used as a chemical waste disposal area. Research reveals that the site contained as much as 20,000 tons of toxic waste. The waste was sealed in metal drums, then placed in the canal. The drum disposal method has been is now illegal. After the canal had been contaminated, it was filled in and sold to buyers who used the land for an elementary school and housing. During the late 70s and 80s, some of the waste materials began seeping from their drums and reaching the surface. This leakage contributed to birth defects, miscarriages, cancer, and other illnesses. The site was eventually completely evacuated and deemed a national emergency. In 1990, after a $20,000,000 settlement, the area was decontaminated and was repopulated. The parties responsible for the damages were also ordered to pay the state of New York $98 million in 1994, and were ordered to pay the federal government $129 million for cleanup costs. ("Love Canal").

Like Love Canal, Times Beach was contaminated by irresponsible waste disposers. The start of the problem came about when Bliss, a local chemical company, contracted another company, ICP, to do waste disposal. According to Robert Emmet Hernan, in his book, *This Borrowed Earth*, (©2010, Chapter "Times Beach"), "ICP was being paid $3,000 per load to haul away toxic waste from Northeastern Pharmaceutical and Chemical Company (NEPACCO), and

ICP would turn around and pay Bliss $125 to take it off their hands. NEPACCO operated a facility producing hexachlorophene in Verona, Missouri" (qtd. in "Times Beach, Missouri," 2011). Some parts of the facility had been used for the production of Agent Orange during the Vietnam War, and the waste clay and water contained levels of dioxin some 2,000 times higher than the dioxin content in Agent Orange. Bliss mixed some of the waste with oil and sprayed it in the area to control dust. He claimed he was unaware that the waste contained toxins as he had even sprayed it around his own home ("Times Beach, Missouri," 2010). The contamination apparently killed 62 horses and seemed to be responsible for many other human illnesses and miscarriages. Finally, after the local river flooded and dangerous levels of dioxin were found, the Environmental Protection Agency bought out the town. On April 2, 1985, the Board of Aldermen voted unanimously voted to disincorporate the town ("AROUND THE NATION; Times Beach,"1985).

There are two types of water: surface water and groundwater. While the two are closely related, it is important to understand the difference between the two. Just as surface water can become groundwater, groundwater can become surface water. There can be a transfer of contamination between the two types of water. T he transfer usually takes place when some water from one location either overflows because of rain. Surface water usually consists of rain water that builds in bodies of water on the surface—for instance, lakes, oceans, and streams. Groundwater is another source of surface water. Groundwater becomes surface water when it discharges, thus reaching the surface, at that point becoming surface water. The actual pollution or contamination of surface water takes place when "hazardous substances are discharged directly from an outfall pipe or channel or when they receive contaminated storm

water runoff" ("Surface Water Contamination," 2011). Storm water becomes contaminated when rain water comes into contact with contaminated soil and either dissolves the contamination or carries contaminated soil particles. Surface water can also be contaminated when contaminated groundwater reaches the surface through a spring or other vessel, or when the contaminants in the air are deposited on the surface water. Contaminated soil particles carried by storm water runoff or contaminants from the air can sink into the bottom of a surface water, where it hardens when mixed with sediment ("Surface Water Contamination," 2011). The image below (see Figure D) is a river being polluted by a nearby copper plant.

Figure D. A stream contaminated by copper.
http://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/AngleseyCopperStream.jpg/

This is just one example of runoff pollution. Contamination of surface water has one of the biggest effects on the economy. It impacts the health of lower food chain organisms and the availability of food supply to travel up the food chain. Wetlands, the ability to control flooding, and filtration of pollutants are also threatened severely by surface water contamination ("Surface Water Contamination," 2011).

Most drinking water is surface water. Though the cleanest water is groundwater, surface water is easier to access. Once the water is retrieved, it is put through a filtration and purification process, making it suitable for humans and animals to consume. Those are the two key elements to making water safe. At the first stage, filtration, the untreated water is put through a screening process, which removes twigs and leaves. Once done with this stage, the water is moved through a pre-sedimentation basin, where the sand and silt settle into the bottom of the basin. At the next phase of the filtration process, the water gets sped up and coagulant is added though a "flash-mix" process. Coagulant contains ions. The water is then put into another basin. In this basin, it is stirred by large paddles. "As the particles join together, they become heavier and start to settle. The process, called flocculation, takes about 25 minutes" ("How Water Is Made Safe," 2008). When flocculation is done, the water enters the last sedimentation basin. All of the floc from earlier in the process settles to the bottom. This process takes about four hours:

> Water at the very top of the basin then moves to a large gravity filter. The filtration media can be a combination of hard coal (anthracite), gravel and sand or, sometimes, just coal or just sand.

> After the water is filtered, chlorine is added to kill any disease causing bacteria. Fluoride also is added to help prevent tooth decay. After water has completed the treatment process, it is referred to as finished or potable water. Most people simply call it drinking water.
>
> The total treatment process takes five to eight hours. ("How Water Is Made Safe," 2008)

Though this process is a very long and tedious one, it is essential that it is completed properly to ensure the public clean, clear, uncontaminated drinking water. The diagram on the next page (Figure E) shows the process. If any step in the process is skipped or overlooked, the water consumed could be deadly:

> Water-related diseases are one of the leading causes of death worldwide. Over 3 million people die each year, nearly all in developing countries. In some poor countries, diseases resulting from contaminated water comprise 80% of the total disease burden. It is estimated that up to half of all hospital beds in the world are occupied by patients suffering from water-borne diarrhea ("Water Treatment Process," 2010).

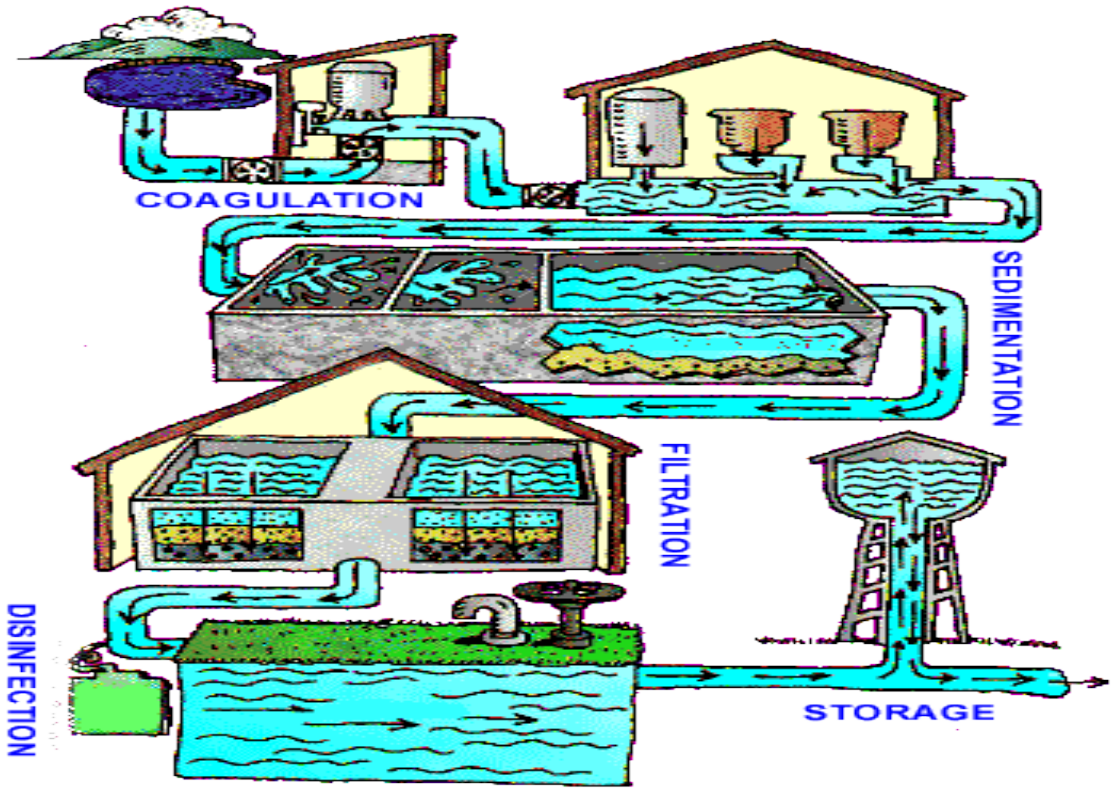


Figure E. A diagram of a typical filtration system.
http://www.epa.gov/ogwdw/kids/watertreatmentplant/images/image_watertreatmentcycle.gif

The biggest killer of people across the globe is waterborne diarrhea, which most people contract from drinking contaminated and polluted water. A staggering 1.8 million child deaths per year are related to diarrhea. In 3rd-world countries, such as some parts of Africa and Asia, half of all cases of malnutrition are caused by diarrhea. Diarrhea is preventable. The mortality from water-contracted diarrhea has been greatly reduced as technology has increased ("Water Treatment Process," 2010).

The process of restoring a site that has been contaminated with hazardous wastes can be very time consuming, tedious, and complex. According to the official EPA website, the process involves the sites being assessed and then being placed on the National Priorities List, which leads to establishment and implementation of cleanup plans suited for the site. The

process is a long-term cleanup process. In addition, according to the EPA website, the Agency has the authority to do the following:

- to conduct removal actions where immediate action needs to be taken;
- to enforce against potentially responsible parties;
- to ensure community involvement;
- involve states;
- and ensure long-term protectiveness. ("CERCLA/Superfund," 1998)

By using the National Oil and Hazardous Substance Pollution Contingency Plan (also known as NCP), a general guideline is laid out, making the process less strenuous. The EPA website notes that this regulation is applicable to all federal agencies that take part in hazardous substance release. One important fact to note is that unlike other environmental acts, CERCLA is geared more towards report and response issues other than regulatory matters ("CERCLA/Superfund," 1998).

Water contamination and pollution control improves more and more every day as technology improves. The efforts to stop water pollution and contamination are also becoming more voluminous. Although there is not much one person can do to stop the pollution, every individual can take the necessary steps to do his or her own part, thereby making the water better fit for consumption. Start by correctly disposing of all waste materials. No matter how big or small, make sure that any waste materials are properly disposed of to ensure that they do not make their way to bodies of water. In a home setting, try using nontoxic materials. This will help ensure that the toxicity levels of water lower. Recycle and dispose of all trash properly:

"Never flush non-degradable products -- such as disposable diapers or plastic tampon applicators -- down the toilet. They can damage the sewage treatment process and end up littering beaches and waters" ("How to Clean Up Our Water," 2001). Use natural fertilizers. When doing work in yard, try not to use too much water. This could cause leaking of toxins in fertilizers to seep into groundwater, thereby contaminating that water ("How to Clean Up Our Water," 2001). By every person taking part in these simple anti-contamination and pollution steps, the world will be on its way to safer, cleaner water.

Clean water is not only a luxury but a necessity; if people are to avoid dangerous diseases, it is vital that that we protect our water supply from chemical and solid waste. We need EPA regulations to deal with both point and non-point source pollutants and CERCLA to handle any contaminations that occur in situations such as Love Canal and Times Beach. Most of our drinking water comes from surface water that needs careful filtration and treatment to make it potable. We need to be aware of the importance of water purification and all do our part to preserve our natural resources, particularly our water, which so important and precious.

References

805 F.2d 1: Anne Anderson, et al., Plaintiffs, Appellees, v. Cryovac, Inc., et al., Defendants, Appellees.globe Newspaper Company, Intervenor, Appellant. (n.d.) *Justia U.S. Law.com*. Retrieved from http://law.justia.com/cases/federal/appellate-courts/F2/805/1/170771/

Amico, C. (2010, May 9). How much oil leaked into the Gulf of Mexico? *PBS NEWSHOUR.* Retrieved from http://www.pbs.org/newshour/rundown/2010/05/how-much-oil-has-spilled-in-the-gulf-of-mexico.html

Around the nation; Times Beach, Mo., votes itself out of existence. *(*1983, April 27). *The New YorkTimes.* Retrieved from http://www.nytimes.com/1983/04/27/us/around-the-nation-times-beach-mo-board-moves-to-seal-off-town.html

Basic information about the radionuclides rule. (2011, 29 March). *United States Environmental Protection Agency.* Retrieved from http://water.epa.gov/lawsregs/rulesregs/sdwa/radionuclides/basicinformation.cfm#one

Case summary - Anne Anderson et al. *v.* W.R. Grace & Co. et al. (2008, April 23). *The Science Education Resource Center at Carleton College*. Retrieved from http://serc.carleton.edu/woburn/Case_summary.html

Categories of pollution: Nonpoint source (2008, March 25). *National Oceanic and Atmospheric Administration*. Retrieved from http://oceanservice.noaa.gov/education/kits/pollution/04nonpointsource.html

Categories of pollution: Point source. (2008, March 25). *National Oceanic and Atmospheric Administration*. Retrieved from http://oceanservice.noaa.gov/education/kits/pollution/03pointsource.html

CERCLA/Superfund. (1998, August). *Formerly Utilized Sites Remedial Action Program (FUSRAP) at the Maywood Chemical Company Superfund Sit*e. Retrieved from http://www.fusrapmaywood.com/factsheet/cercla.htm

Chemical contamination. (2010. April 29). *World Health Organization Regional Office for Southeast Asia*. Retrieved from http://www.searo.who.int/LinkFiles/SDE_Chemical-contamination.pdf

The environment - What is eutrophication? (2011). *eNotes*. Retrieved from http://www.enotes.com/science-fact-finder/environment/what-eutrophication

How to clean up our water. (2001, November 4). *National Resources Defense Council.* Retrieved from http://www.nrdc.org/water/pollution/gsteps.asp

How water is made safe for drinking. (2008, November 5). *City of Phoenix Official Web Site.* Retrieved from http://phoenix.gov/WATER/drinkhow.html

Jeantheau, M. (2005). *Grinning Planet*. Retrieved from http://www.grinningplanet.com/2005/07-26/water-pollution-facts-article.htm

Love Canal. (2010). *Columbia University Press Encyclopedia*. Retrieved from http://education.yahoo.com/reference/encyclopedia/entry/Lovecana

Neeves, R., & Lourenço, S. (1996, December 5). Thermal pollution. *Rensselaer Polytechnic Institute.* Retrieved from http://www.rpi.edu/dept/chem-eng/Biotech-Environ/Environmental/THERMAL/tte1.htm

Superfund. (2011, February 28). *United States Environmental Protection Agency.* Retrieved from http://www.epa.gov/superfund/about.htm

Surface water contamination. (2011, August 9). *United States Environmental Protection Agency.* Retrieved from http://www.epa.gov/superfund/students/wastsite/srfcspil.htm

Times Beach, Missouri. (2010). *Wikipedia: The Free Encyclopedia*. Retrieved from http://en.wikipedia.org/wiki/Times_Beach,_Missouri

Water: Laws and executive orders. (2010, December 3). *United States Environmental Protection Agency.* Retrieved from http://water.epa.gov/lawsregs/lawsguidance/index.cfm

Water treatment process. (2010, April 21). *United States Environmental Protection Agency.* Retrieved from http://water.epa.gov/learn/kids/drinkingwater/watertreatmentplant_index.cfm

Waterbourne diseases. (2011). *Water Treatment Solutions Lenntech*. Retrieved from http://www.lenntech.com/library/diseases/diseases/waterborne-diseases.htm

Zollweg, C. G. (2006, March 5). Total suspended solids (TSS) are solids in water that can be trapped by a filter. *The College at Brockport State Universitiy of New York.* Retrieved from http://vortex.weather.brockport.edu/~jzollweg/oakorchard/docs/waterquality.pdf

Images References

http://oceanservice.noaa.gov/education/kits/pollution/media/pol04a_460.jpg

http://oceanservice.noaa.gov/education/kits/pollution/media/pol03b_240.jpg

http://oceanservice.noaa.gov/education/kits/pollution/media/pol03c_240.jpg

http://upload.wikimedia.org/wikipedia/commons/thumb/3/3a/AngleseyCopperStream.jpg/220px-AngleseyCopperStream.jpg

http://www.epa.gov/ogwdw/kids/watertreatmentplant/images/image_watertreatmentcycle.gif

http://www.grinningplanet.com/2005/07-26/water-pollution-table.gif