Water History

Water Timeline

- 6000 BC – Ancient Persians use irrigation systems to grow barley where natural rainfall is insufficient.
- 5300 BC – Ancient civilizations flourish around rivers and major waterways: Mesopotamia near the Tigris and Euphrates Rivers and Egypt near the Nile River; earliest evidences of sailing ships used for transportation.
- 4000 BC – Ancient Hindu writings recommend water treatment, such as filtration through charcoal, exposure to sunlight, boiling or straining.
- 1700 BC – Plumbers on the island of Crete construct an elaborate sewage system, creating the first flush toilet.
- 400 BC – Hippocrates, a Greek physician, recommends boiling and filtering water for cleanliness.
- 312 BC – Aqueducts built in Rome to help meet ever-increasing water demand.
- 200 BC – Greeks invent the water wheel to mill flour, grind wood for making paper, crush ore and pound fiber for cloth.
- 1698 – Steam engine patented by Thomas Savery for the purpose of pumping water out of coal mines.
- 1804 – Lewis and Clark explore the Louisiana Purchase through major waterways to the Pacific Ocean.
- 1871 – Hydroelectricity is first produced at Niagra Falls.
- 1890 – First drinking water treatment systems are built in the United States to reduce contamination.
- 1914 – First water quality standards are established for drinking water in the United States.
- 1930s – Dust Bowl years are the worst droughts in the history of the United States.
- 1933 – The Hoover Dam is built to control floods, provide irrigation water and produce hydroelectric power.
- 1972 – The Clean Water Act is passed to clean up and protect water resources in the United States.
- 1989 – Surface Water Treatment Rule makes new requirements for filtration and disinfection of surface water to prevent waterborne disease caused by viruses in the United States.
- 2000 – Norway, Democratic Republic of Congo, Paraguay and Brazil produce over 85 percent of their electricity from hydropower.
- 2007 – World's then largest desalination plant operating in Jebel Ali in the United Arab Emirates uses multistage flash distillation to produce 300,000 cubic meters of desalinated water per year.

To meet our future water needs, with an ever growing population and continually increasing demand, we look to utilizing poorer water sources such as gray water (household wastewater), seawater and brackish water (slightly saline) to water plants and flush toilets. Also, improved water treatment technologies will increase available water sources. Oceans can help power future energy needs. They represent a vast untapped source of renewable energy carried by waves, tides, salinity and temperature differences. This energy has the potential to provide a substantial amount of electricity and renewable energy around the world.

Water Is Vital

Water Is Vital for Life

An adequate supply of water is vital to life on earth. All known living things need water. The human body feels solid but it is actually about 70 percent water. Safe drinking water is essential. An average adult should consume about 2 quarts of water per day. Evaporation from the skin, in the form of perspiration, helps regulate body temperature. Tears bathe eyes, saliva soothes throats and aids in digestion. Water is necessary in breaking down and carrying nutrients to all parts of plants and animals. The nutrients are transformed into energy or into materials used for growth and repair, with the assistance of chemical reactions. Chemical reactions within an organism primarily occur in water solutions. Water also helps an organism expel waste products.

A water molecule has two hydrogen atoms and one oxygen atom. This explains its chemical formula, H_2O. The electronic forces that make water molecules cling together also make them cling to the atoms of other substances such as salts, pulling them apart so they dissolve. This makes water an ideal medium for the chemical reactions that are the basis of life.

How Much Water Is Available?

Looking at the earth from space, you see a beautiful blue planet. It is blue because more than 70 percent of the earth is covered by water. However, if all the earth's water could fit in a gallon container only two tablespoons of it would be available for human use. Water has three states of matter, solid (ice), liquid (water) and gas (water vapor). Earth is unique in the solar system in having abundant liquid water. However, scientists estimate that less than one percent of the water on earth is available for human use.

The oceans contain 97 percent and glaciers comprise another two percent of the water on the earth. The majority of the water available for human use is found below the surface of the earth, often beyond the reach of conventional and economical drilling technologies. Our remaining fresh water supply is found in rivers and lakes. Each year the demand for water increases. In some cases, water is being withdrawn from aquifers faster than it can be replenished.

How Much Water Do We Use?

The average person uses approximately 80 to 100 gallons (303 to 379 liters) of water per day.[1] Water is used for cooking, cleaning, bathing and disposing of waste. Most items used every day require water in their manufacturing. People irrigate land where rainfall is insufficient for crop production through massive sprinkling systems. Agriculture accounts for approximately 80 percent of U.S. consumptive water use.[2]

[1] *usgs.gov/special-topic/water-science-school/science/water-qa-how-much-water-do-i-use-home-each-day?qt-science_center_objects=0#qt-science_center_objects*, accessed November 2021
[2] *nationalgeographic.org/media/earths-fresh-water/*, accessed November 2021

Water Fun!

The hydrologic cycle is affected by weather and the seasons. To find out why, fill two glass containers with water. Place one container in a warm, sunny area. Place the second in a cool, dark area.

What happened to the water in the two containers after a period of time? Which had the faster rate of evaporation? Why?

Water on the Earth

The Water Cycle/Hydrologic Cycle

The never-ending circulation of the earth's water supply has come to be known as the water cycle, or hydrologic cycle. The hydrologic cycle is a gigantic system powered by energy from the sun. Large bodies of water, such as oceans and lakes, are heated by the sun's energy. This heat causes some of the water to evaporate, or change from a liquid to a gaseous state, thereby transferring water to the atmosphere in the form of water vapor. Wind carries the water vapor across the earth as rain, snow, sleet or hail, all of which are forms of precipitation. Most of the precipitation returns to the oceans by way of streams and rivers, however, a portion of the water seeps into the ground.

Groundwater

Groundwater is one aspect of the hydrologic cycle. The major source of groundwater is precipitation. It seeps into the ground, filling the porous space between rocks and sediments. Around 30 percent of our fresh water is groundwater. Different geologic formations hold varying amounts of water, but those that yield water in usable quantities are called aquifers.

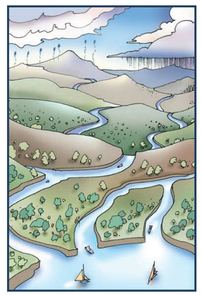
Aquifers

Groundwater flows slowly through an aquifer. An aquifer is any natural material that contains water in sufficient amounts to be recovered by drilling wells. Many aquifers are being depleted or contaminated. Aquifer depletion occurs when more water is pumped out than is replaced by the water cycle.

Watersheds

Watersheds are areas where surface water flows toward a particular water body, such as a stream. A ridge or other area of elevated land, called a divide, separates one watershed from another. Streams on one side of the divide flow a different direction than streams on the other side.

Stream Systems



Stream systems include surrounding watersheds, stream channels, in-stream habitats, stream banks, ponds, reservoirs, lakes and rivers. Whether in the mountains or flatlands, all natural stream systems possess a great diversity of plants and animals. A decline in this diversity or the number of organisms occurs when the system is disturbed. One way stream systems can be disturbed is through pollution. Some natural pollutants can create problems for streams, ponds, lakes and rivers. However, most problems result from human activities such as runoff from agriculture or lawns which contains dissolved fertilizer.

Wetlands

A wetland is an area with water saturated soil, either permanently or seasonally. Wetlands contribute in positive ways to the environment and the water cycle. The plants and animals that inhabit wetlands are unique, and many are protected by the Endangered Species Act. Once thought of as wastelands, wetlands support an immense variety of species.

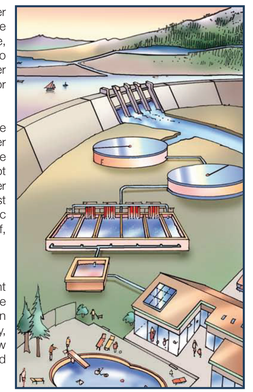
Water Treatment

Water Treatment

Treatment is used to purify raw water coming from nature for potable use as drinking water and to clean wastewater following human use. A number of steps may be used in combination to treat both types of water.

- Screens remove large objects from water.
- Flocculation, a gentle stirring, causes particles to stick together.
- Particles sink to the bottom of clarifiers where they are removed with pumps.
- The surface of wastewater clarifiers can be skimmed to remove things that float, like oil and grease.
- Filters or thin membranes are used to remove some of the smallest of particles. Granular media filters use things like sand and coal to filter out particles.

When wastewater is treated, it goes to aeration basins filled with microorganisms. There, oxygen is added to the wastewater enabling the microorganisms to break down organic pollution into mostly harmless carbon dioxide and water.



Before water is ready for potable use, or treated wastewater is released to the environment, the water is disinfected. In the disinfection process, chemicals like chlorine, chlorine dioxide, or ozone molecules that kill harmful pathogens, are added to the water to make it safe for drinking or swimming. Often after disinfection, treated wastewater, or gray water, is reused for things like irrigation.

The water treatment process is not final even when potable water is ready for use. Biosolids, that were taken out of water during treatment must have excess water removed before disposal. Similarly, the wastewater treatment process is not complete until the biosolids are stabilized. Stabilization further reduces biosolids and eliminates its pathogens. This is most often done using processes called anaerobic or aerobic digestion. Finally, the biosolids are dewatered and disposed of, or used as fertilizer.

America's Clean Water Act

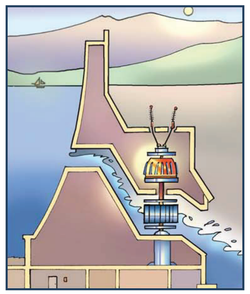
In 1972, in response to citizens' demands that the government do something to clean and protect water, Congress passed the Federal Water Pollution Control Act Amendments. This "Clean Water Act," managed by the Environmental Protection Agency, made discharge of pollution to U.S. waters unlawful. The law called for water to be clean enough for swimming, fishing and other recreational uses.

Water and Energy

The Connection Between Water and Energy

Water and energy are connected in many ways. It takes a great deal of energy to pump, treat and transport water. In turn, energy production is responsible for a significant portion of the water we use. For example, nearly half of U.S. water use is involved in generating electricity with steam driven generators. Hydropower and nuclear are forms of energy that involve large quantities of water.

Hydropower



About one-sixth of the world's electriciy comes from hydropower.[1] The potential of water at an elevation above sea level is one of the "purest" forms of energy available. The power of water is essentially kinetic energy, or energy possessed by something due to its motion. Humans have learned to understand and take advantage of water's movement from higher to lower elevation.

Hydroelectric dams are constructed not only to control the flow of water, but to increase the head. Head is the difference in elevation between the water's surface in the reservoir behind the dam and the stream below the dam. The water pressure is proportional to the depth of the reservoir created by the dam. Therefore, head is a measure of water pressure. Higher dams have greater water force to push the turbine and can generate more electricity. Pipes, called penstocks, channel the flow of water from the reservoir through the dam. Once in the dam, water drives turbines, which spin generators to produce electricity. Hydroelectric plants produce very few pollutants, have relatively low operating and maintenance costs and long life spans.

Nuclear Power

Nuclear energy is found inside the nucleus of atoms. Nuclear power plants release this energy from atoms through nuclear fisson (splitting the atoms to form smaller atoms). Uranium is used as the fuel to split atoms in a nuclear reactor core. This produces a large amount of heat, which turns water into steam. Generators, which have turbine blades turned by the steam, create electricity.

After electrical generation, nuclear power plants use water again. Steam is cooled back into water in a cooling tower. In addition, radioactive decay continues to produce heat after fission stops. Nuclear power plants must get rid of more waste heat than other electrical generation systems to avoid damage. Unlike other types of electrical generation systems, nuclear generation cannot rely on flues or stacks to discharge waste heat. Instead, water is most commonly used for this cooling. Because nuclear power generation is so dependent upon water, plant sites are often selected based on its availability.

[1] *usgs.gov/special-topic/water-science-school/science/hydroelectric-power-water-use?qt-science_center_objects=0#qt-science_center_objects*, accessed November 2021

Water Efficiency

Limited Resource

Water is considered a renewable resource but it is possible to use it faster than it can be naturally recirculated. Vast amounts of water are used to produce our energy, grow the food we eat, provide for our daily needs, maintain our homes and cities, fight fires and provide for transportation and recreational purposes. Because it is essential to every aspect of our lives, water must be used wisely.

Saving water can happen in two ways. First, we can use wise behaviors such as taking shorter showers or turning off the water when we brush our teeth. We can also use water-efficient technologies such as high efficiency shower heads or automatic sprinklers.

There are many reasons to use water as efficiently as possible. The cost of a monthly water bill is only a part of the price consumers pay for fresh, clean water. There are many other costs to consider. Water does not just come from the faucet, it comes from pumping stations, wells, reservoirs, pipelines, water treatment plants and even wastewater treatment plants which all have a cost. Fresh, clean water can be expensive. Conserving water and using it wisely can reduce treatment, transportation, distribution and heating costs. This results in saving not only water but saving energy, resources and money.

Water Efficiency Tips

Which of these practices does your family implement?

- Take quick showers instead of baths.
- Install high-efficiency shower heads and faucet aerators.
- Turn the water off while you brush your teeth or wash your hands.
- Run the dishwasher only with a full load.
- Check all water fixtures for leaks and fix or replace leaky faucets and toilets.
- Use a broom to clean the driveway instead of a hose.
- Always wash full loads of laundry, using cold water whenever possible.
- Use a trigger nozzle when washing your car.
- Put a water flow restrictor in the tank of your toilet to save water.
- Keep a pitcher of water in the refrigerator for a cold drink.
- Use mulch in gardens and choose plants that use less water.
- Wash and rinse dishes by hand in a basin of water instead of under running water.
- When purchasing new appliances, look for the most water-efficient models.
- Conduct a home water audit to see where water usage could be more efficient.

Water Fun!

Water early in the morning, avoid shallow watering and do not cut lawns too short to decrease the amount of water a lawn needs. Watering to a depth of 1 inch is optimal for most lawns.

To determine proper watering, place several shallow containers in different places on a lawn. Measure the water in each container after the sprinklers run. Adjust watering times if measurements are more or less than 1 inch.

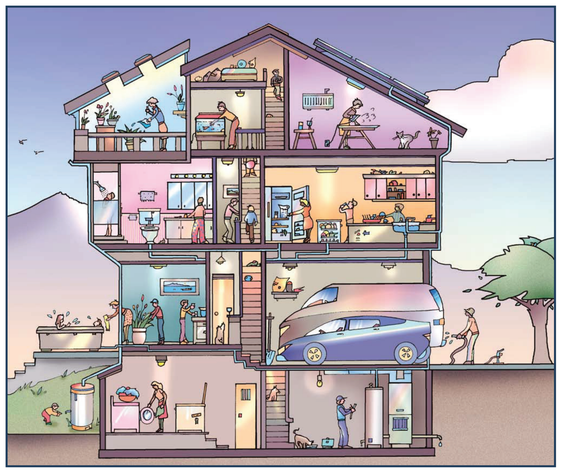
Water in the Home

Daily Water Use

Because three-quarters of the earth's surface is covered with water, it is sometimes difficult to understand the importance of using water resources carefully. We must understand that only a small amount of the earth's water is fresh and available for human use.

Knowing how water is used in our homes helps us to be efficient with its use. Flushing toilets is the biggest user, accounting for 24 percent. Showers and faucets come in second, each using 19 percent. Clothes washers make up 16 percent of our indoor water use, leaks 14 percent and all other uses account for 8 percent.[1]

Find all the water uses represented in the picture below. Determine which efficiency tips from the "Water Efficiency" panel could apply to each usage.



[1] *allianceforwaterefficiency.org/resources/residential*, accessed November 2021

Water Quality

Nature's Purification System

We can determine uses for water based on its quality. Water that is not suitable for drinking can irrigate crops. The water cycle helps to clean the earth's water. However, "pure" water in nature is difficult to find because it has the ability to dissolve many contaminants.

Pollution

Many forms of pollution affect water quality. High water flows, silt deposits or toxins contaminate water. In the atmosphere, particles of dirt, salt and smoke can combine with gases to form weak acids that are carried to the earth's surface by precipitation. Observable signs of water contamination include discoloration, odor, cloudy or silty water, excess algae growth and damage to living things.

If a single source, such as a sewage plant, can be identified as the cause of contamination, the pollution is referred to as a point source. In nonpoint source pollution, the origins of contamination cannot be easily identified or controlled. This type of pollution occurs as water flows over the land, picking up sediments, organic wastes, toxic substances, bacteria and other pollutants. Such contaminants can make their way into the groundwater where they can remain for decades or even centuries.

Careers

Advanced technology has changed water management for industry agriculture and utilities. Highly skilled technical and professional individuals are needed to manage water distribution and quality.

Water utilities need individuals to collect, treat and distribute water to municipalities across our nation. Hydrologists solve water related problems in our communities. Supervisors, plant operators, laboratory technicians, equipment operators, service persons, maintenance mechanics, meter repair persons, pipe fitters, meter readers, construction workers and scientists are just a few of the people who keep water supplied to buildings and homes.

Project designers, administrators, engineers, planners and engineering technicians make certain that industrial operations and businesses have adequate quantities of water. Accountants, analysts and controllers are kept busy in companies dealing directly with water and in companies dependent on water for business.

About the National Energy Foundation

The National Energy Foundation (NEF) is a unique 501(c)(3) nonprofit educational organization dedicated to cultivating and promoting an energy literate society since 1976.

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