Great Lakes Water Pollution

An Online Continuing Education Course for Engineers

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Introduction

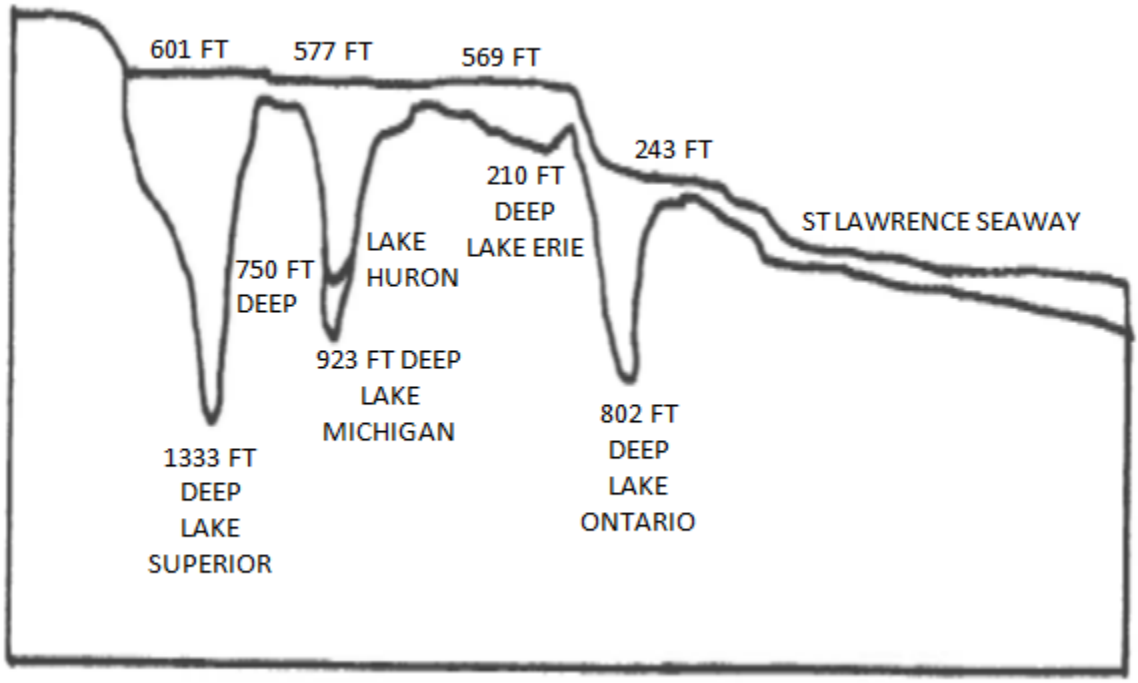
The Great Lakes of North America are located in the northeastern part of the United States on the Canadian border. They form the largest supply of freshwater in the world. The Great Lakes were formed during the last Ice Age, ten thousand years ago, when glaciers sculpted out large quantities of earth and filled them with melting ice water.

Lake Superior is the largest of the Great Lakes when comparing both surface area and volume of water and also the highest in elevation. Lake Superior flows southeast through the St. Mary's River into Lake Huron which is the second largest Great Lake in surface area. Lake Michigan flows through the Mackinac Strait also into Lake Huron. Lake Michigan is the third largest Great Lake in surface area. Lake Huron flows south through the Detroit River into Lake Erie. Lake Erie is the fourth largest and, by far, the shallowest of all the Great Lakes. Lake Erie flows east through the Niagara River into Lake Ontario. Lake Ontario, the smallest of the Great Lakes, flows through the St. Lawrence Seaway into the Atlantic Ocean. (See Figure 1)

Figure 1
Great Lakes Map

The drop in surface elevation of the first four lakes in the flow line is just 32 feet compared to the drop from Lake Erie to Lake Ontario which is 326 feet. (The drop in elevation from Lake Erie to Lake Ontario includes the drop down Niagara Falls.) (See figure 2.)

Figure 2
Great Lakes Elevation



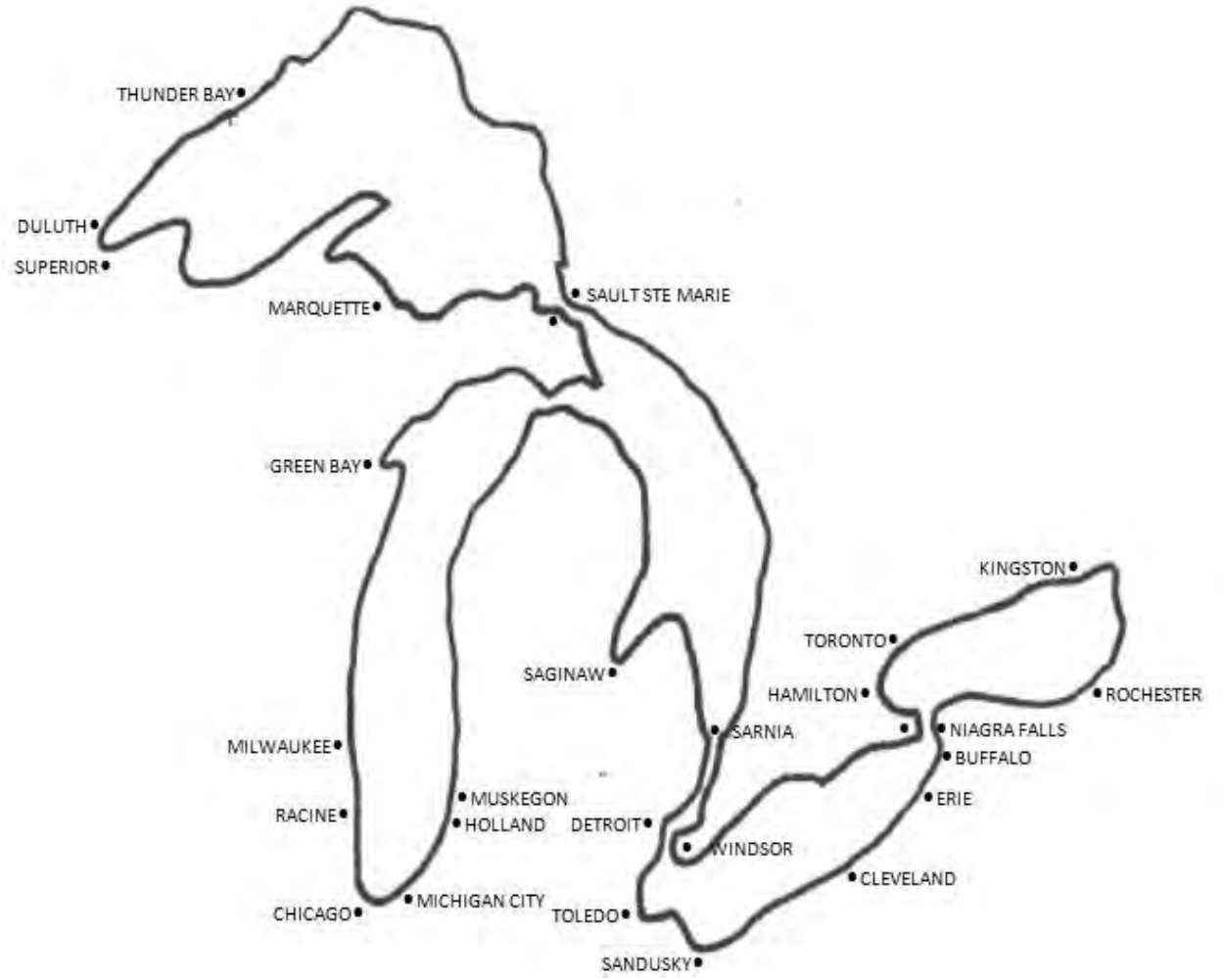
The major cities on Lake Superior are: Sault Ste. Marie, Michigan; Marquette, Michigan; Superior, Wisconsin; Duluth, Minnesota; Thunder Bay, Ontario; and Sault Ste. Marie, Ontario. The major cities on Lake Michigan are: Muskegon, Michigan; Holland, Michigan; Michigan City, Indiana; Chicago, Illinois; Racine, Wisconsin; Milwaukee, Wisconsin; and Green Bay, Wisconsin.

The major cities on Lake Huron are: Saginaw, Michigan; and Sarnia, Ontario.

The major cities on Lake Erie are Detroit, Michigan; Toledo, Ohio; Sandusky, Ohio; Cleveland, Ohio; Erie, Pennsylvania; Buffalo, New York; Windsor, Ontario.

The major cities on Lake Ontario are: Rochester, New York; Rochester, New York; Hamilton, Ontario; Toronto, Ontario; and Kingston, Ontario. (See Figure 3)

Figure 3
Great Lakes Cities



Great Lakes Water

The Great Lakes basin provides water for domestic and industrial needs, transportation, recreation, and a variety of other uses to one-tenth the population of the United States and to one-quarter the population of Canada.

Although the Great Lakes are the largest source of fresh water on earth, they are not without being susceptible to the problems associated with environmental pollution. The pollution can come from waste water emission from municipal and industrial sources and the various other

land born pollutants in the streams and rivers feeding the lakes. Another source of pollution comes from the atmosphere as particle fallout through direct deposition from falling rain or snow on the large surface area of the Lakes as well as on their watersheds (The land being drained by the streams and rivers feeding the lakes). Invasive species (fish and other aquatic animals and plants) have invaded the Great Lakes from foreign bodies of water. In many locations, environmental pollution of the Great Lakes has upset the delicate balance that nature has provided between water and its aquatic flora and fauna.

An extreme amount of time and money has been spent on Great Lakes cleanup that has helped but there is still an extensive amount of work that must be accomplished. The balance must be maintained if the lakes are to survive as we know them today.

In the 1970's, large investments were made in improving waste water treatment plants. Improvements were and are still being made in agriculture practices to reduce the amount of waterborne pollution such as fertilizers, pesticides, and suspended soil from entering the lakes through the many streams and rivers that compromise the lakes' drainage basin. Efforts are being made to extinguish the number of invasive species that have infiltrated the Great Lakes. The improvements that have been made have helped; however, there is a vast amount of work that must be completed if the lakes are to survive in their natural state.

Water Pollutants

Most water pollutants can generally be classified as follows:

Soil: Soil is one of the more recent major causes of pollution in our waters. Most of the soil comes from fields or large tracts of land where trees, shrubs, and grass have been removed for farming, mining, logging, or construction leaving the earth exposed to be washed away during periods of heavy rainfall. The fast-moving streams that are created wash away banks and bottoms adding to the concentration of soil in the water. The muddy water flows into rivers and lakes killing fish by clogging their gills and killing aquatic plants by blocking out sunlight.
The solution is to disturb the land as little as possible and not leave large tracts of barren land unprotected. Where the loose soil has been exposed, vegetation should be left standing or planted all around the entire site to filter rain water or use special low-lying type shielding fences to contain loose soil inside sites where the ground has been broken.

Bacteria: Bacteria are single celled organisms (living matter) that are present in all living creatures. Bacteria are necessary for decomposition and digestion of food in human beings. Helpful bacteria are called antigenic while harmful disease-causing bacteria are called

pathogenic. Pathogenic bacteria can cause cholera, dysentery, shigellosis, and typhoid fever. (Shigellosis is an infectious disease that can cause fever, stomach cramps, and diarrhea, in humans.) The main source of harmful bacteria in our waters is from sewage treatment plants overflowing during heavy rainfalls. Interconnecting sanitary sewer and storm sewer plumbing systems are one reason treatment plants overflow during heavy rainfalls. Also, animal wastes (manure) and dog droppings can be washed into storm sewer systems causing harmful bacteria to enter our streams, rivers, and lakes. Government mandated high efficient, high capacity treatment plants and control of animal wastes has helped to redu umber of bacteria entering our waterways. Also, separating sani systems reduces the chance of sewage treatm

Nutrients: Nutrients are a e two most common nutrients are phosphorus in farmland crop fertilizer. Nutrients cause a water shades sunlight from aquatic plant en from the water. Oxygen is a necessary ingre rmers are finding new ways to minimally appl bove for soil runoff; however, the proble

Polychlorinated biphenyls: (hemicals which can be odorless solids or oily tes as hydraulic fluid, adhesives, fire retardan ome people who drink water containing P CBs get into drinking water from landfill runoff and waste chemicals. In 1974, Congress passed the Safe Drinking Water Act which directed the Environmental Protection Agency (EPA) to determine maximum contaminant levels (MCLs) to be allowed in drinking water. Because PCBs are such a great danger to human health the MCL for the chemical was set at the extremely low concentration of 0.0005 mg/l (milligrams per liter) for public plants to meet in treated drinking water.

Mercury is an extremely rare element that is the only metal found in liquid form at standard temperature and pressure. Mercury occurs in deposits in the ground throughout the world. Mercury is used in many devices such as switches, thermometers, and bulbs. Because of its toxicity, the use of mercury is now being restricted to scientific research.

Mercury enters the atmosphere from the burning of fossil fuels, mainly coal in utility and industrial boilers, and from natural sources such as volcanoes and the weathering of ordinary rocks. Mercury in the air settles in water bodies affecting water quality. Mercury in the air can