Environmental Management & Pollution

WATER POLLUTION

6.1 Overview: Sources of Water Pollution

In summary, although water control structures provide benefits to society, such as hydropower, irrigation, and flood control, they also contribute to water pollution. These control structures should be recognized not only for their benefits to society, but also for their costs to the environment. The purpose of this lesson was to introduce you to some of the sources of water pollution: stormwater runoff, domestic discharges, industrial discharges, accidental spills, and water control structures. You learned that stormwater runoff is currently the leading cause of water pollution in the United States.

What causes water pollution? This question has many answers. Humans and the various activities we participate in cause water pollution, as do forest fires, floods and other natural events. A catastrophe such as the wreck of an oil tanker can pollute our waters, but so can a less dramatic event like a failing septic system.

Some of the most common causes of water pollution include stormwater runoff, domestic discharges, industrial discharges, accidental spills, and use of water control structures such as dams. Some of the most common causes of water pollution include stormwater runoff, domestic discharges, industrial discharges, accidental spills, and use of water control structures such as dams.

6.2 Stormwater Runoff

When rain falls on roads, parking lots, or farm fields, it either soaks into these surfaces or runs off. The rainwater that runs off is called stormwater runoff. Stormwater runoff typically contains many pollutants. For example, runoff from roadways and parking lots often contains oil, gasoline, and other automobile fluids. Runoff from farm fields may include pesticides, fertilizers, and animal wastes. Runoff from forested areas may have soil, vegetation, and other debris in it.

Stormwater runoff from golf courses may contain pesticides and fertilizers. Industrial sites may produce runoff containing industrial chemicals. Runoff from construction or other areas where the land is being disturbed often contains eroded soils, dissolved minerals, and debris. Stormwater runoff carrying these pollutants enters storm gutters, pipes, and ditches—and ultimately our rivers, streams, and lakes. We only recently began treating stormwater runoff to remove pollutants before it enters our waterways.

These sources of stormwater pollution, alone and combined, have resulted in serious water pollution problems. Stormwater discharges from agricultural fields, for instance, have contaminated rivers with organic material and bacteria from animal waste. Stormwater discharges containing phosphorus have contributed to the undesirable growth of large numbers of algae in lakes and rivers. Stormwater discharges containing eroded soils have damaged fish spawning beds and other aquatic habitat. Most of the sources causing stormwater-related pollution are referred to as nonpoint sources because they come from broad areas rather than single points of origin. How big is the problem of nonpoint source pollution?

According to the Environmental Protection Agency (EPA), nonpoint sources of pollution are the leading cause of water pollution in the United States today. Only about half of the miles of rivers and acres of lakes assessed by state agencies have sufficient water quality to fully support their designated uses for fishing, swimming, and drinking. Nonpoint pollution from agriculture, in particular, has been cited by the EPA as a major cause of the degradation of these waters. Other sources of pollution are referred to as point sources because they originate from single points of discharge, such as the ends of pipes. Domestic discharges are point sources of water pollution. Most of us take modern sewage collection and treatment for granted. We flush the toilet and the waste goes away. Where does it go? In most cases, it goes either to a septic system or to a sewage treatment plant.

6.3 Septic Systems

Septic systems consist of a large buried tank, usually about 1,000 gallons (3,800 liters) in size, and a series of perforated pipes—called a drain field—that are placed in the soil down slope from the tank. Sewage solids are retained in the tank and the liquid effluent enters the drain field and percolates into the underlying soil. Millions of people in the world rely on septic systems for managing their sewage, making these systems a considerable source of water pollution when used inappropriately.

Septic systems can cause water pollution when they are placed in areas with poor soil conditions, high water tables, or in areas without sufficient area for them to function properly. For example, septic systems do not work well when placed in tightly packed, fine-grained soils such as clay, because effluent from the septic tank cannot pass through the soil easily. Instead, it collects at or near the surface of the ground and may run off into nearby waters.

Effluent from a septic tank is essentially raw sewage and it poses both an environmental and a health hazard. If drain pipes from the septic tank are too close to the water table, effluent will enter the groundwater before being properly treated in the soil, resulting in groundwater contamination. If septic systems are placed too close together in densely populated areas, adequate space will not be available for the systems to function properly. The soil will become overloaded beyond its capacity to adequately treat the wastewater, resulting in surface or ground water pollution.

6.4 Sewage Treatment Plants

Fortunately, in the United States, municipal sewage collection and treatment plants serve most areas where housing is dense. In areas where cities provide sewer service to their residents, wastewater from individual homes flows through house plumbing and underground sewer pipes to the community's sewage treatment plant. The plant treats the wastewater to remove approximately eighty-five percent of the solid and organic materials in the wastewater, disinfects it to kill bacteria and viruses, and then usually discharges it into the nearest waterway.

Although sewage treatment plants are intended to help prevent water pollution, they can also contribute to it in a number of ways. The solid and organic materials not removed through the conventional treatment process, which is approximately fifteen percent of the amount entering the system, can degrade water quality. For instance, when large volumes of effluent are discharged into small, poorly mixed waterways, wastewater can dominate the receiving stream, reducing the concentration of dissolved oxygen in the stream.

Nutrients not removed through the conventional treatment process, especially phosphorus, can contribute to eutrophication, causing the undesirable growth of algae and other nuisance organisms. Nitrogen, in the form of ammonia, can be toxic to fish and other aquatic species and can also lower dissolved oxygen in the receiving stream. Chlorine, which is commonly used for disinfection at a treatment plant, can be toxic to organisms in the receiving water. Again, the toxic effect of chlorine is more pronounced in small waterways with low flow rates and poor mixing conditions.

Conventional municipal treatment systems do not typically treat toxic substances very well. Substances such as some household cleaners, petroleum products, metals, and other toxic compounds that are sometimes found in sewage can pass through the system without being properly treated, causing toxicity in the receiving stream. They can also contaminate the sewage solids removed during treatment, making these solids difficult to dispose of or use for beneficial purposes such as fertilizer without harming the environment.

Poor performance of the treatment system due to upsets in the biological treatment process, operator error, or storm-related problems can result in the discharge of improperly treated sewage. Poor performance under stormy conditions is a serious problem for both municipal treatment plants and collection systems. During a rainstorm, stormwater can enter sanitary sewer pipes through cracks or improper joints. This stormwater flows to the treatment plant, where it can overload the system. These extra flows reduce the time available for settling and biological treatment, and can result in insufficient treatment of the sewage prior to discharge.

In some older communities, the pipes carrying sewage are connected to the pipes carrying stormwater. During rainstorms, the sewer pipes become so full they overflow into the stormwater pipes. These stormwater pipes do not go to the sewage treatment plant; they go directly to nearby waterways. These overflow events are called combined sewer overflows (CSOs). Combined sewer overflows result in untreated sewage being discharged directly into a nearby river or stream, posing both an environmental and a human health hazard.

CSOs are a serious problem in larger, older cities where these combined sewage and stormwater collection systems were used extensively in the past to save money. Cities in the United States currently contending with CSO problems include Portland, Oregon; Seattle, Washington; New York, New York; Boston,
Combined sewer outfall, Willamette River, Oregon Massachusetts; Chicago, Illinois; and St. Louis, Missouri. These cities and others are currently spending millions of dollars to separate their sewage and stormwater collection systems. They are also trying to discover other ways of solving their CSO problems, such as treating the combined wastewater prior to discharge.

6.5 Industrial Discharges

Although domestic discharges can be a significant source of water pollution, they usually pose less of an overall threat to water quality than do industrial discharges. Industrial discharges are often larger, and they may contain more harmful materials. Large, ***"wet"*** industries like pulp and paper mills are almost always built near the banks of rivers because of their high demand for water. They obtain clean water by directing river water from upstream diversions to their plants below.

Once the clean water reaches the plant, it is used in the production process and then sent to a treatment system to remove the pollutants acquired during production. This treated process water is then discharged back into the river downstream of the plant. Obviously, the process East River near Brooklyn Bridge, New York waters used by industry must be treated properly to prevent water pollution. For instance, at a pulp and paper mill, clean water is mixed with wood chips and chemicals during the pulping process.

This processing water must then be treated to remove the pollutants acquired from both the wood and pulping chemicals prior to discharge. Industrial treatment systems generally remove more than ninety percent of the solid and organic materials in the wastewater. They also address other industry-specific problems by removing metals or neutralizing acids. However, like municipal systems, industrial treatment systems can also contribute to water pollution, though they are intended to prevent it. Water pollution problems can arise from:

1) improper operation and poor performance of the treatment system,
2) the adverse conditions caused by the ten percent or more of solids, organics, and other materials that cannot be not removed through standard treatment processes, and
3) specific chemicals that are toxic in low concentrations and difficult to remove entirely.

Which industries use water in their production processes? Almost all industries manufacturing any type of product use water during production. Some of the more common industries requiring process waters include food processors, electronic equipment manufacturers, rare metal manufacturers, forest products producers, textile manufacturers, pharmaceutical manufacturers, pulp and paper mills, leather tanners, and chemical manufacturers. These industries and the many others that use water in their production processes must continuously provide proper treatment of their process waters prior to discharge to prevent water pollution.

6.6 <u>Accidental Spills</u>

Industrial and domestic discharges and stormwater runoff are somewhat predictable sources of water pollution. When it rains, we know stormwater pollutants run off the land and enter our waterways. When domestic and industrial discharges are not managed properly, we know they can degrade the quality of our waters. Another source of water pollution results from events that are unpredictable: accidental spills.

In the early hours of March 24, 1989, the thousand-foot long oil supertanker Exxon Valdez traveled outside of its shipping channel and ran aground on Bligh Reef in Prince William Sound, Alaska. This catastrophe resulted in the largest and most devastating oil spill in United States history. Almost eleven million gallons of crude oil spilled into the sound. The spill migrated over an area of more than 11,000 square miles, killing an estimated 300,000 birds and hundreds of mammals. The spill killed bald eagles, peregrine falcons, murres, loons, grebes, and puffins. It also killed and injured sea otters, harbor seals, salmon, and many other species.
The effects of this tragic spill could have been prevented or lessened in many different ways. Those responsible for piloting the ship could have been more conscientious and more skillful in keeping the ship on course. The tanker could have been doublehulled to provide a secondary means of containment once the first hull ruptured. The emergency response could have been more rapid and better organized. Official crews did not arrive on the scene for approximately ten hours and it took them more than thirty-seven hours to place the floating booms used to corral the floating oil.

Although this major oil spill was devastating to the environment, nature is now recovering in Prince William Sound. Much of the oil floating on the surface of the sound migrated into small coves and inlets, protected from wind and waves, where it eventually congealed and fell to the bottom of the sound. Oil that had washed up on the shoreline adhered to soil and vegetation, where it formed sticky tar and asphalt-like deposits. Given enough time, these deposits of spilled oil will eventually be biodegraded by bacteria and other naturally occurring microorganisms. Although we know that biodegradation will eventually occur, no one knows how long it will take. Neither the long-term effects of the spill nor the environment's ability to recover will be known for many years.

Many different types of materials have spilled into waterways in the United States and continue to do so, causing water quality degradation and killing fish and other aquatic organisms. For instance, in Oregon, a tractor-trailer filled with hydrochloric acid jackknifed and ran off the road, spilling its contents into the John Day River. In California, derailed train cars carrying herbicides plunged into the nearby Sacramento River, spilling their contents.

In Idaho, a tractor-trailer full of industrial chemicals ran off the highway into a tributary of the Salmon River. In Utah, chlorine from a water treatment facility spilled into the Ogden River. Large spills of oil and other chemicals do not occur frequently, but the results are often catastrophic when they do. Some of the more common types of spills, however, are spilled petroleum products from 55-gallon drums, overflows from sewage pump stations, breaks in sewer lines, breaks in oil and gas lines, and spills of gasoline and antifreeze. These lesser spills also pose a threat to water quality.

6.7 Water Control Structures

Dams, levees, and other water control structures alter the natural courses of our rivers and streams. Some control structures turn free-flowing waterways into standing bodies of water. These changes in the natural movement of our waterways can reduce Bennett Dam, Peace River, British Columbia water quality in a number of ways. For instance, the temperature of water held behind a dam increases because more water surface is exposed to the sun and less vegetation exists to provide shade.

This increase in temperature reduces the amount of oxygen that will dissolve in the water and become available for fish and other aquatic organisms. The water held behind an impoundment usually has less natural turbulence than a moving waterway, also resulting in lower concentrations of dissolved oxygen. By slowing down the movement of the water, control structures also cause pollutants suspended in the water, such as nutrients and sediments, to settle out of the water and concentrate. This slow-moving, warm water with a high concentration of nutrients provides a good environment for algae. As algae grow and multiply, the water can become green and turbid. Algae can also cause unhealthy shifts in dissolved oxygen and pH, as described earlier.

Control structures can severely alter fish habitat. Waters passing through a dam can become over-saturated with dissolved gases, such as nitrogen, that are harmful to fish and other aquatics. Silt and other materials settling from the water held behind a dam can cover fish spawning beds. Migratory routes can be completely cut off or made more difficult. In the United States, many runs of both Atlantic and Pacific Salmon have been devastated because water control structures have disrupted their migratory routes and habitat.

The loss of natural flood plains and wetlands because of the use of dikes and levees also reduces water quality. Flood plains filter out and remove pollutants as water passes through vegetation and over soil during flooding. These benefits are lost when dikes are placed to prevent water from entering them.