Chapter 22 -Water Pollution and Treatment

Case Study: Outbreak

This case study points out that the primary water pollution problem in the world (although not so much in developed countries) is the lack of clean disease-free drinking water. One such disease that occurs in epidemics is cholera, which causes diarrhea and can result in death from dehydration. Another one, which occurred in the US in 1993 is *Cryptosporidiosis*.

Water pollution Basics

Water pollution is the degradation of water quality. In terms of water for human consumption this relates to whether the water is suitable to be consumed. In terms of water in the environment (and not intended for human consumption) it can refer to how degradation of water quality disrupts ecosystems. Some **major sources of surface water pollution** are urban and agricultural runoff, runoff from industrial sites and sediment from erosion. Some **major sources of groundwater pollution** are leaks from waste disposal (landfills) leaks from buried tanks and seeps and spills from mines, pipelines and industrial sites. An excellent list is Table 20.1.

WATER POLLUTANTS

The kinds of pollutants regulated in our dirnking water are listed in table 20.3.

Biochemical Oxygen Demand (BOD)

When dead organic matter enters stream or other bodies of water, bacteria begin to decompose it. The bacteria use oxygen and multiply quickly, using even more oxygen from the water. The amount of oxygen in the water is called **dissolved oxygen (DO).** Normal levels of DO in a healthy pond or stream would be 6-9 ppm, but below 5 it becomes difficult for heterotrophs such as fish to survive. See fig 20.2 for an example of BOD pollution resulting from a spill from a sewage treatment plant.

Waterborne Disease

In order to measure the chance of disease causing bacteria being present in a body of water we count **fecal coliform bacteria**. Although the bacteria are not generally dangerous, their presence indicates the chance that other bacteria associated with animal waste could be present.

Nutrients

Major nutrients that pollute water are phosphorous and nitrogen. This pollution results from agricultural runoff of fertilizers, urban runoff from fertilizers and detergents, and increased runoff resulting from deforestation. Over 90% of all nitrogen added to the environment is from agriculture (including runoff from feedlots). These nutrients can result in eutrophication (see A Clocer Look 20.2).

Oil

Oil can be a pollutant in surface water. This can happen from leaks from undersea drilling and from leaks from Oil tankers (ships). The most famous recent tanker spill was from the *Exxon Valdez* (prounounced val-deez') which spilled 250,000 barrels of oil into the Prince William Sound in coastal Alaska in 1989 (fig. 20.6 and 20.7). this resulted in the death of many seals and sea birds. The short term results can be dramatic, but the long term effects may not be significant (also see Durand Notes for chapter 16). Accumulated small leaks from normal shipping probably release more total oil than spills.

Sediment

"**By volume and mass, sediment is our greatest water pollutant. Sediment** is made of particles of gravel, sand, and silt. It results from erosion and it reduces the quality of the water it is in. The presence of sediment is measured as **turbidity**, which is a measure of how much light can travel through the water. Sediment is caused by land conversion: from forest to clearing, agricultural use, deforestation.

Acid Mine Drainage

Acid mine drainage refers to water leaving the site of a mine where it has leached sulfur compound from mine tailings. This water has then been converted to sulfuric acid and can pollute surface and ground water. It comes mostly from coal mines but can alos come from metal mines. A common sulfur compound it interacts with at these sites is pyrite (fool's gold). This is a significant problem on the east coast, where the acid water has polluted streams.

Surface Water Pollution

Pollutions can come from **point sources**, such as a pipe or single building, or **non-point sources**, such as the acuumulated runoff of an urban or agricultural community.

Ground Water Pollution

About 50% of US residents depend on groundwater for their water source. As much as 75% of the 175,000 waste disposal sites in the us may be leaking plumes that are migrating towards groundwater.

Groundwater pollution v. Surface water pollution

a) groundwater lacks oxygen, kills aerobic bacteria, but can harbor anaerobic ones so bacterial breakdown of pollutants does not occur

b) the rate of movement in the ground is low, so poluttants are not diluted.

Salt Water Intrusion (see A Closer Look 20.3 p. 427)

A salt water intrusion occurs in coastal areas where groundwater is being overdrafted. The spot where the well reaches the water table creates both a cone of depression and a cone of ascension (fig 20.11) (like the way a dip forms in a thick shake around the straw when you suck on it). The cone of ascension can sick in salt water.

Wastewater Treatment

This includes treatment of water used in industry, commerce (stores and restaurants) and in household use (sinks, toilets, showers). In some areas it also includes the water from gutters that flows into storm drains.

Septic tanks for household treatment (fig20.13)

Septic tanks are used in rural areas with no centralized sewer wywtem A pipe leads to an underground tank which separates solids from liquids, uses bacteria to decopmpose the waste and then slowly discharge the treated a series of pipes that disperses it throughout a field.

Wastewater Treatment Plants (sewage plants) (fig. 20.14)

Primary Treatment

A) Incoming water passes through screens to collect larger objects

B) Water is sent to the **grit chamber**, where the flow slows down to allow particles like stones and sand to settle and be removed

Secondary Treatment involves activated sludge, in which bacteria, nutrients (sludge) and oxygen are combined ot encourage the breakdown of organics that still remain in the water. The resulting sludge is removed and recycled back into activated sludge tanks to continue the breakdown of organics in more incoming water. Th other sludge moves to a sludge digester where breakdown is completed by anaerobic bacteria.This process produces methane, which is often used to produce electricity in treatment plants. This resulting sludge is then dried and disposed of in landfills or used for agricultural fertilizer, it is now known as "**biosolids.**"

Advanced Wastewater Treatment (tertiary treatment)

To remove pollutants such as dissolved nitrates phosphates and heavy metals special processes must be used sucha s filters or chemical application. This could also include chlorination or disinfection by UV or ozone as in treatment for domestic use.

Water Treatment for Domestic Use

Water is treated after it is taken form the ground or from surface water, but before people consume it or us it for other household reasons, such as cooking. The water is filtered and then treated with a disinfectant such as chlorine (or UV or ozone treatment). Some water is also additionally filtered in the home.

Land Application of Wastewater (grey water) (fig 20.15)

1) return wastewater to to crops