CHAPTER 2

WASTEWATER MANAGEMENT CONSIDERATIONS

2-1. Introduction

a. Technological considerations. Programs formulated to manage the discharge of wastewaters generated by domestic use and industrial operations require a broad understanding of the relationship between water sources, waste generation, and the environmental consequences of waste disposal. With very few exceptions, all problems associated with wastewater discharges have environmentally acceptable solutions. The technology for achieving any desired level of effluent quality is already developed and in most cases, well proven. The task of the environmental engineer dealing with wastewaters is to identify the problem and to apply the most appropriate technology in order to achieve the desired goal.

b. Wastewater disposal. Liquid wastes from domestic and industrial sources are ultimately disposed of into receiving water bodies or onto land. Portions of the waste products may be volatilized and discharged to the atmosphere, while part or all the water may be recycled for repeated use. When an environmentally acceptable solution to a problem is being sought, equal emphasis should be placed on all three components of the environment, i.e., land, air, and water.

2-2. Water resources and usages

a. The hydrologic cycle. The cycle of water in nature allows water to be used repeatedly. Water vapor is condensed from the atmosphere in the form of precipitation which falls to the ground and either flows as runoff to surface waters (streams, rivers, lakes and eventually oceans) or infiltrates the ground to feed groundwater aquifers. Plants draw water from surface water or groundwater sources or intercept the water as precipitation and return a portion of the water to the atmosphere through evapo-transpiration. Evaporation from surface waters contributes the majority of the water returned to the atmosphere.

b. Water uses. Water quality criteria in the U.S. are normally established to protect the water users. In foreign locations where no pertinent water quality regulations exist, downstream water uses must be recognized and pollution control steps taken to avoid interference with these uses.

(1) Water supply. Water supplies are required for domestic, industrial and agricultural uses. Domestic uses include water for drinking and food preparation, washing, waste transport, lawn sprinkling, fire fighting and commercial water uses. industrial uses include process water, cooling water and transportation of waste materials. The main agricultural water use is irrigation; others are livestock watering and waste disposal.

(2) Indirect water reuse. The indirect method of water reuse is commonly practiced when wastewater from one community is discharged to a receiving water and subsequently used as a water supply by another community. Due to the treatment provided by modern water treatment facilities and the natural assimilation of wastes by the receiving water, this type of water reuse has become acceptable. The main pollution control need for waters used for public supplies is to remove constituents that may pass through the water treatment facility or result in excessive treatment costs.

(3) Wildlife habitat. Wildlife, such as waterfowl, waterbased animals, fish, shellfish, plankton and other aquatic life, require water that is free of oil, excess solids and other toxics and that meets their needs for dissolved oxygen, temperature, etc. The successive buildup of chemicals in the flesh of predator animals has been extensively documented. Similarly, the buildup of toxic materials and flavor tainting substances have been observed in fish and shellfish.

(4) Recreation. The pollution control requirements to maintain recreational uses are related to those of wildlife habitation through hunting, fishing and other activities that utilize wildlife. Primary (complete) body contact activities such as swimming have strict water quality requirements regarding bacteria, pH and turbidity.

(5) Aesthetics. Waste treatment requirements for aesthetic reasons have become increasingly important with the emphasis on environmental concerns and protection of the complete human environment. Control of odor, color and turbidity; removal of objectionable and unsightly floating materials; and elimination of secondary effects on aquatic or stream bordering plants will usually satisfy aesthetic requirements.

2-3. Effects of discharge on the environment

Water usage generally results in production of wastewaters requiring disposal. These wastes are

usually disposed of by discharge to surface waterways. Thus, water is returned to the water cycle along with a variety of contaminants incorporated in the wastewater during use. These contaminants may have detrimental effects on the environment of the receiving surface waters.

a. Waste water characteristics. In dealing with wastewaters, several typical undesirable characteristics may be identified. These are listed in table 2-1. Although an individual wastewater may not have all of these characteristics, it is important to recognize the detrimental factors which may be present and the effects they may have on the environment. The parameters used to describe the quality of wastewater are discussed in chapter 3. Examples of typical wastewater characteristics from specific sources are also presented.

b. Surface discharges. Federal, State, and local governments have placed restrictions on wastewater discharge quality in order to control the detrimental effects of contaminants as described in the last section. These restrictions may require a certain type of treatment system be used, or they may specify concentration limits on certain parameters regardless of the treatment system used. Typically, the quality of the receiving stream or body of water is taken into consideration along with the intended use of the water following the wastewater discharge. Each state has classified its major streams and bodies of water according to their own set of use classifications. The regulations involved in water quality control are discussed in the following chapter.

c. *Ocean discharges.* Domestic users and industrial plants located on the ocean coast may discharge their treated wastewater through an ocean outfall. Although the ocean offers abundant dilution water, careful attention should be given to the fate of the various constituents as they are discharged and their effects on the marine environment. Generally, most degradable organics can be safely discharged to the sea if proper discharge facilities are installed. However, inadequate design of discharge facilities may result in severe environmental nuisances including oxygen depletion, color and turbidity, algae blooms, and public health problems. Non-degradable constituents and toxic materials should generally be eliminated from wastewaters prior to discharge to the ocean. Once these materials reach the marine environment their fate is unknown and uncontrollable. Toxic materials may be passed to man through marine food chains. They may cause fish kills or sublethal effects on marine organisms.

d. Land discharges. Wastewater discharged to land should be considered on a constituent-by-constituent basis in order to make sure that no land is irreversibly removed from some other potential use. Land application of wastewater requires intimate mixing and dispersion of the waste into the upper zone of the soil-plant system with the objective being assimilation of all constituents by mechanisms such as microbial decomposition, adsorption, immobilization, and plant recovery. Adequately designed land application systems should avoid groundwater or surface water contamination from leachates, air pollution, and other aesthetic nuisances in the application area. Assimilative capacities of each wastewater constituent must be carefully established in order to make sure none are exceeded.

e. *Atmospheric discharges.* The atmospheric environment should also be considered during all phases of a wastewater management program. Although only a small portion of the wastewater constituents is intentionally discharged to the air there may be unintentional discharges of sufficient magnitude to cause environmental concern. Atmospheric pollution can be caused by gaseous materials, particulate, or aerosols. The most frequent complaint is associated with malodorous gases in the vicinity of a treatment plant. Although this is the most obvious air pollution nuisance it is not necessarily the most severe. Toxic gases and to a lesser extent pathogen-carrying aerosols may have significant public health effects. Careful attention should be given to the potential air pollution problems that may arise in any waste treatment design.

Table 2-1. Undesirable characteristics and effects of wastewater discharges and remedial approaches

Constituent	Undesirable Characteristics and Remedial Approaches
Soluble Degradable Organics	Depletion of dissolved oxygen in streams leading in severe cases to fish kills; development of anaerobic conditions; evolution of malodorous gases and an unsightly environment. Discharge within assimilative capacity of water body or by effluent standards.
Toxic Materials and Elements	Adverse effects on aquatic life; accumulation of toxic materials and transfer to man via food chains; introduction of toxic materials to domestic water supply systems. Usually rigid limitation imposed on discharge of such materials.
Color and Turbidity	Aesthetically undesirable; impose increased loads on water treatment plants.
Refractory Organics	Persist in the environment for long periods; may cause aesthetic (e.g., foam) or public health (e.g., chlorinated hydrocarbons) problems.
Oil and Floating Materials	Aesthetically undesirable; may interfere with natural stream reaeration. Regulations usually require complete removal.
Nutrients (nitrogen and phosphorus)	Enhance eutrophication (i.e., blooms of algae in lakes and ponded areas); critical in recreational areas.
Suspended Solids	Create sludge deposits in streams resulting in malodorous and anaerobic conditions. Discharge limits are imposed by regulatory agencies.
Acids and Alkali	Shift the acid-base equilibria in streams; endanger aquatic life; adversely affect water quality for domestic, industrial, and navigational use. Most regulatory codes require neutralization of wastewater prior to discharge.
Heat	Thermal pollution resulting in depletion of dissolved oxygen; thermal barriers restrict movement of aquatic organisms and cause a shift in biotic composition.
Dissolved Salts	Increases the salinity of receiving fresh water i.e., brackish water; impairs reuse for water supplies.