Chapter 4
Collection Systems

4-1. General

The purpose of a wastewater collection system is to convey wastes from the point of generation to the point of treatment or disposal. Depending on site conditions and economics, collected wastewater is conveyed either by truck transport or by piping system. The piping system may employ gravity, pressure, vacuum, or a combination of the first two. *Graywater* is defined as all wastewater produced from an occupied building unit (shower, bath, stationary stands, or lavatories) and generated by water-using fixtures and appliances, excluding the toilet and possibly garbage disposal, if any. *Blackwater* refers to pit privy waste and consists primarily of human excreta.

4-2. Absence of Pressurized Water Supply

When no pressurized water is available or soil conditions are unsuitable for direct ground disposal, the choice for onsite treatment may be limited to privies or waterless toilets. A privy, an outhouse over an earthen pit, is the simplest solution. When the pit is full, the privy may be closed or relocated. If the soil conditions are such that contamination of a groundwater source is a potential problem, impervious pits may be used and the subsequently collected waste (septage) pumped out and transported to a central holding tank or station. Both types of privies have been widely used for unserviced campgrounds, parks, and recreational areas without pressurized water service.

4-3. Transport by Truck

a. General. Trucks are used to transport four types of wastes: septic tank sludge, vault wastes, recirculating and portable chemical toilet wastes, and low-volume flush wastes. Factors to consider when designing a truck transport system include length of haul to the treatment facility, frequency of hauls, and the effect that the trucked waste has on the treatment facility (Clark 1971).

b. Effects on treatment facility.

(1) Table C-10 presents the characteristics of a 3800-L (1000-gal) load of nonwater carriage wastes. Addition of this waste type to a conventional treatment facility, without dilution, would adversely affect its efficient operation. Three parameters to be considered in developing dilution criteria for such wastes include solids concentration, presence of oxygen-demanding substances, and toxic chemical additives.

(2) Addition of truck-transported concentrated wastes to any treatment facility affects the equilibrium of a biological process. Operational procedures such as loading and wasting factors of the receiving wastewater treatment plant must be altered to accommodate the increase in solids concentration. To avoid an upset to the biological process equilibrium, the design engineer must estimate the amount of dilution required such that the sudden increase in mixed-liquor solids does not exceed 10 to 15 percent.

(3) Dilution and increased aeration capacity are both required to avoid the depletion of plant oxygenation capacity. Tradeoffs between dilution and increased aeration must be considered in order to treat concentrated wastes with minimal upset to the treatment system. For the waste types shown in Table C-10, the following dilution ratios may be used (USDHEW 1967):

- 19 parts water to 1 part septic tank waste
- 59 parts water to 1 part vault waste
- 44 parts water to 1 part low-volume waste
- 59 parts water to 1 part chemical toilet waste

c. Design considerations. To estimate the total amount of solids a system can tolerate, multiply the total amount of mixed-liquor volatile suspended solids by 10%. Table C-10 and the dilution factors shown above can be used to calculate the number of 3800-L (1000-gal) truckloads a conventional plant should receive. Therefore, frequency of truck transport can be estimated as a function of the receiving plant capacity.

d. Operational considerations. If a specifically designed wastewater treatment facility receives trucked wastes on a regular basis, oxygen demand becomes the limiting factor. If the treatment plant receives wastes on an irregular basis, both the solids equilibrium and the oxygenation capabilities must be considered. If the waste contains toxic chemical additives, maintaining the solids equilibrium should provide adequate dilution.

e. Requirements for a transfer facility. Primary requirements of a transfer facility include adequate storage capacity, ease of pumper truck unloading, comminution, odor control, and pumping flexibility and reliability. A typical truck unloading site contains a large discharge chute, bar screens, comminutors, and pressure water connections for flushing the truck after each dump. Transfer tanks should be equipped with dual pumps for reliability.

f. Holding tanks or septage receiving stations. Wastewaters from several pit privys, vaults, or small toilet systems may be temporarily held in a central holding tank or septage receiving station and then transported off-site for subsequent treatment and disposal.

(1) Considerations of design include adequate sizing with a liquid holding capacity of 7 to 14 days and a minimum capacity of 9500-L (2500 gallons); no discharges permitted from the tanks other than by pumping; a high-water alarm provided with allowances for a 3- to 4-day additional storage after activation; and the tank must be readily accessible to vehicles for frequent pumping. Since a holding tank constructed in or near fluctuating groundwater strata will be subject to flotation forces when the tank is evacuated or pumped clean, these considerations must be addressed in the holding tank's structural design.

(2) Septage receiving stations usually consist of an unloading area, reinforced-concrete septage storage tank and one or more grinder pumps, and a dry well on the effluent or pumping side of the septage wet well. Storage tanks are provided to store solid organic material to be disposed to an off-site treatment facility. The tank should be covered for odor control. If pretreatment (grit and screens) is not provided before storage, the tank should be equipped with influent grinder pumps to macerate any accumulated large solids. Chemical treatment (chlorine or lime) equipment can be provided if it is concluded in advance that the septage will require treatment, neutralization, or odor reduction.

(3) Design considerations for septage receiving stations include pressure hoses and washdown equipment; watertight truck hose connections and quick-release discharge tubes for the hose connections;

provisions for heater cable installations in the concrete chamber bottom to prevent freezing in colder climates; and a sloped ramp to tilt the pumper tank truck for complete discharge of contents.

(4) Pumping station designs should include a fail-safe arrangement for preventing pumper tank trucks from releasing septage without proper hose connections. In areas with a number of septic tanks or other individual sanitary facilities to be serviced, it is often difficult to discharge from pumper trucks unless a receiving station or holding tank is part of the overall septic collection system. Therefore, septic receiving and storage facilities with separate screening and grit removal constitute the best design arrangement. Generally, 100 mm (4 in) but preferably 150 mm (6 in) diameter lines are the minimum size for handling, receiving, and discharge lines.

(5) Design information for septage receiving stations can be found in Metcalf & Eddy 1991 and WEF MOP-8.

4-4. Gravity Flow Systems

a. General. Gravity flow systems consist of a network of underground sewer pipes sloping continually downhill to the wastewater treatment facility. Gravity systems must incorporate lift stations in order to avoid deep excavation that would be required in a flat or undulating terrain. It is desirable that piping systems be designed to avoid the formation of septic conditions, i.e., the velocity of wastewater through the piping system must be maintained to avoid the formation of septic conditions. The result of septic conditions is the formation of hydrogen sulfide, which causes odor and may cause damage to the piping materials. Therefore, maintaining a minimum flow of fresh wastewater is an important consideration when formulating a piping collection system.

b. Design of gravity sewer systems. Design information for gravity sewer systems can be found in Metcalf & Eddy 1991, TM 5-814-1, and WEF MOP-11.

c. Manhole design. Design information for manholes can be found in TM 5-814-1.

d. Materials of construction. Design information and guidance for the selection of materials for sanitary sewer construction can be found in TM 5-814-1.

e. Installation and testing. Design guidelines for sewer system layout and protection of water supplies can be found in TM 5-814-1.

4-5. Force Main Systems

a. General.

(1) Recreational areas may require pumping of wastewater from the point of generation to the point of treatment or disposal. Pumping is necessary when gravity flow is not practical due to topography and/or economic considerations, when there is insufficient head for gravity flow through a treatment system, or when the plant effluent must be lifted into the receiving stream or body of water. More details on general site selection requirements can be found in TM 5-814-2.

(2) There are two types of force main pressure systems: positive pressure and vacuum pressure. Table 4-1 presents a comparison of advantages and disadvantages of the two types of pressure systems.

b. Location. Guidance on location of pumping stations can be found in TM 5-814-2.

Table 4-1
Comparison of Pressure Systems

Positive Pressure Systems		Vacuum Pressure Systems	
Advantages	Disadvantages	Advantages	Disadvantages
Eliminate the need to lay pipe to hydraulic grade lines.	Wastewater pumps are required at every sewage input point to lift the wastewater into the network of collection lines.	Use a central pumping station to maintain vacuum on the main line.	Length of pumping possible due to head limitations.
Eliminate the need for lift stations of a conventional system.	Require electrically operated mechanical equipment at every sewage input point.	Require a normally closed (NC) valve at each point of sewage input.	
Substitute the small-diameter plastic pipe for large diameter pipe.	Solids must be broken up by providing either a grinder pump or other comminution units at each entry point.	Collection lines are small-diameter pipes that can be laid without regard to hydraulic grade lines.	Possible vacuum leaks that render the system inoperable.
Infiltration is eliminated because manholes are not required, thus piping materials are not exposed to groundwater fluctuations.		Reduction in quantity of flushing water needed.	

c. Materials of construction. Design information and guidance for the selection of materials for force main pressure sanitary sewer construction can be found in TM 5-814-1 and TM 5-814-2.

d. Installation and testing. Guidelines for force main pressure sanitary sewer system site selection and building and site requirements can be found in TM 5-814-1 and TM 5-814-2.

e. Pumping equipment. Four basic types of pumps are employed in wastewater collection systems: centrifugal pumps, screw pumps, pneumatic ejector pumps, and grinder pumps. Descriptions and general design specifications for each pump type can be found in TM 5-814-2.

f. Pump selection. Design guidance for pumping systems design and pump selection can be found in TM 5-814-2.

g. Wet well requirements. Guidance for wetwell design can be found in TM 5-814-2.

h. Pump station components. Guidance for pump stations construction and components design can be found in TM 5-814-2.

4-6. Alternative Wastewater Collection Systems

a. System types. As the cost of conventional gravity sewer collection systems sometimes exceeds the cost of wastewater treatment and disposal facilities, it has become necessary to develop alternative sewer collection systems. Current alternatives to conventional gravity collection systems include positive pressure sewer systems, vacuum sewer systems, and small-diameter gravity sewers. Alternative sewer collection systems are applicable to remote or recreational areas. However, the final selection of an alternative wastewater collection system should be based on economic considerations.

b. Examples. Design examples of the three alternative wastewater collection systems can be found in EPA/625/1-91/024.