CE 370

Wastewater Characteristics

Quantity

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Introduction

- The design of a wastewater treatment plant requires knowledge of:
  - Quantity or flowrate of wastewater.
    - Required to determine the size of the various unit operations and unit processes.
  - Quality of raw wastewater.
    - Required to determine which unit operations and processes to be used.
  - Quality required for the effluent (treated wastewater).
    - Required to determine the degree of treatment needed to produce the required quality of the effluent.

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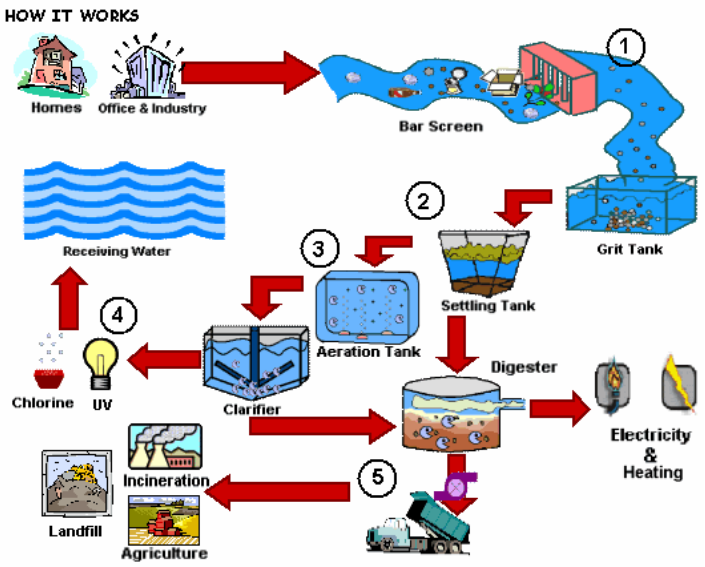

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Wastewater Quantities

- **The sanitary sewer system**
  - The purpose is to receive liquid wastes from the city (buildings, houses institutions, and other entities) and transport them to the treatment plant.
  - The system consists of the collection pipes and appurtenances, such as manholes, pumping stations, and others.
- **Sources (components) of wastewater flow**
  - **Domestic**: discharges from residential, commercial, and institutional facilities.
  - **Industrial**: discharges from different industries.
  - **Infiltration**: groundwater seepage that enters sanitary sewer through cracks in pipe joints and manholes.
  - **Inflow**: water that enters through drains which is relatively unpolluted source of water.
  - **Storm water**: runoff from rain.

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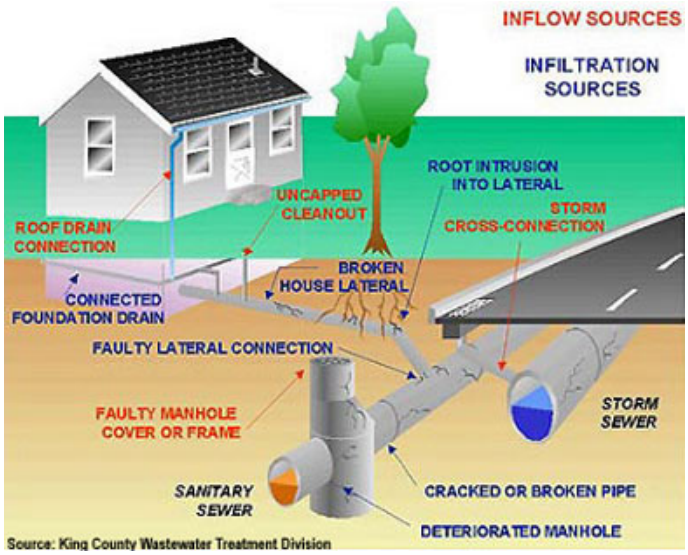
Wastewater Sewer System



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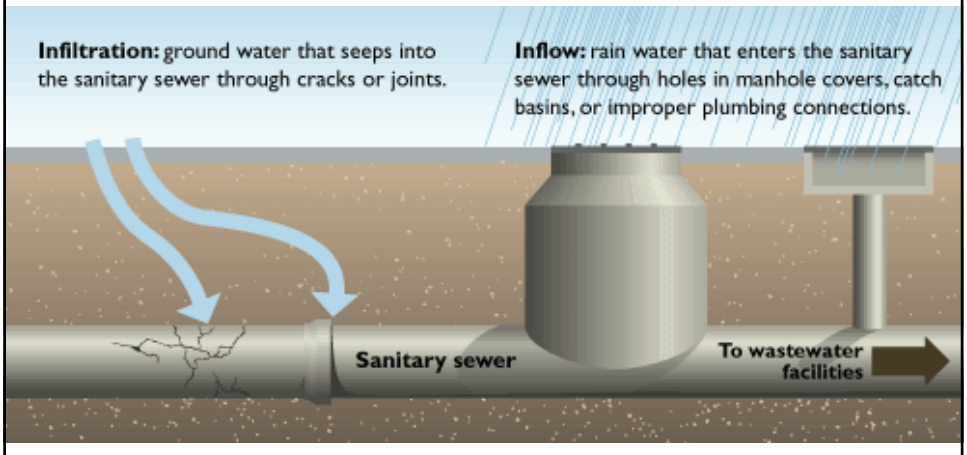
Wastewater Sewer System



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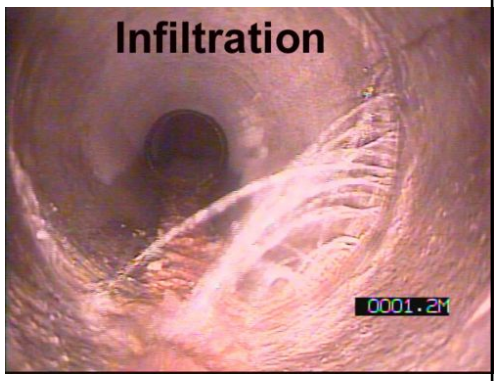
Wastewater Sewer System



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Wastewater Quantities

➢ **Types of sewer systems**

- **Sanitary Sewer**
  - – Carries domestic, industrial, and infiltration/inflow
- **Storm Sewer**
  - – Carries storm water
- **Combined Sewer**
  - – Carries both

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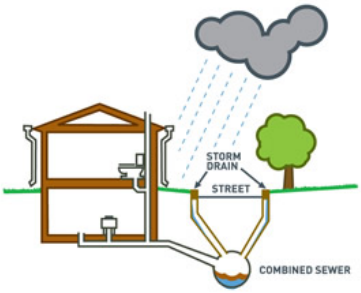
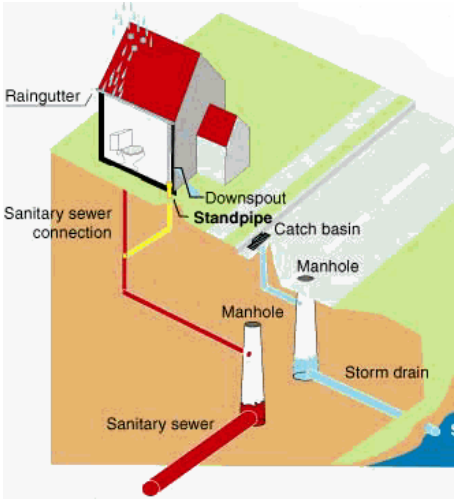
Types of sewer systems





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Wastewater Quantities

➢ **Estimate of wastewater quantities**

- Quantity of wastewater is related to water consumption
- The relationship between water demand and wastewater flow varies from city to city.
- Wastewater flow is usually from 50 to 100% of the water demand (Figure 5.1).
- Accurate wastewater determination comes from past gauging (measurements) records.
- Usually the recommended design flowrate is not less than 100 gal/cap-d (380 *l*/cap-d)

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TABLE 5.1 *Average Annual Wastewater Flows of Selected Cities and Districts in the United States*

CITY OR DISTRICT	AVERAGE ANNUAL WASTEWATER FLOW gal/cap-d	AVERAGE ANNUAL WASTEWATER FLOW ℓ/cap-d	PERCENTAGE OF THE WATER DEMAND
Baltimore, Md.	100	379	63
Berkeley, Calif.	68	257	89
Boston, Mass.	140	530	97
Grand Rapids, Mich.	190	719	84
Greenville, S.C.	150	568	73
Hagerstown, Md.	100	379	100
Jefferson County, Ala.	100	379	98
Johnson County, Kan.	60	227	86
Lancaster County, Neb.	92	348	55
Las Vegas, Nev.	209	791	51
Little Rock, Ark.	50	189	100
Los Angeles, Calif.	85	322	46
Peoria, Ill.	75	284	83
Memphis, Tenn.	100	378	80
Orlando, Fla.	70	265	47
Rapid City, S.D.	121	458	99
Santa Monica, Calif.	92	348	67
Wyoming, Mich.	82	310	56
Averages	100	396	76

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Wastewater Quantities

➢Variation in wastewater flow

- Important in designing the different components of the wastewater collection, treatment, and disposal systems.
- Variation occurs daily, weekly, and monthly.
- Variation differ from city to city depending on many factors such as: Climate, Community size, Economics, and Quality of water supply.
- **Daily variation**: usually, peak flow (maximum flow) occurs around lunchtime, while minimum flow is during nighttime.
- **Weekly variation**: maximum day of the week is usually the first day of the week (Sat) and the minimum is the last day of the week (Fri).
- **Monthly variation**: maximum month is usually during summer and minimum month is during winter.

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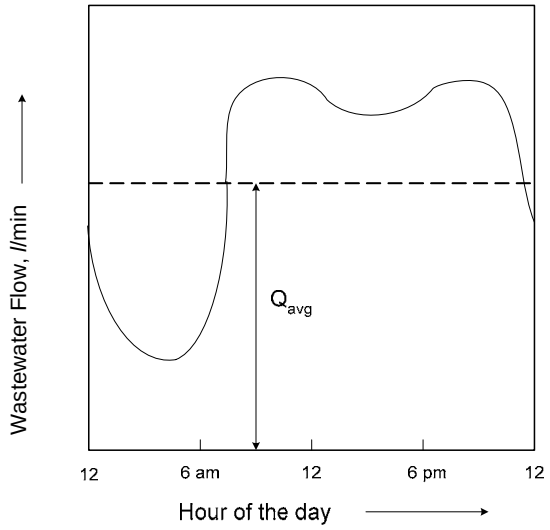
Wastewater_ Daily Variation



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Wastewater Quantities

➢ Calculating flows

- The ratio of the **peak hourly** flow to the average hourly flow for the day is given by the following equation:

$$\frac{Q_P}{Q_A} = \frac{5}{P^{0.2}}$$

Where;

Q_P = peak hourly flow

Q_A = average hourly flow

P = population, thousands

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Wastewater Quantities

➢ Calculating flows

- Infiltration:
  - During dray weather infiltration is low and during wet-weather its high.
  - The amount of infiltration will depend on:
    - the care with which the system is constructed
    - the groundwater height
    - the type of soil
  - From design point of view, it is common to consider the following values for infiltration flow:
    - 71 m^3/km-d, when the system is above groundwater table
    - 142 m^3/km-d, when the system is below groundwater table

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Wastewater Quantities

➢ Calculating flows

- Commercial and Industrial flows
  - Usually estimated based on volume per area per day (gal/acre-day, or *l*/ha-d).
  - Commercial flow varies from city to city and may range from 2,000 to 90,000 gal/acre-day with an average value of 28,200 gal/acre-day.
  - Industrial flows varies from 2,000 to 250,000 gal/acre-day with an average of 49,800 gal/acre-day.

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Wastewater Quantities

➢ **Design flows**

- The minimum flowrate.
  - Important in designing pipes and channels in the wastewater treatment plant.
  - Flow should be designed to prevent suspended solid from deposition in the piping system.
  - The minimum velocity required to keep organic solids in suspension is 1.0 ft/sec (0.3 m/s).
  - The minimum velocity required to keep silt and fine sand in suspension is 2.0 ft/sec (0.6 m/s).

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Wastewater Quantities

➢ **Design flows**

- The design flowrate.
  - Usually assumed to be the average daily flow at the end of the design period of the system.
  - The average daily flow is considered to be the average daily flow for a continuous 12-month period.
  - The design flowrate is used in determining:
    - The organic loading to the treatment plant
    - Sizing the primary, secondary, and tertiary treatment units
    - Sludge treatment and handling facilities

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Wastewater Quantities

➢ Design flows

- The maximum flowrate.
  - Is the peak hourly flowrate plus flow due to infiltration and inflow.
  - The maximum flow is important in determining:
    - The hydraulic capacity of the collection system
    - The hydraulic capacity of the treatment plant.

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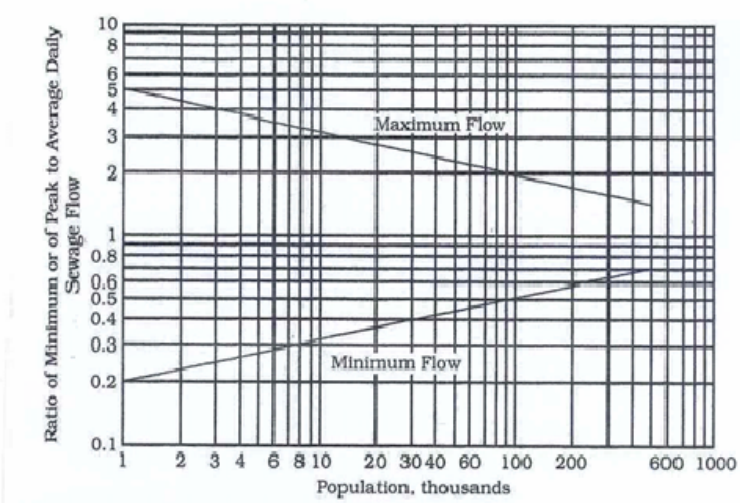

FIGURE 5.3 *Ratio of Extreme Flows to Average Daily Flow for Municipal Wastewaters in Various Areas of the United States*

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