WATER SUPPLY AND WASTE WATER MANAGEMENT

Lecture - 03

Wastewater: *Flows Estimation*

Why we need to Measure Wastewater Flow?

Wastewater: *Flows Estimation*

Why we need to Measure Wastewater Flow?

- Determining the rates of wastewater flow is a fundamental step in the design of wastewater collection, treatment, and disposal facilities.
- In situation where wastewater flow rate data are limited or unavailable, wastewater flow rate estimates have to be developed from water consumption records and other information.

Why we need to Measure Wastewater Flow?

- Estimated residential flow rates need to account for not only averages, but peak flows. Peak flows of short duration may or may not have a deleterious affect, however peak flows that continue for days can include hydraulic failure..

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Why we need to Measure Wastewater Flow?

- To develop a basis for properly assessing wastewater flow rates for a community, the following subjects should be considered.

  - **Definition of the various components that make up the wastewater flow rates.**
  - **Water supply data and its relationship to wastewater flow rates.**
  - **Wastewater sources and flow rates.**
  - **Analysis of flow rate data, and**
  - **Methods of reducing wastewater flow rates.**

COMPONENTS OF WASTEWATER FLOWS

- The components that make up the wastewater flow from a community depend on the type of collection system used and may include the following:

  - Domestic (also called sanitary) wastewater. Wastewater discharged from residences and from commercial, institutional, and similar facilities.
  - Industrial wastewater. Wastewater in which industrial wastes predominate.

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COMPONENTS OF WASTEWATER FLOWS

- Infiltration/Inflow (I/I). Water that enters the sewer system through indirect and direct means.
  - Infiltration is extraneous (not directly connected) water that enters the sewer system through leaking joints, cracks and breaks, or porous walls.
  - Inflow is storm water that enters the sewer system from storm drains connection, roof leaders, or through the manhole covers.
- Storm water. Runoff resulting from rainfall and snowmelt.

COMPONENTS OF WASTEWATER FLOWS

- Therefore, wastewater flows in sanitary sewers consists of three major components:
  (1) domestic wastewater,
  (2) industrial wastewater, and
  (3) infiltration/inflow.

The percentage of wastewater components varies with local conditions and the time of the year.

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ESTIMATING WASTEWATER FLOWRATES FROM WATER SUPPLY DATA

- For areas served with sewers, wastewater flow rates are commonly determined from existing records or by **direct field measurements**.
- For new developments, wastewater flow rates are derived from an analysis of population data and corresponding projected unit rates of water consumption or from estimates of per capita wastewater flow rates from similar communities.

ESTIMATING WASTEWATER FLOWRATES FROM WATER SUPPLY DATA

- If field measurements of wastewater flow rates are not possible and actual wastewater flow rate data are not available, **water supply records** can often be used as an aid to estimate wastewater flow rates.
- Where water supply records are not available, useful data for **various types of establishments and water-using devices** are provided for making estimates of wastewater flow rates.

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Municipal Water Use

- Municipal water use is generally divided into four categories:.
  - Domestic (water used for sanitary and general purposes)
  - Industrial (nondomestic purposes).

Municipal Water Use

- Public service (water used for fire fighting, system maintenance, and municipal landscape irrigation).
- Unaccounted for system losses and leakage.

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Domestic Water Use

- Domestic water use encompasses the water supplied to residential areas, commercial districts, institutional facilities, and recreational facilities, as measured by individual water meters. The uses to which this water is put include drinking, washing, bathing, culinary (referring to cooking), waste removal and yard watering. Most of the water used in Palestinian municipal water supply system is for domestic purposes.
  - **Residential areas**. Water used by residential households consists of water for interior use such as showers and toilets and water for exterior use such as lawn (garden) watering and car washing. Water use for exterior applications varies widely depending upon the geographic location, climate, and time of year and mainly consists of landscape irrigation.

Domestic Water Use

- **Commercial facilities**. The water used by commercial facilities for sanitary purposes will vary widely depending on the type of activity (e.g., an office as compared to a restaurant). For large commercial water-using facilities such as laundries and car washes, careful estimates of actual water use should be made.
- **Institutional facilities**. Water used by facilities such as hospitals, schools, and rest homes is usually based on some measure of the size of the facility and the type of housing function provided (e.g., per student or per bed).
- **Recreational facilities**. Recreational facilities such as swimming pools, camps, and clubs perform a wide rang of functions involving water use.

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Typical distribution of residential interior water

Use	% of Total
Baths	8.9
Dishwashers	3.1
Faucets (taps)	11.7
Showers	21.2
Toilets	28.4
Toilet leakage	5.5
Washing machine	21.2
	100.0

Unaccounted System Losses and Leakage

- Unaccounted system losses include unauthorized use (Black Losses), incorrect meter calibration or readings, and improper meter sizing.
- Leaking is due to system age, materials of construction, and lake of system maintenance.
- Unaccounted system losses and leakage may range from 10 to 12 percentage of production for newer distribution systems (less than 25 years old) and from 15 to 30 percent for older systems.
- In small water systems, unaccounted losses and leakage may account for as much as 50 percent of production.
- As much as 40 to 60 percent of the unaccounted water may be attributed to meter error. Therefore, while water records may be useful in forecasting wastewater flow rates, the accuracy of the records must be checked carefully.

Wastewater: *Flows Estimation*

Estimating Water Consumption From Water Supply Records

- Water records of various types are kept by water supply agencies.
- These records usually include information on the amount of water produced or withdrawn and discharged to the water supply system and the amount of water actually used (consumed).
- The distinction is important because more water is produced than is actually used by the consumer.

Estimating Water Consumption From Water Supply Records

- The difference between these two values is the amount of water lost or unaccounted for in the distribution system plus the amount used for various public services that may be unmetered. Therefore, in using water supply records to estimate wastewater flow rates, it is necessary to determine the amount of water actually used by the customers.
- Unaccounted water and losses do not reach the wastewater system and have to be excluded in making flow estimates.

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Factors Affecting Municipal Water Use

- **Density of development**. The density of development (i.e. single-family housing, condominiums, and apartments) affects both interior and exterior water use. Single-family homes may have more water-using appliances such as washing machines and dishwashers than apartments. Exterior water use for condominiums and apartments is generally much less than single-family homes because of reduced needs for landscape watering.

- **Economics**. The affluence or economic capabilities of a community affects water use (and resulting wastewater flows). As the assessed value of property increases, so does water use and wastewater flow rates.

Factors Affecting Municipal Water Use

- **Dependability and quality of Supply**. A water supply that is dependable and of good quality encourage use by its customers. Supplies that are not dependable in terms of poor pressure and limited quantities during peak or dry periods or that have objectionable taste or mineral content may have lower water use.

- **Water conservation**. For estimating wastewater flow rates from water use, the effect of conservation on interior water use is of particular interest. The effect of the installation of water conserving fixtures on interior water use and resulting wastewater flow rates will be discussed later.

Wastewater: *Flows Estimation*

Proportion of Municipal Water Supply Reaching the Collection System as Wastewater

- Because wastewater consists primarily of used water, the portion of the water supplied that reaches the collection system must be estimated.
- A considerable portion of the water produced does not reach the sanitary sewer system and includes:
  - Product water used by manufacturing establishments,
  - Water used for landscape irrigation, system maintenance, and extinguishing fires,
  - Water used by consumers whose facilities are not connected to sewers, and
  - Leakage from water mains and service pipes (unaccounted for losses).

Proportion of Municipal Water Supply Reaching the Collection System as Wastewater

- About 60 to 85 percent of the per capita consumption of water becomes wastewater .
- Application of appropriate percentages to records from metered water use generally can be used to obtain a reasonable estimate of wastewater flow rates, excluding infiltration/inflow.

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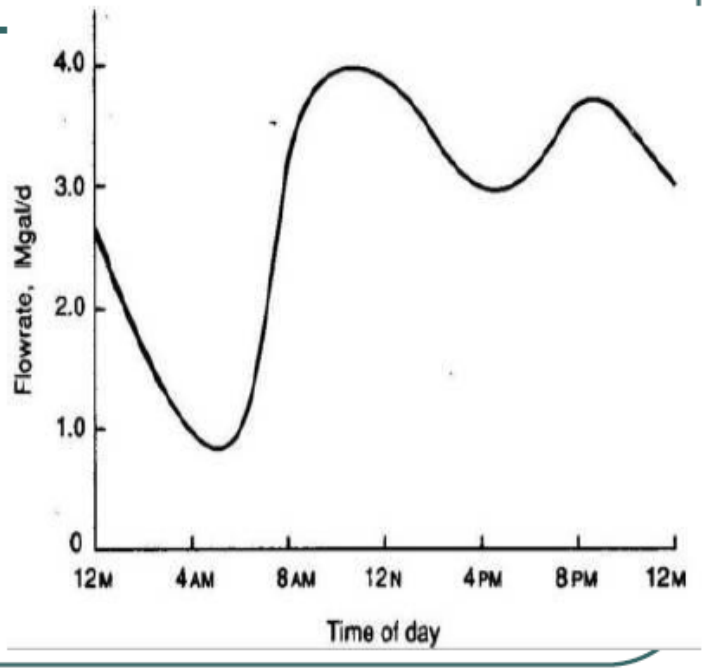
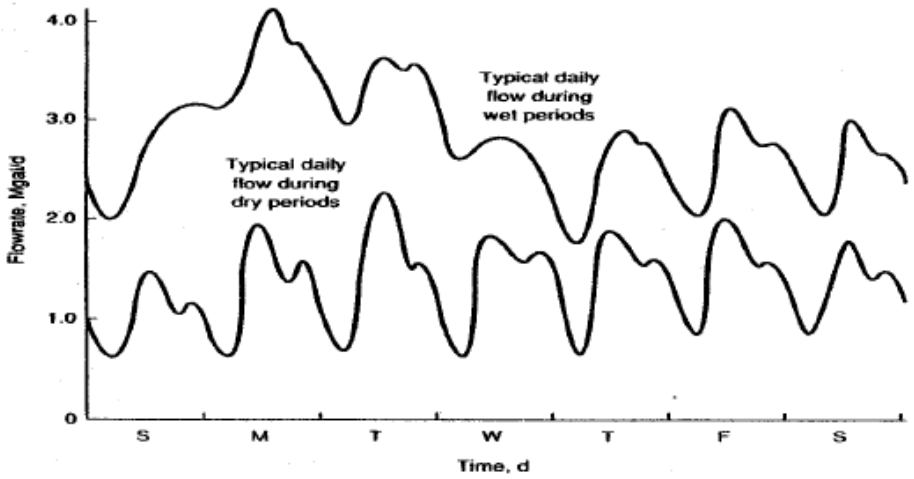
Variation in Wastewater Flow rates

Short-Term Variations

- Minimum flows occur during the early morning hours when water consumption is lowest and when the base flow consists of small quantities of sanitary wastewater.
- The first peak flow generally occurs in the late morning when wastewater from the peak morning water use reaches the treatment plant.
- A second peak flow generally occurs in the early evening, but this varies with the size of the community and the length of the sewers.



Variation in Wastewater Flow rates



Seasonal variations in domestic wastewater flows

Wastewater: *Flows Estimation*

Water Quantity Estimation

The quantity of water required for municipal uses for which the water supply scheme has to be designed requires following data:

1. Water consumption rate *(Per Capita Demand in litres per day per head)*
2. Population to be served.

Quantity= Per capita demand x Population

Water Consumption Rate

It is very difficult to precisely assess the quantity of water demanded by the public, since there are many variable factors affecting water consumption. The various types of water demands, which a city may have, may be broken into following classes:

Water Consumption for Various Purposes:

	Types of Consumption	Normal Range (lit/capita/day)	Average	%
1	Domestic Consumption	65-300	160	35
2	Industrial and Commercial Demand	45-450	135	30
3	Public Uses including Fire Demand	20-90	45	10
4	Losses and Waste	45-150	62	25

Design Periods & Population Forecast

This quantity should be worked out with due provision for the estimated requirements of the future . The future period for which a provision is made in the water supply scheme is known as the **design period**.

Design period is estimated based on the following:

- Useful life of the component, considering obsolescence, wear, tear, etc.
- Expandability aspect.
- Anticipated rate of growth of population, including industrial, commercial developments & migration-immigration.
- Available resources.
- Performance of the system during initial period.

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Example:

A city has a projected population of 60,000 spread over area of 50 hectare. Find the design discharge for the separate sewer line by assuming rate of water supply of 250 LPCD and out of this total supply only 75 % reaches in sewer as wastewater. Make necessary assumption whenever necessary.

Solution:

Given data

Q = 250 lit/capita/day

Sewage flow = 75% of water supply

= 0.75* 250

= 187.5 LPCD

Total sewage generated = 187.5*60000/(24*3600)

= 130.21 lit/sec

= 0.13 m^3/s

Assume peak factor = 2

Total design discharge = 0.26 m^3/s.

THANK YOU