

Chapter-1

Prof. dr. Samir Afifi

Wastewater Flow Rate

Why we need to Measure Wastewater Flow?



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..

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.

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.

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.

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.

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

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- **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 range of functions involving water use.

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

Industrial (Nondomestic) Water Use

- The amount of water supplied by municipal agencies to industries for process (nondomestic)
- Purposes is highly variable. Because industrial water use varies widely,
- It is therefore desirable in practical design work to inspect the plant concerned and to make careful estimates of the quantities of both water used from all sources and the wastes produced.

Public Services and System Maintenance

- Public service water represents the smallest component of municipal water use.
- Public service water uses include water used for public buildings, fire fighting, irrigating public parks and greenbelts, and system maintenance.
 - System maintenance water uses include water for disinfecting new water lines and storage reservoirs, line and hydrant flushing, and hydraulic flushing of sewers.
 - Only small amounts of water used for these purposes reach the sanitary sewer system, except that from public building.

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 lack 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.](#)

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.

Factors Affecting Municipal Water Use

- **Climate.** Climatic effects such as temperature and precipitation can significantly impact consumption. Water use is at its peak when it is hot and dry, due to largely to increased need for exterior use such as landscape irrigation.
- **Community size.** Community size affects not only the average per capita water use but also the peak rate of use. The rate of use fluctuates over a wider range in small communities with higher peak flow (as compared to average use) and lower minimum flows.

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.

Factors Affecting Municipal Water Use

- **Metered services.** Water agencies with metered services usually charge their customers based on the water used. Systems with unmetered services charge customers some form of a flat rate for unlimited water use. Metering the individual consumer's supply and billing at established meter rates indirectly prevents waste of water by users and tends to reduce actual water use.

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.

Proportion of Municipal Water Supply Reaching the Collection System as Wastewater

- In some cases, however, excessive infiltration, roof water, and water used by industries that is obtained from privately owned water supplies make the quantity of wastewater larger than the water consumption from the public supply.
- If a community has well-constructed sewers and if stormwater drainage is excluded and there is no substantial change in the industrial uses of water, the variation from year to year in the ratio of wastewater to water supply will not be great.

RESIDENTIAL AREAS WASTEWATER SOURCES AND FLOWRATES

- For many residential areas, wastewater flow rates are commonly determined on the basis of the population density and the average per capita contribution of wastewater.
- For large residential areas, it is often advisable to develop flow rates on the basis of land use areas and anticipated population densities. Where possible, these rates should be based on actual flow data from selected similar residential areas, preferably in the same locale.
- In the past, the preparation of population projections for use in estimating wastewater flow rates was often the responsibility of the engineer, but today such data usually available from local, regional, and state planning agencies. If the data are not available and the population projections have to be prepared, [population forecasting methodology](#) can be used.

Infiltration into Sewers

- One portion of the rainfall in a given area runs quickly into the storm sewers or other drainage channels; another portion evaporates or is absorbed by vegetation; and the remainder percolates into the ground, becoming groundwater.
- With an increase in the percentage of area in a community that is paved or built over comes:
 - An increase in the percentage of stormwater conducted rapidly to the storm sewers and watercourses;
 - A decrease in the percentage of the stormwater that can percolate into the earth and tend to infiltrate the sanitary sewers.
- The rate and quantity of infiltration on the **length of sewers, the area served, the soil and topographic conditions**, and, to a certain extent, **the population density** (which affects the number and total length of house connections).

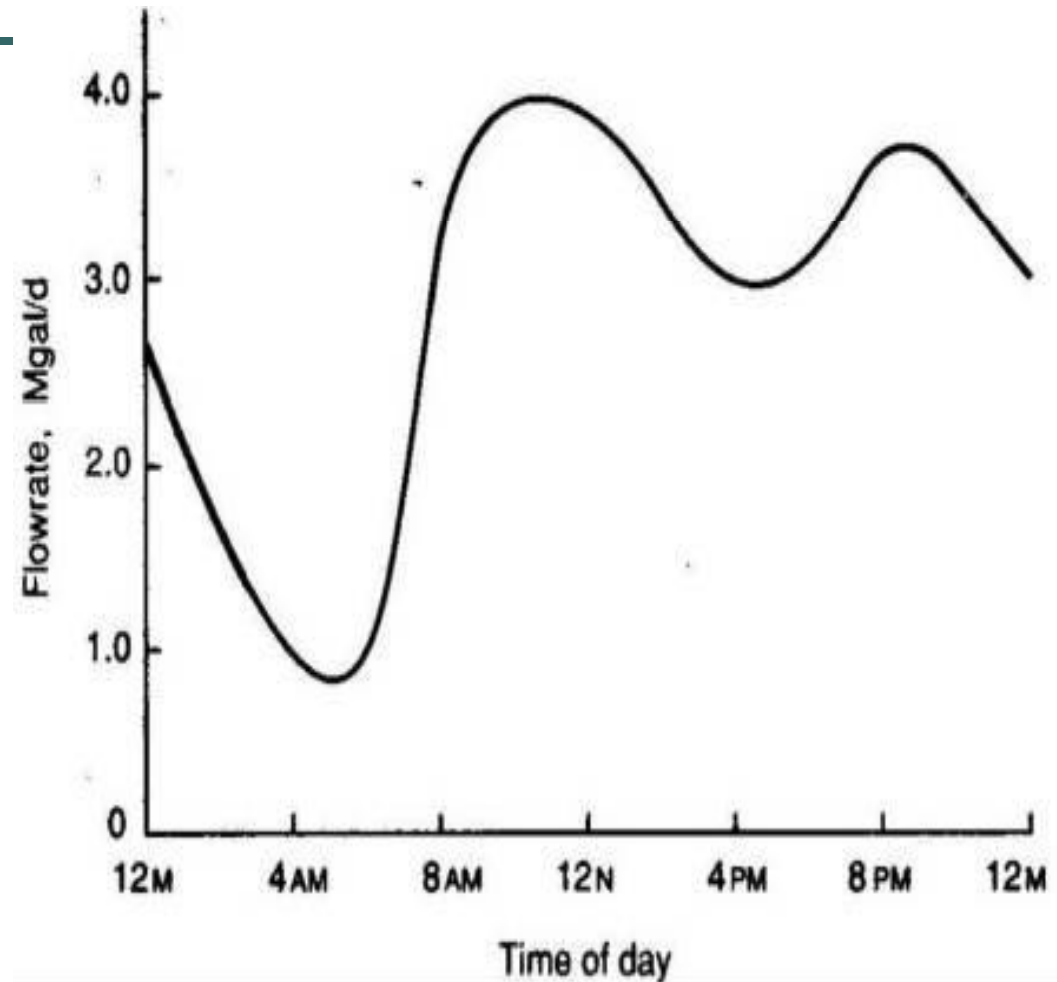


Mixed “Wastewater and Stormwater” flows out of a sewer manhole
(Infiltration into Sewers)

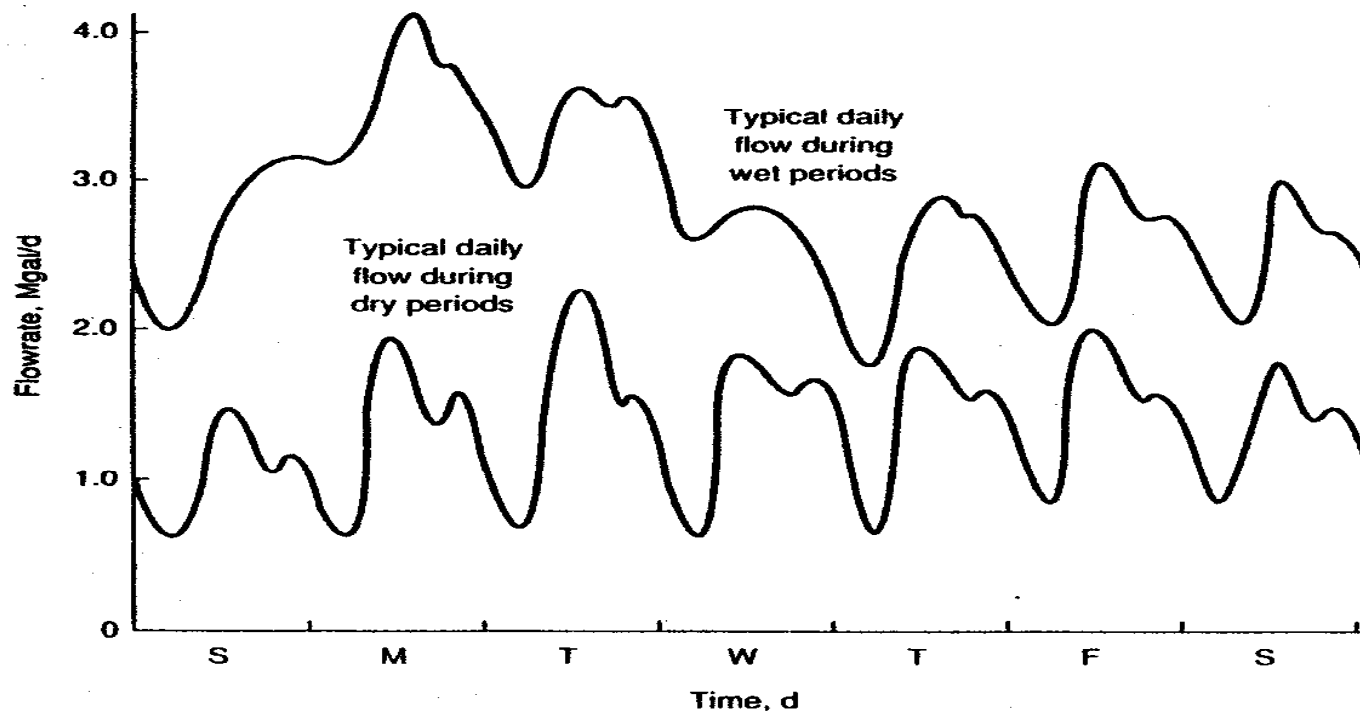
Variation in Wastewater Flow rates

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

MUNICIPAL WATER SUPPLY FOR NABLUS CITY

- Nablus city has been divided into 7 categories of enumeration areas according to the type of building, population density and water consumption so as to figure out where exactly and in which amount the demand is located and who causes this demand.

Name of Category	Description
A	2-storey buildings/villas
B	Up to 7-storey buildings
C	Up to 4-storey buildings
D	7-10 floors, commercial areas
E	Industrial areas
F	Old City
G	Refugee Camps

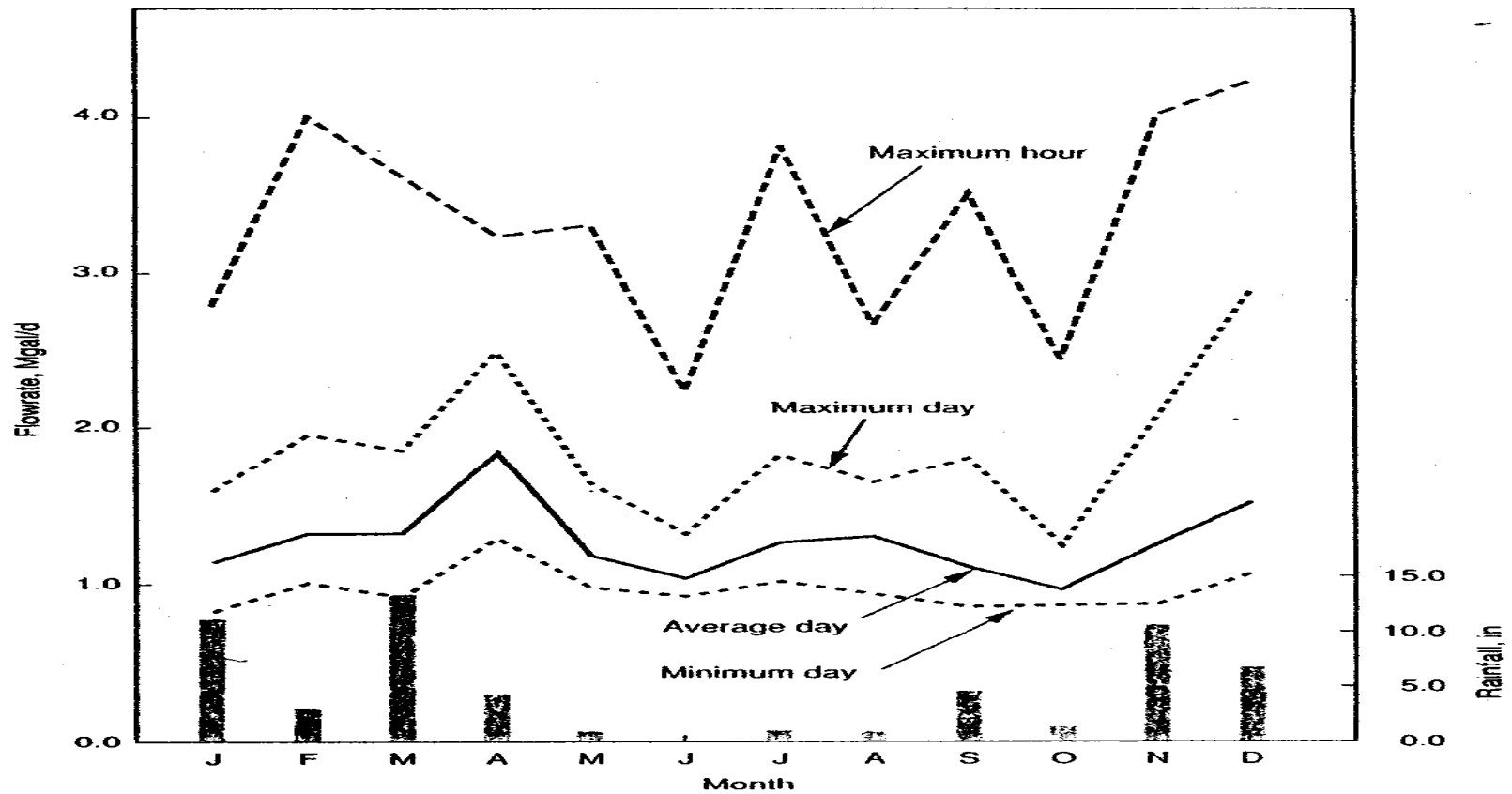
- The present specific demand (LPCD) for each housing/consumer category was estimated considering the evaluation of the metered consumption in Nablus.

Housing type/user category	Domestic Water Consumption (LPCD)	Population/Housing category
A: 2 floors/villa	110	10,291
B: 7 floors	70	74,576
C: 4 floors	70	33,312
D: 7-10 floors commercial	70	3,008
E: Industry	70	2,084
F: Old City	60	11,338
G: Camps	50	27,159
New Extensions	50	4,650
Total Population		166,418
Unaccounted for water (UfW)		35%

ANALYSIS OF WASTEWATER FLOWRATE DATA

- Because the hydraulic design of both collection and treatment facilities is affected by variations in wastewater flow rates, the flowrate characteristics have to be analyzed carefully from existing records.
- Where flow records are kept for treatment plants and pumping stations, at least two years of the most recent data should be analyzed. Long-term records may be analyzed to determine changes or trends in wastewater generation rates. Important information that needs to be obtained through the analysis of wastewater flowrate data include the followings:

ANALYSIS OF WASTEWATER FLOWRATE DATA



ANALYSIS OF WASTEWATER FLOWRATE DATA

- **Average daily flow.** Occurring over a 24-hour period based on annual flow rate. The average daily flowrate is used in evaluating treatment plant capacity and in developing flowrate ratios used in design.
- **Maximum daily flow.** Calculate on over a 24-hour period based on annual operating data. The maximum daily flowrate is important particularly in the design of facilities involving retention time such as equalization basins.
- **Peak hourly flow.** The peak sustained hourly flowrate occurring during a 24-hour period based on annual operating data. Data on peak hourly flows are needed for the design of collection and interceptor sewers, wastewater-pumping stations, wastewater flow meters, sedimentation tanks and channels in the treatment plant.

ANALYSIS OF WASTEWATER FLOWRATE DATA

- **Minimum daily flow:** The flow rate occurs over a 24-hour period based on annual operating data. Minimum flow rates are important in the sizing of the conduits where solids deposition might occur at low flow rates.
- **Minimum hourly flow.** The minimum sustained hourly flow rate occurring over 24-hour period based on annual operating data. Data on the minimum hourly flow rate are needed to determine possible process effects and for sizing of wastewater flow-meters, particularly those that pace chemical-feed systems. At some treatment facilities, such as those using trickling filters, recirculation of effluent is required to sustain the process during low-flow period. For wastewater pumping, minimum flow rates are important to ensure that the pumping systems have adequate turndown to match the low flow rates .

Forecasting Average Flowrates

The development and forecasting of average daily flow rates is necessary to determine the design capacity as well as the hydraulic requirements of the treatment system. Average flow rates need to be developed both for the initial period of operation and for the future (design) period. In determining the design flow rates, elements to be considered are (1) the current base flows; (2) estimated future flows for residential, commercial, institutional and industrial sources; and (3) no excessive infiltration/inflow.

Peaking Factors Developed from Flowrate Data

The most common method of determining peaking factors is from the analysis of flowrate data. Where flowrate records are available, at least two years of data should be analyzed to develop the peak-to-average flowrate factors. These factors may then be applied to estimated future average flow rates, adjusted for any anticipated future spatial conditions.

Peak factors for the various categories of flow should be estimated separately.