SECTION 4

CRITERIA

4-1 GENERAL

Establishing performance standards is an important part of evaluating wastewater collection systems, as it forms the basis for system analysis and system improvement recommendations. These standards include methodology for estimating wastewater design flows and minimum design standards for the collection system pipes, pump stations, and force mains.

Average wastewater flows can be reasonably estimated from land use and their corresponding unit flow factors. The results are then compared to measured flows. Peaking factors are needed for estimating peak dry weather and peak wet weather flows. Peak wet weather flows include an allowance for inflow and infiltration (I/I).

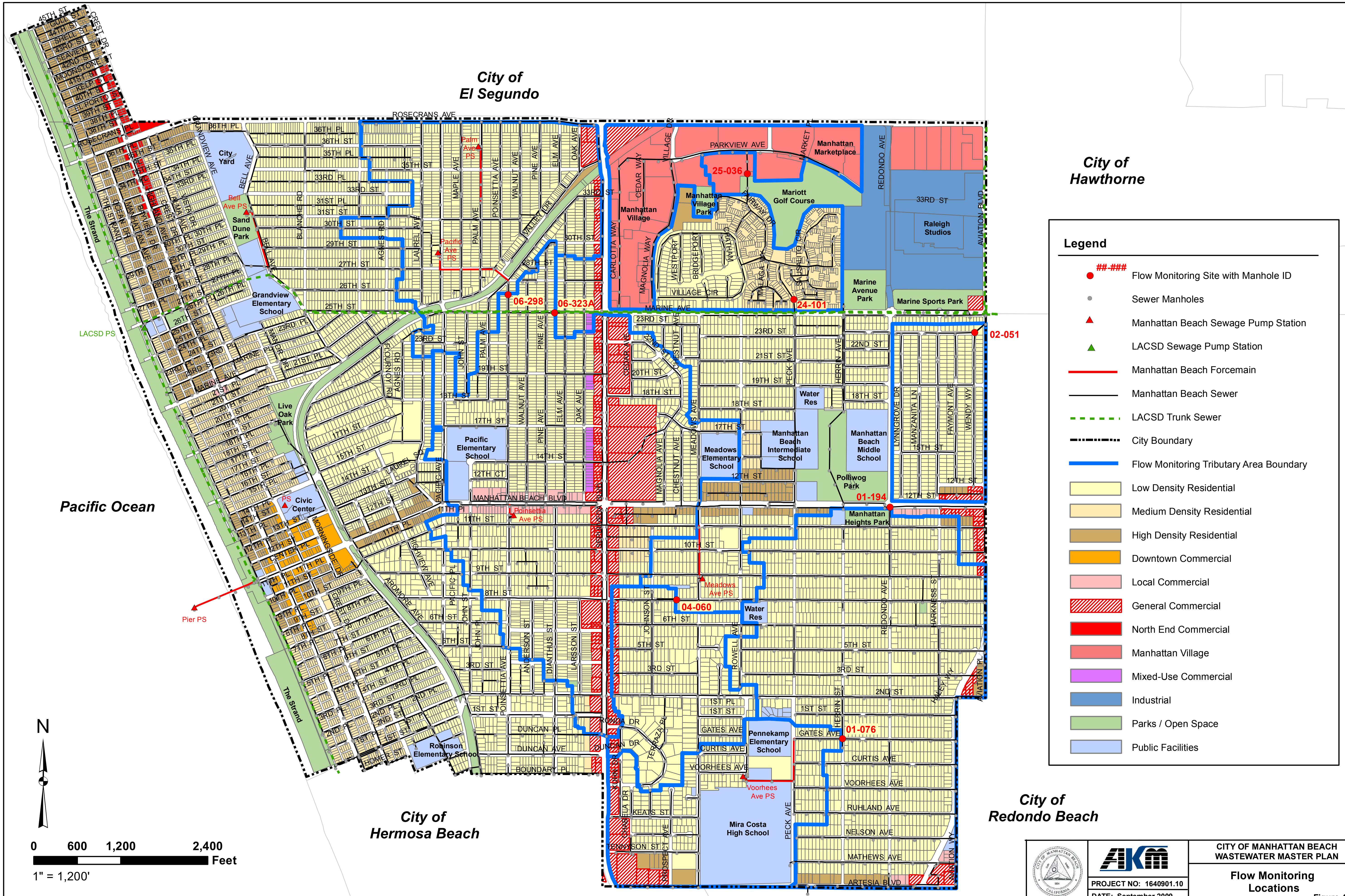
Collection system design standards include minimum pipe size, minimum flow velocity, and depth of flow to pipe diameter ratio (d/D). Pump station criteria include the capacity and number of pumps, wet well and force main sizes, redundancy, emergency power, remote monitoring capabilities, as well as safety and regulatory agency requirements. Finally, facility useful lives are needed for adequately scheduling replacement of the aging infrastructure.

4-2 FLOW MONITORING

Data collection and review is essential in developing unit flow factors, calibrating the system model, and estimating the ultimate average day and peak flows.

A temporary flow monitoring study was conducted by ADS Environmental Services from December 21, 2008 to March 14, 2009 at eight locations. The selected flow monitoring locations and a summary of the results are shown on Figure 4-1 and in Table 4-1. The measured flows are graphically depicted on Figure 4-2. Detailed flow monitoring data can be found in Appendix 1.

The flow monitoring sites were strategically selected to aid in the development of unit flow factors and calibration of the model. Sites were selected in an attempt to get a good sampling of data across the study area. At the same time, the areas tributary to each site must generate depths of flow large enough to develop accurate wastewater flows.

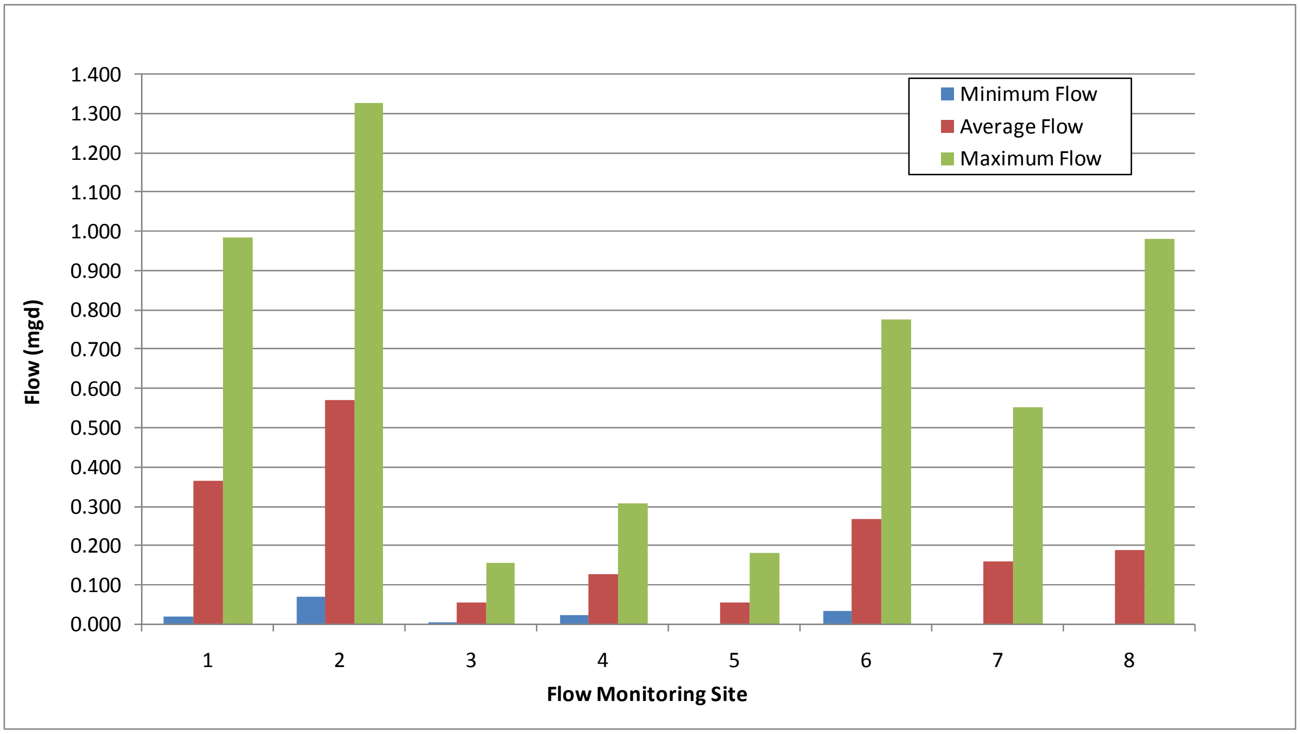


City of El Segundo
City of Hawthorne
Pacific Ocean
City of Hermosa Beach
City of Redondo Beach
25-036
24-101
06-298
06-323A
02-051
01-194
04-060
01-076
Legend
##-### Flow Monitoring Site with Manhole ID
Sewer Manholes
Manhattan Beach Sewage Pump Station
LACSD Sewage Pump Station
Manhattan Beach Forcemain
Manhattan Beach Sewer
LACSD Trunk Sewer
City Boundary
Flow Monitoring Tributary Area Boundary
Low Density Residential
Medium Density Residential
High Density Residential
Downtown Commercial
Local Commercial
General Commercial
North End Commercial
Manhattan Village
Mixed-Use Commercial
Industrial
Parks / Open Space
Public Facilities
N
0 600 1,200 2,400 Feet
1" = 1,200'
PROJECT NO: 1640901.10
DATE: September 2009
CITY OF MANHATTAN BEACH
WASTEWATER MASTER PLAN
Flow Monitoring Locations
Figure 4-1

Table 4-1
Flow Monitoring Results

Site ID	Pipe ID	Manhole ID	Location	Pipe Size (in)	Reason	Gross Area (Ac)	Depth (in)			Velocity (ft/s)			Flow (mgd)		
							Min	Ave	Max	Min	Ave	Max	Min	Ave	Max
1	01194-01195	01-194	Redondo Ave and Manhattan Beach Blvd	18	Unit Flow Factor	422	1.8	3.9	5.9	0.3	1.9	3.4	0.017	0.367	0.987
2	06311-06323A	06-323A	Marine Ave between Pine Ave and Elm Ave	18	Calibration	516	1.9	4.7	7.2	0.9	2.2	3.3	0.071	0.572	1.329
3	04059-04060	04-060	8th St between Johnson St and Meadows Ave	12	Unit Flow Factor	92	1.1	2.2	3.5	0.2	0.8	1.3	0.006	0.057	0.159
4	25035-25036	25-036	On the easement west of Parkview Ave, between Park Way and Village Dr	12	Unit Flow Factor	86	1.3	2.4	3.9	0.8	1.7	3.1	0.024	0.128	0.308
5	02051-02052	02-051	On the easement between intersection of Wendy Way & 23rd St and Aviation Blvd	8	Unit Flow Factor	70	0.2	2.3	4.1	0.3	0.9	1.8	0.001	0.057	0.182
6	24100-24101	24-101	Marine Ave and Gateway Dr	15	Unit Flow Factor	81	1.6	3.4	5.7	0.5	1.9	3.1	0.033	0.270	0.777
7	01073-01076	01-076	Gates Ave and Herrin St	8	D/S of Voorhees PS Forcemain & Unit Flow Factor	118	0.4	2.8	5.9	0.1	1.9	4.6	0.001	0.163	0.553
8	06297-06298	06-298	Poinsettia Ave and Marine Ave; downstrem of Pacific Pump Station	8	D/S of Pacific PS Forcemain & Unit Flow Factor	172	0.2	1.3	3.2	1.1	5.9	11.6	0.002	0.190	0.982

Figure 4-2
Measured Flow Data



4-3 UNIT FLOW FACTORS

Unit flow factors utilized in this study were developed based upon the existing land uses obtained from the City's GIS, and results of the flow monitoring studies discussed in Sub-section 4-2. Water use records, aerial photographs and field reviews supplemented this information.

The average daily flow recorded at each flow monitoring site was utilized in determining calibrated existing unit flow factors for each land use, which are shown in Table 4-2. The flow factors were developed in units of gallons per day per acre.

Table 4-2
Unit Flow Factors

Land Use Description		Unit Flow Factor (gpd/ac)
Downtown Commercial	DC	1,500
General Commercial	GC	1,500
High Density Residential - District 1 & 2	HDR	3,000
High Density Residential - District 3 & 4	HDR3	4,200
Industrial	IND	2,000
Local Commercial	LC	1,500
Low Density Residential - District 1	LDR1	1,100
Low Density Residential - District 2	LDR2	1,400
Low Density Residential - District 3	LDR3	3,800
Medium Density Residential - District 1	MDR1	1,400
Medium Density Residential - District 2	MDR2	1,600
Medium Density Residential - District 3	MDR3	4,000
Mixed-Use Commercial	MUC	1,500
Manhattan Village	MV	1,600
North End Commercial	NEC	1,500
Parks/Open Space	OS	200
Public Facilities	PF	1,200

4-4 PEAKING FACTORS

Peak Dry Weather

The wastewater unit flow factors discussed in Sub-section 4-3 are used to generate average dry weather flows (ADWF) entering the collection system. However, the adequacy of a sewage collection system is based upon its ability to convey the peak flows. At any point in the system, peak dry weather flow (PDWF) is estimated by converting the total average flow upstream of the point in question to peak dry weather flow by an empirical peak-to-average relationship.

The peaking formula commonly used in sewerage studies is of the following form:

$$PDWF = a \times ADWF^{b}$$

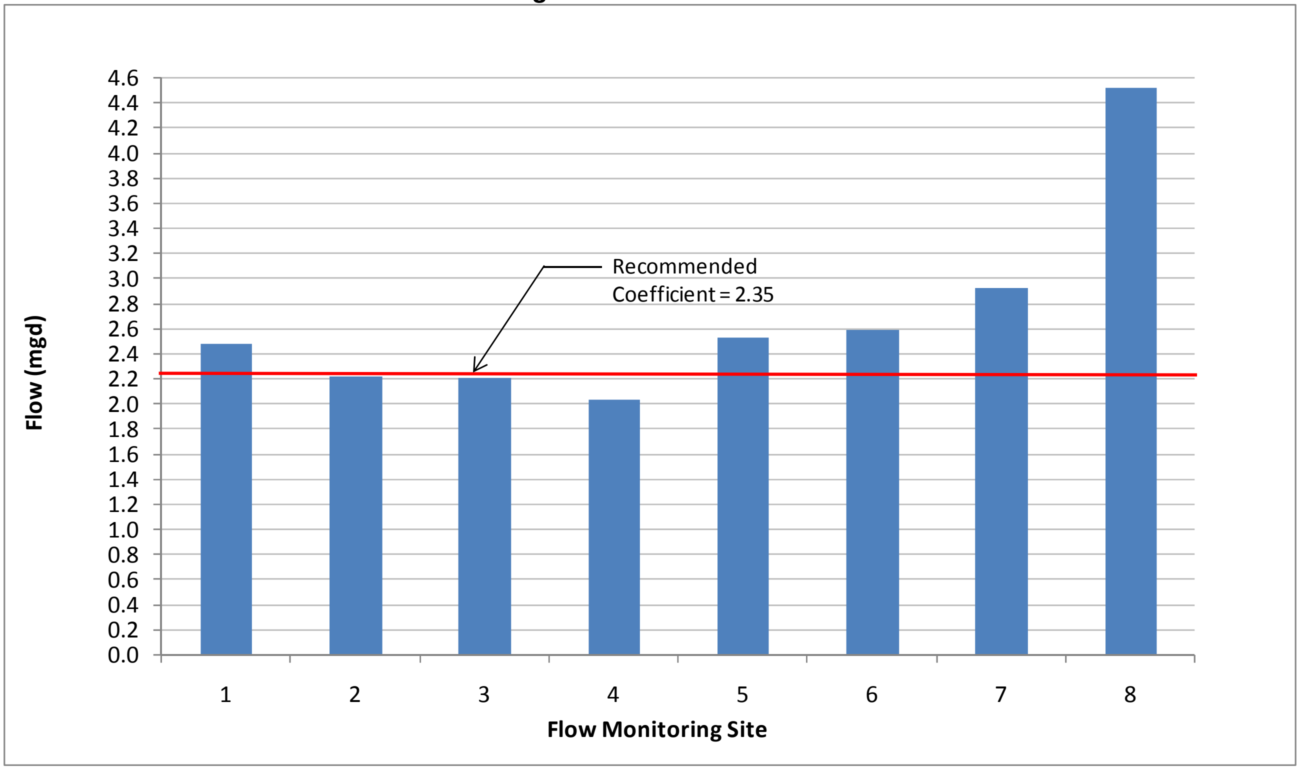
where PDWF = Peak Dry Weather Flow
ADWF = Average Dry Weather Flow
a, b = Peaking Formula Coefficients

The temporary flow monitoring data was reviewed to develop peaking relationships at each site. As expected, these relationships varied from site to site depending upon the makeup and size of the tributary land use. Coefficient “b” is typically found to be in the range of 0.91 to 0.92 based on empirical studies. Using a coefficient “b” of 0.92, the resulting coefficient “a” can be calculated from the measured flow data. The calculated coefficient “a” for each flow monitoring site is shown graphically on Figure 4-3.

The following peaking relationship was selected for this study:

$$PDWF\ (mgd) = 2.35 \times ADWF\ (mgd)^{0.92}$$

Figure 4-3
Peaking Formula Coefficient "a"



It should be noted that Site 7 and Site 8 were located downstream of a sewer pump station force main discharge location. The peaking coefficients are believed to be unusually high and were therefore not incorporated into the development of the recommended coefficient.

Peak Wet Weather

The peak wet weather flow (PWWF) has two components: peak dry weather flow (PDWF) and rainfall dependent inflow/infiltration (I/I) as expressed by the following equation:

PWWF = PDWF + I/I

Inflow and infiltration is discussed further in Sub-section 4-5.

Although the flow monitoring effort for this study covered the normal wet weather period, significant precipitation did not occur to develop what would be considered peak wet weather flows. Until wet weather flow data can be collected, it is recommended that the peak wet weather flow be estimated as the following:

Peak Wet Weather Flow (PWWF) = 1.35 x Peak Dry Weather Flow (PDWF)

Although the PWWF/PDWF factor of 1.35 may not cover all situations, it is not reasonable or feasible to design the sewer system to carry the flows that would result from the use of a larger ratio. Instead, it is recommended that the City concentrate on projects such as replacing manhole covers, installing plugs in manhole covers, and replacing or relining cracked pipes to reduce inflow and infiltration.

4-5 INFLOW AND INFILTRATION

Inflow is the surface water that typically gains entry to the sewer system through perforated or unsealed manhole covers during rainfall events. Infiltration is defined as water entering the collection system from the ground through defective pipes, pipe joint connections, or manhole walls. The sewer system design capacity must include allowances for these extraneous flow components, which inevitably become a part of the total flow. The amount of inflow and infiltration (I/I) that enters the system typically depends upon the availability, adequacy, and location of the storm water drainage facilities; age and condition of structures; materials and methods of construction; the location of the groundwater table; and the characteristics of the soil. In the absence of flow monitoring data, many regulating agencies utilize commonly accepted practices for estimating I/I. For example, I/I is often estimated based on the diameter and length of pipeline (100 to 400 gpd/ in. dia/ mile) or as a percentage of the peak flow or pipeline capacity.

AKM's experience from other master planning studies and review of limited flow monitoring information available during severe rainfall events indicate that the peak wet weather flow can vary from 110 percent of peak dry weather flows in steeper areas with adequate drainage facilities, to over 200 percent of peak dry weather flows in flat areas that lack significant drainage facilities.

For this study, extraneous flow due to inflow and infiltration is included in the peak wet weather flow formula described in Subsection 4-4. If better data becomes available subsequently for specific areas, the analysis should be updated based upon that information.

4-6 SEWER DESIGN CRITERIA

Design criteria are established to ensure that the wastewater collection system can operate effectively under all flow conditions. Each pipe segment must be capable of carrying peak wet weather flows in the hydraulically stable zone of the pipe. Low flows must be conveyed at a velocity that will prevent solids from settling and blocking the system.

The design capacity of a gravity pipeline is the calculated capacity of the pipeline based on the Manning formula:

$$\mathbf{Q = 1.486\ A\ R^{2/3}\ S^{1/2} / n}$$

where, **Q** = flow in cubic feet per second
R = hydraulic radius in feet = A / P
A = cross-sectional area of flow in the pipe in square feet
P = wetted perimeter in feet
S = slope of pipe in feet of rise per foot of length
n = Manning's friction factor

Sewer system capacity is established using a Manning's friction factor of 0.013 for vitrified clay pipe.

The design and analysis of sewer pipes is typically based upon the depth to diameter ratio (d/D). In this study, **existing** pipes are considered capacity deficient if the d/D is above 0.64 at peak dry weather flows. This d/D ratio was arrived at by taking 75 percent of a pipe's maximum stable flow capacity, which is at a d/D of 0.82. The area above a d/D of 0.82 is considered hydraulically unstable. This provides capacity for 25 percent of peak dry weather flow for inflow and infiltration. Calculated capacity deficiencies should be verified through flow monitoring prior to replacing facilities.

The extra pipeline capacity allows for the possibility that actual wastewater flows may be slightly higher than anticipated, especially during the hours when instantaneous or intermittent peaks may occur. These peaks are generally observed between the hours of 6:00 a.m. and 9:00 a.m. and 7:00 p.m. and 9:00 p.m. during weekdays and somewhat later in the morning hours during weekends in the predominantly residential areas. They may also be observed during rainfall events due to inflow and infiltration. Additionally, the area above the water surface helps to keep the sewage aerated, reducing the possibility of septic conditions and odors.

For **new construction**, the design and analysis of gravity sewer pipes should be based on the following depth to diameter ratios:

- Pipes **12-inches and smaller** in diameter shall be designed to flow at a maximum **d/D of 0.50** under peak dry weather flows
- Pipes **15-inches and greater** in diameter shall be designed to flow at a maximum **d/D of 0.64** under peak dry weather flows
- For either group, the depth of flow to diameter ratio shall not exceed 0.82 with peak wet weather flows

At a minimum, all pipes should be 8 inches or larger in diameter and the velocity of flow in the pipe should be greater than 2 feet per second at average dry weather flow (ADWF). This velocity will prevent deposition of solids in the sewer and help to resuspend any materials that may have already settled in the pipe. The minimum corresponding slopes for various pipe sizes are shown in Table 4-3.

Table 4-3
Minimum Sewer Sizes

Sewer Size	2 ft/s Velocity Slope
8"	0.0057
10"	0.0042
12"	0.0033
15"	0.0019
18"	0.0014
21"	0.0011
24"	0.0008
27"	0.0008
30"	0.0007
33"	0.0006
36" & larger	0.0005

It is important to note that the slopes listed above assume the depth of flow in the pipe is 50 or 64 percent full. If there is insufficient flow to create this condition, greater slopes than those shown may be required.

The peak flow velocity should be less than 10 feet per second in vitrified clay pipe and 5 feet per second in poly vinyl chloride (PVC) pipe.

4-7 PUMP STATION DESIGN CRITERIA

It is desirable to develop a sewer collection system with as few pump stations as possible due to the associated cost and maintenance required. Pump stations must be designed to be reliable, and sized with sufficient capacity. They must contain redundant equipment, an emergency power supply, bypass pumping capability, sufficient wet well storage, and be able to notify the appropriate personnel in the event of failure.

The primary components of a typical pump station are the wet well, motors, valves, dry well, pumps, ventilation, electrical, controls and the force main. The following general criteria are recommended.

The wet well stores the incoming wastewater until a pump is activated to discharge it to a gravity facility for further conveyance. It should be designed with sufficient capacity to prevent short cycles whereby the pumps frequently start and stop, yet small enough that it will regularly evacuate sewage from the wet well to prevent the wastewater from becoming septic. Generally, the desired number of pump cycles should be limited to no more that 6 per hour for motors up to 10 horsepower. Motors up to 75 horsepower should start no more than 4 times per hour. Larger motors should cycle less frequently. Pump stations should also have sufficient volume to store sewage in the event of mechanical or electrical failures, until the City can respond to the failure and prevent overflows. The necessary emergency storage is dependent upon how rapidly the City can respond to a failure and mitigate it. A minimum emergency storage of 30 minutes at peak wet weather flow should be provided.

The pumps should be sized to efficiently handle the peak wet weather flows. A minimum of two pumps sized at the peak wet weather flow to the station should be provided so that sufficient standby capacity is available when one pump is removed for repairs or experiences a mechanical failure. The pumps should be able to pass a minimum solid size of 3 inches without clogging. The shafts, seals and impellers should be constructed of wear resistant material to provide long life. Tungsten Carbide seals, Ni-Hard impellers, and 316 stainless steel pump shafts are recommended. For services where aggressive agents may be found in the sewage, such as at golf courses, complete stainless steel construction is recommended. This includes the pump bowl, shaft, impeller, and motor housing.

The dry well houses the valves, pumps, motors and electrical equipment and controls. It must be well ventilated and provide unobstructed access to all equipment. A minimum 3-foot clearance from all obstructions should be provided. Greater clearances may be required for equipment with special maintenance needs. Provisions for equipment removal including hatches, large door openings, and hoists should also be provided.

The force mains should be selected to operate within a 3 feet per second to 5 feet per second velocity range, but should not be smaller than 4-inches in diameter.

While submersible pump stations may be utilized for the small flows, the larger pump stations should be the wet well/dry well type. They should be designed with easy access to all equipment. The National Electric Code classifies the wet wells of wastewater pumping stations as Class I, Group D, Division 1 facilities if ventilated at less than 12 air changes per hour, and Division 2 if continuously ventilated at 12 or more air changes per hour. Dry wells, which are physically separated from wet wells, if ventilated at less than 12 air changes per hour, are classified as Class I, Group D, Division 2 locations. Wet wells, and under certain circumstances dry wells, are considered confined spaces and should be entered in accordance with the corresponding requirements of Occupational Safety and Health Administration (OSHA).

All pump stations should incorporate redundant control systems for operation of the pumps. A float system should be used as a backup for a primary control system that utilizes an ultrasonic device or a bubbler system for level measurement and pump operation.

Telemetry equipment which includes a telephone dialer as a minimum, must be provided at all sewer pump stations. When an alarm or failed condition occurs, the dialer calls pre-programmed telephone numbers in sequence until the call is acknowledged, indicating response will be provided by City staff. If the alarm or failed condition is not corrected within a set time, the dialer will call the pre-programmed numbers again. The dialer can also be used to remotely check the status of the station if desired. A summary of sewer system design criteria is listed in Table 4-4.

Table 4-4
Sewer System Criteria

Collection System	
Minimum Pipe Size	8-inch
Minimum Velocity	2.0 ft/sec at average flow 3.0 ft/sec at peak dry weather flow
Pipe Depth to Diameter Ratio for *Existing Pipes*	0.64 for all pipe sizes at peak dry weather flow 0.82 for all pipe sizes at peak wet weather flow
Pipe Depth to Diameter Ratio for *New Construction*	0.50 for pipes 12-inches and smaller at peak dry weather flow 0.64 for pipes 15-inches and larger at peak dry weather flow 0.82 for all pipe sizes at peak wet weather flow
Pump Stations	
Pumps	▪ Minimum 2 each sized at peak wet weather flow ▪ Minimum solids handling capacity 3"
Wet Wells	▪ Sized to limit pump cycling to less than 4 to 6 times/hr ▪ Provide sufficient storage at peak wet weather flow to allow response to a failure ▪ Equipment to be maintained must be accessible without entering structure
Ventilation	▪ 12 -air changes/hour minimum in dry well and as required by NFPA 820 ▪ 30-air changes/hour minimum in wet well if not operated continuously ▪ 12-air changes/hour minimum in wet well if operated continuously
Controls	Redundant system. Float operated back-up controls.
Emergency Power	Stationary source with automatic transfer switch
Telemetry	Dialer system at all pump stations to alert personnel in the event of a station failure.
Force Mains	▪ Minimum velocity 3.0 ft/sec, maximum velocity 5 ft/sec. ▪ Minimum size 4" ▪ Air/Vacs installed in vaults ▪ Plumb Air/Vac piping back to wet well to avoid discharges of raw sewage to vaults

4-8 SERVICE LIFE OF PIPE AND LIFT STATION EQUIPMENT

In addition to the design criteria discussed in previous sections, the useful lives for which one can expect relatively trouble-free service is also of great importance when assessing an existing or future sewer system. Once the service life of a facility is exceeded, it becomes subject to failure and is often expensive to maintain. The determination of useful life can be difficult and depends on many different considerations including the following:

- Type of materials used and recorded performance of similar installations
- Velocities and flow rates expected in the system
- Chemical and biological conditions of the wastewater
- Construction methods and installation

The values listed in Table 4-5 are generally accepted as prudent planning criteria and are used as benchmarks for replacement recommendations in this study.

Table 4-5
Planning Criteria for Facility Useful Life

Facility	Description	Useful Life (Years)
Gravity Sewers:	Cast Iron Pipe (CIP)	20
	Plastic Pipe	65
	Vitrified Clay Pipe (VCP)	75
Force Mains:	Asbestos-Cement Pipe (ACP)	40
	Ductile Iron Pipe (DIP)	40
	Plastic Pipe	30
Pump Stations:	Structure	60
	Piping	30
	Valving	20
	Mechanical	15
	Electrical	15

4-9 CRITERIA FOR SPECIFIC PLANS AND DEVELOPMENT SUBAREAS

Each party wishing to pursue development of a tract or area within the City's study area shall develop a Sub-Area Master Plan (SAMP). The developer's plans for providing adequate sewer service to all users within the proposed development, how the local sewer system will connect to the backbone and regional system, and the impact of the proposed development to the downstream facilities (starting at the local system and extending to the regional system) shall be fully described in the SAMP. The local sub-area sewers shall meet the sewer design criteria provided in this document and the City Standard Drawings for Sewer Construction. At a minimum, sewage flow calculations shall be based upon the unit flow factors described in Section 4-3, or higher factors if specific conditions require it. A typical Sub-Area Sewer Master Plan Report shall include, but not be limited to the following:

- Map showing project boundaries and drainage areas
- Detailed land use description and map
- Average dry weather, peak dry weather, and peak wet weather flow calculations
- Exhibit showing all proposed sewer facilities and connections to the downstream regional system
- Phasing of development and wastewater flows
- Hydraulic calculations for phased and fully developed ultimate conditions, from the development to the regional system, meeting all sewer design criteria