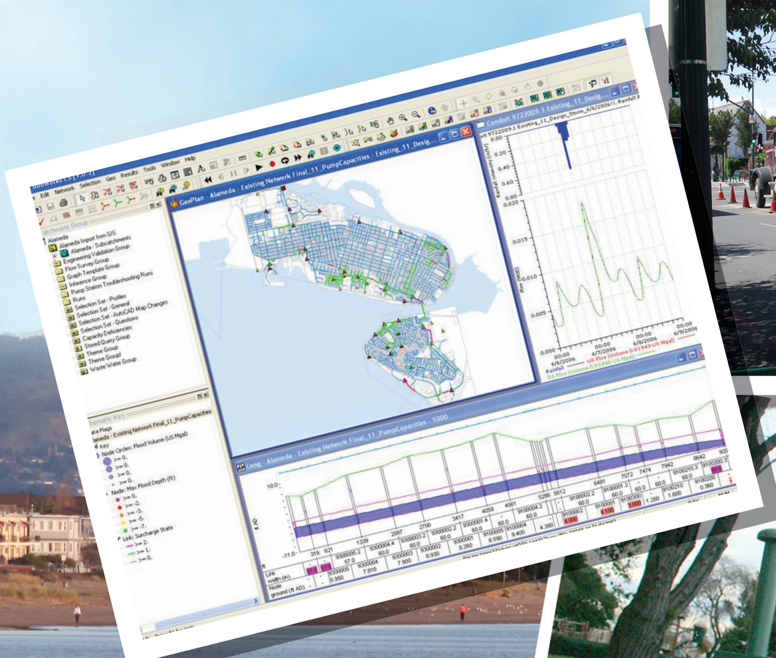
Chapter Three
Capacity Assessment



Chapter 3 Capacity Assessment

This chapter documents the development of the hydraulic model that was used to assess the capacity of the City's sewer system and presents the results of the capacity assessment. The chapter provides an overview of the model development process, including description of the modeled sewer network and the land use and flow monitoring data used as the basis for estimating wastewater flows and calibrating the model. The chapter also documents the criteria on which the capacity assessment was based and presents the model results and required capacity improvements. A discussion of the future Alameda Point sewer system is also provided.

The modeling utilized InfoWorks™ CS, a fully dynamic hydraulic modeling software supported by a GIS-based modeling interface. The model was originally developed as part of the *Sanitary Sewer System Hydraulic Analysis* completed by RMC for the City in 2010. For this study, the model was updated based on the City's latest sewer GIS and pump station data, and the model "loads" were updated based on current assessor parcel information and projections of future development and redevelopment.

3.1 Modeling Terminology

Key modeling terminology applicable to Alameda's model is defined below.

- **Network** refers to the representation of the physical facilities being modeled. Modeled network components include pipes, manholes, and other control structures such as diversion weirs.
- **Nodes** are primarily manholes and other sewer structures such as mainline cleanouts and pump station wet wells, but also include pipe junctions without structures and model "outfalls" (discharge points from the modeled system). Key data associated with nodes are manhole ground elevations and, for pump stations, wet well bottom elevation and cross-sectional area.
- **Links** are connections between nodes, including pipeline conduits (gravity sewers and force mains). Weirs and pumps are also represented as links in the model. Key data associated with pipes are upstream and downstream node IDs, pipe length, diameter, roughness factor, and upstream and downstream invert elevations. Data required for weirs include width, elevation, and weir coefficient. Pump data include pump type and maximum discharge rates, head-discharge curves if applicable, and pump on/off settings.
- **Subcatchments** (also called sewersheds) are areas that contribute flow to the modeled sewer network. Data associated with subcatchments include sanitary flow (computed based on population, land use, or other available data), type of diurnal sanitary flow profile (which is a function of land use), infiltration/inflow (I/I) parameters, and the node or pipe at which the flow from the subcatchment enters the modeled system.
- **Model loads** are the flows entering the modeled sewer system from each subcatchment. Model loads include residential and commercial sanitary or base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall-dependent I/I (RDI/I). As a sum, they represent the total wastewater flow applied to the model.
- **Models** are the combination of a modeled network, its associated subcatchments and loads, and other data (e.g., rainfall, diurnal profiles, hydraulic boundary conditions, inflows from other areas, etc.) that comprise a specific model scenario.

3.2 Modeled System

The Alameda modeled network consists of the entire existing sewer system (with some exceptions as noted below), including the EBMUD interceptors located within the City and some private sewers that are included in the City's GIS. Some short, upstream terminal pipes (including a number of them that represent lower laterals included in the City's GIS) and sewers located upstream of unmodeled pump stations are not included in the model, nor is the existing system serving Alameda Point. (A model of the future Alameda Point system has been developed separately, as discussed later in this chapter.) The model includes 27 of the 31 City-owned pump stations (not including those at Alameda Point). In total, the network includes about 148 miles of pipelines (123 miles or about 97 percent of the City-owned sewers, 8.7 miles of EBMUD interceptor pipes, and 16.3 miles of private sewers). The network has two model outfalls at the discharge points to the EBMUD Alameda siphons at the Alameda terminus of the Posey Tube. One outfall is the inlet to the original double-barrel siphons, and the second outfall is the inlet to the third siphon that was constructed in 2000 when flows from the Alameda NAS were re-routed to the siphons. The model network is shown in **Figure 3-1**.

Although EBMUD interceptor facilities have been included in the Alameda's hydraulic model, the performance of those facilities were not assessed for this study. The purpose of including EBMUD facilities in the model is to provide a single, hydraulically connected system, since the interceptor essentially serves as the "backbone" of Alameda's sewer system. Furthermore, most of the flow meters used for model calibration, as discussed later in this chapter, were located on the EBMUD interceptors.

3.2.1 Network Data and Data Validation

The data used to define the model network and associated attributes were derived primarily from the City's GIS. The GIS includes the locations of sewer manholes and sewer mains; manhole IDs and rim elevations; and pipe diameters, lengths, material, and invert elevations. The GIS was originally created in 2008 from conversion of the City's AutoCAD sewer maps. Additional updates to the GIS were made as part of the 2010 Sanitary Sewer Hydraulic Analysis project, and more recently through updates from as-built plans from previous sewer rehabilitation and replacement projects and recent CCTV inspection data. The new sewer infrastructure in the Alameda Landing area was also added to the GIS.

After the model network was created by importing the data from GIS, a procedure was followed to validate the network data and to confirm network connectivity. The pumps at the modeled pump stations were added, with data primarily derived from the 2010 hydraulic model (refer to the 2010 *Sanitary Sewer System Hydraulic Analysis* report for additional discussion). Due to the lack of available pump curves for most of the stations, City pump station capacities were determined primarily through information from drawdown tests conducted for the City's 2010 Pump Station Condition Assessment project, and the pumps were modeled as "screw pumps" in the model with maximum discharge capacities based on the drawdown test results Since 2010, the City has upgraded five of its pump stations (BFI, Aughinbaugh, Channing, Eighth/Portola, and Pond/Otis); therefore these stations were modeled as rotodynamic pumps with defined head-discharge curves.

City of Alameda
Sewer Master Plan

Figure 3-1a
Modeled Sewer System
(Alameda Island)

J:\Projects\0232 Alameda, City of\0232-013 Alameda Sewer MP Model Update (SJ)\G. GIS\MXDs\Fig3-1a ModeledNtwk.mxd

Sources: ESRI Basemap

Legend

- Modeled Sewers
- Unmodeled City Sewers
- Modeled Force Mains
- EBMUD Interceptor
- Modeled City Pump Stations
- Unmodeled City Pump Stations
- EBMUD Pump Stations
- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure 3-1b
Modeled Sewer System
(Harbor Bay Isle)

RMC water and environment

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Sources: ESRI Basemap

3.2.2 Model Subcatchments

Subcatchments define areas tributary to the modeled pipe network. Each subcatchment is assigned to a manhole or sewer pipe in the modeled system to define where the model load from that subcatchment enters the modeled sewer system.

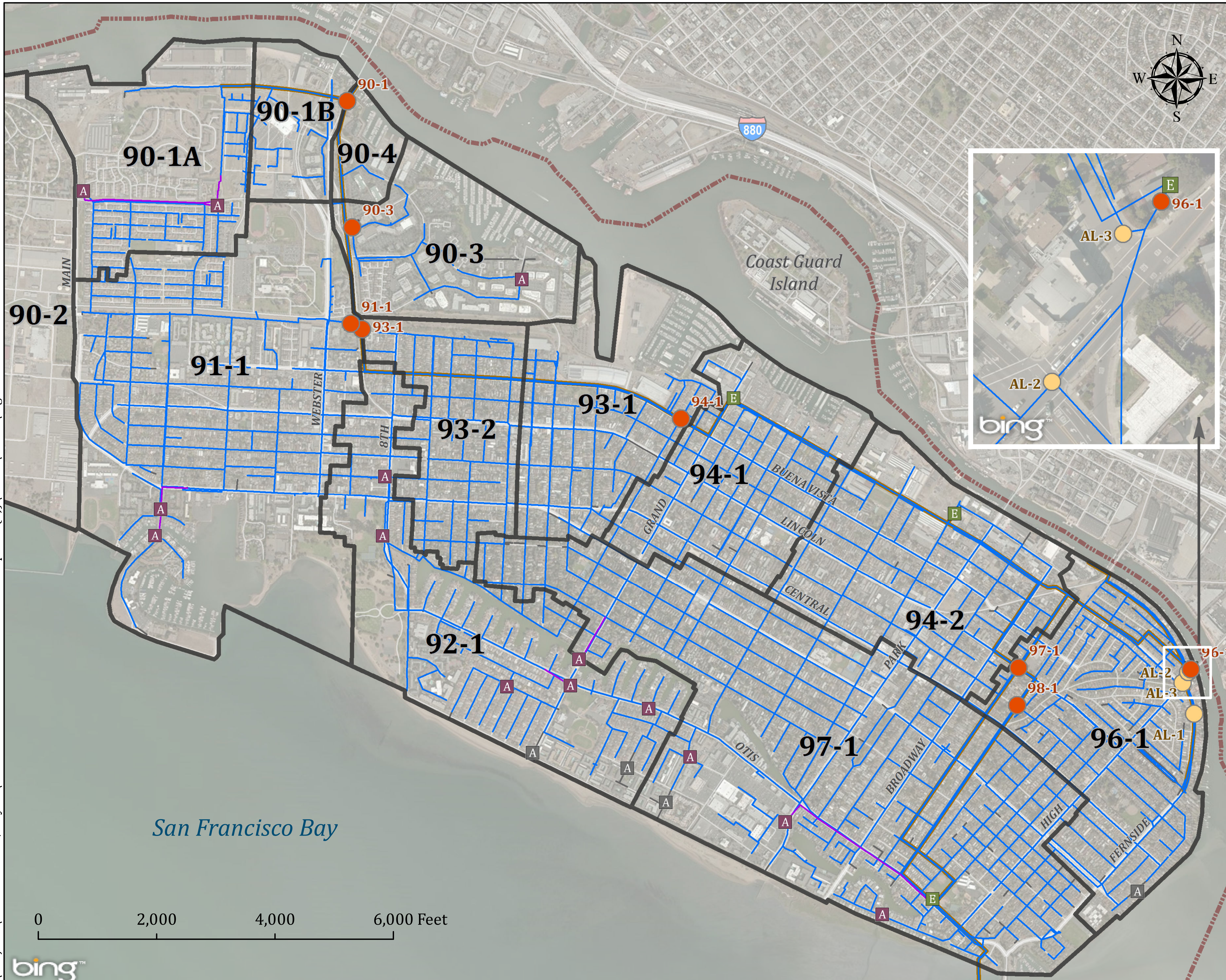
3.3 Flow Monitoring

The purpose of flow monitoring is to quantify flows in the system and to provide data with which to calibrate the hydraulic model (discussed later in this chapter). As noted previously, most flow monitoring in Alameda has been conducted by EBMUD along the interceptor system. The EBMUD flow monitoring data used for this study include programs conducted during the 2009/10 and 2010/11 wet weather seasons (November through March or April). The City also conducted flow monitoring at three sites during the 2010/11 season (December through January) in an area of the system (Basin 96) identified as having higher than average infiltration/inflow (I/I) rates. **Table 3-1** lists the EBMUD and City flow meter locations and pipe diameters. **Figure 3-2** is a map showing the locations of the flow meters.

Table 3-1: Flow Meter Locations

Meter ID	Location	Meter Manhole ID[a]	Pipe Upstream Manhole ID	Pipe Dia. (in.)[b]
EBMUD Meters				
90-1	Downstream end of Mitchell Interceptor	9100100	9100101	20[c]
90-3	Influent line to Marina Village Lift Station	9100311	9100311	15
91-1	Influent line to EBMUD PS F	9110201	9110203	30
93-1	Constitution Way s/o Atlantic Ave.	9100007	9100004	60
94-1	Buena Vista Ave. at Paru St.	9300009	9400001	54
96-1	Influent line to EBMUD PS B	9110201	9630001	24
97-1	Pearl St. at Lincoln Ave.	EBMUDMC1	9610002	21
98-1	Versailles Ave. at Santa Clara Ave.	EBMUDM02	EBMUDM01	24
City Meters				
AL-1	Fernside Blvd. s/o High St.	9630004	9630005	15
AL-2	High St. at Fernside Blvd.	9632001	9632002	14
AL-3	Marina Dr. at High St.	9640001	9640002	12

a. All meters installed in inlet pipe to manhole (i.e., at downstream manhole of pipe), except Meter 90-3.
b. Nominal pipe diameter; actual pipe inside diameter may differ.
c. Slip-lined 24-inch pipe.



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Sources: ESRI Basemap

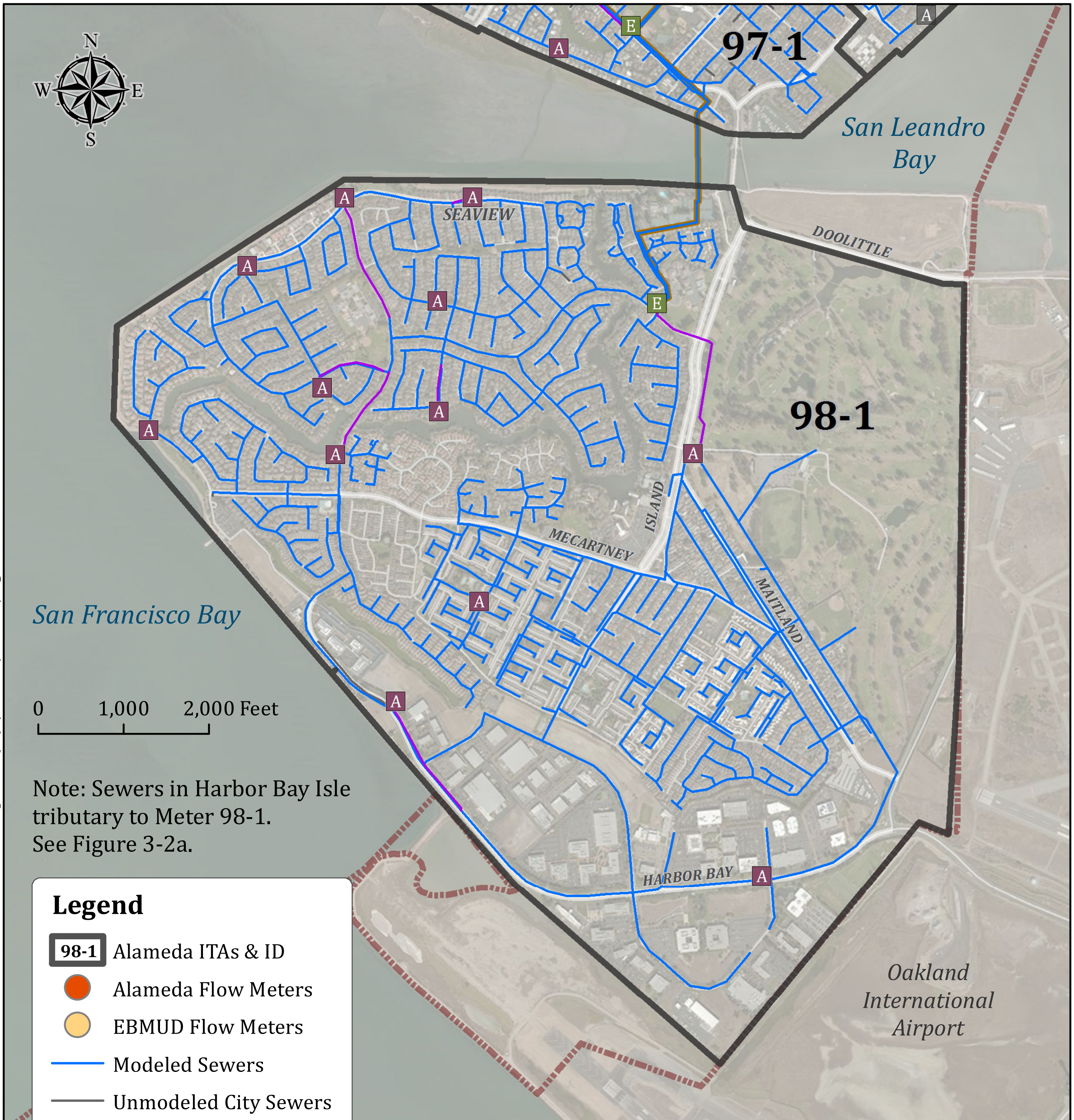
Legend

- 98-1 Alameda ITAs & ID
- Alameda Flow Meters
- EBMUD Flow Meters
- Modeled Sewers
- Unmodeled City Sewers
- Modeled Force Mains
- EBMUD Interceptor
- A Modeled City Pump Stations
- A Unmodeled City Pump Stations
- E EBMUD Pump Stations
- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure 3-2a
Flow Monitoring Sites
(Alameda Island)

RMC water and environment



Legend

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- EBMUD Interceptor
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- A Unmodeled City Pump Stations
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- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure 3-2b
Flow Monitoring Sites
(Harbor Bay Isle)

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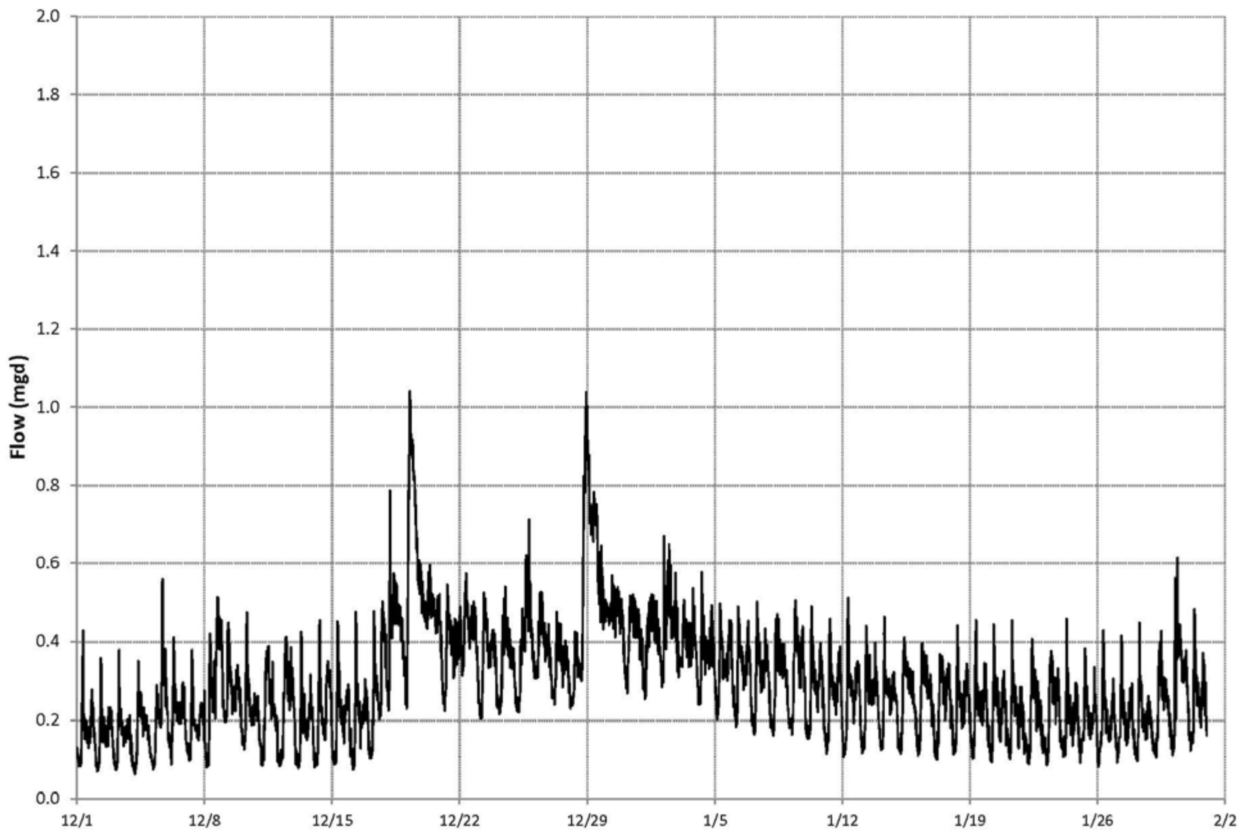
Sources: ESRI Basemap

Major rainfall events during the flow monitoring periods occurred in January and March 2010, December 2010, and March 2011. Rainfall data were captured at a rain gauge installed in Alameda at EBMUD's PS C. **Figure 3-3** shows a plot of measured flow for one of the City's flow meters during the 2010/11 wet weather season, illustrating the increase in flows during storm events in late December 2010.

Figure 3-3: Example Flow Monitoring Data (Meter AL-2, Dec. 2010-Jan. 2011)



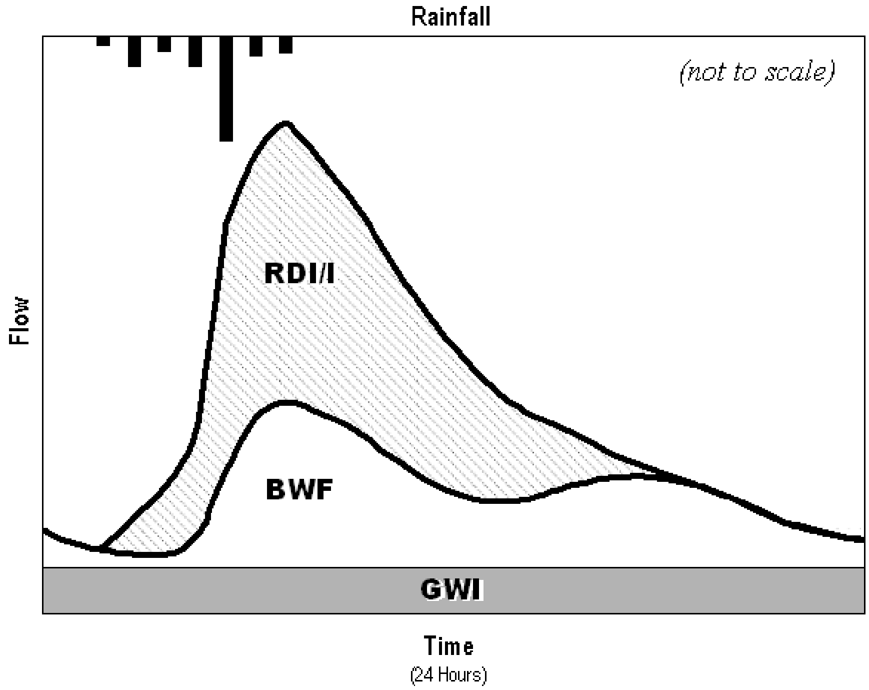
3.4 Flow Estimating Methodology

This section describes the methodology for estimating wastewater flows for loading to the hydraulic model.

3.4.1 Wastewater Flow Components

Wastewater flows typically include three components: base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall-dependent infiltration/inflow (RDI/I). BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the system. GWI is groundwater that infiltrates into the sewer through defects in pipes and manholes. GWI is typically seasonal in nature and remains relatively constant during specific periods of the year. RDI/I is storm water inflow and infiltration that enter the system in direct response to rainfall events. RDI/I can occur through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains (called "direct inflow"), or through defects in sewer pipes, manholes, and service laterals. RDI/I typically results in short term peak flows that recede quickly after the rainfall ends. These three flow components are illustrated conceptually in **Figure 3-4**.

Figure 3-4: Wastewater Flow Components



3.4.2 Base Wastewater Flow

Existing base wastewater flows for Alameda were estimated at the parcel level (over 17,000 connected parcels) based primarily on parcel use information contained in the Alameda County assessor parcel database. Additional flows from new or anticipated future development and redevelopment, originally identified in the 2010 study, were updated based on information provided by City Planning Services staff.

Existing Flows

Existing BWF was determined based on assessor parcel data using the Parcel Use Code (PUC) and other information (number of dwelling units, building square footage) contained in the database. Each parcel was also assigned a user type for purposes of assigning unit flow rates and diurnal BWF profiles (discussed later in this section). In some cases where the parcel was indicated as not vacant but dwelling units or building square footage were not populated in the assessor data, estimates were made based on the type of land use, number of addresses for the parcel (for multi-family parcels), or an assumed floor-area-ratio or FAR (typically 0.4) applied to the parcel size. The number of students for public schools and major private schools located in the Alameda were researched from available information on relevant websites, as were number of rooms for hotels, motels, and nursing homes. Many parcels identified as "exempt public agency" (PUC 300) did not have unit or building square footage information, so these were screened to determine type of use and data populated accordingly. All assumptions made to assign parcel land uses and quantities are documented directly in the model database.

The model database was configured such that the "population" field represents the number of dwelling units (for residential parcels), students (for schools), rooms (for hotels/motels and nursing homes), or square footage of building floor space (for office and commercial parcels), and corresponding unit flow factors were applied to compute the parcel BWF. The same unit flow factors as used in the 2010 study were applied for this model update. The flow factors are listed in **Table 3-2**. It is recognized that these factors, particular for residential flows, may be conservative and clearly higher than wastewater flow rates under current drought conditions. The factors likely represent a pre-drought condition, and may also be assumed to include some normal groundwater infiltration. As discussed later, the factors resulted in a reasonably good match to flow monitoring data from 2009/10 and 2010/11 winter seasons, which were used to calibrate the model.

Table 3-2: Base Wastewater Flow Unit Flow Factors

User Type	Flow Factor	Typical Use Type
Residential Single Family	240 gpd/DU	
Residential Multi-Family	170 gpd/DU	
General Commercial	0.1 gpd/sq. ft.	retail/offices/business park
Non-Residential High Use	0.5 gpd/bldg sq ft	restaurants/car washes
Non-Residential Medium Use	0.25 gpd/bldg sq ft	medical facilities/mixed uses
Non-Residential Very Low Use	0.02 gpd/bldg sq ft	warehouses/distribution centers
Schools	15 gpd/student	elementary/middle/high/college
Hotels/Motels	150 gpd/room	
Nursing Homes	150 gpd/room	

Future Flows

Although Alameda is largely built out, there are several areas of current and projected future development and redevelopment. The 2010 study developed estimates of potential future development based on information available at that time from EBMUD's 2040 Water Supply Management Program. A few of the future developments identified in 2010 have already been constructed and some are no longer likely. For this study, the future development estimates were confirmed and/or updated through review by City Planning Services staff. The developments are shown on **Figure 3-5** and listed in **Table 3-3**. Development names and relevant assumptions are also documented directly in the model database.

As with existing BWF, future development estimates were developed on a parcel basis (in some cases where multiple uses are projected on a single parcel, "dummy" parcels were created to subdivide the original parcel into the different land uses areas). BWF estimates for future development were computed using the same BWF unit flow factors as those applied for existing BWF, as shown in Table 3-2.

BWF Diurnal Profiles

In domestic wastewater systems, BWF varies throughout the day, typically peaking early on weekday mornings (later on weekends) and again in the evening hours in residential areas. BWF patterns in commercial and industrial areas depend on specific land use types but are typically characterized by a more uniform flow that lasts throughout working hours.

The variations in BWF on a typical day are represented by diurnal profiles. Diurnal profiles are defined by a set of hourly factors that are applied to the average BWF for each subcatchment. For Alameda, separate sets of diurnal profiles were defined for residential and non-residential development and for weekdays and weekends (for residential flow). A typical non-residential profile was applied to retail and service establishments that tend to have steady flows throughout normal business hours, including weekends. Business parks may have a similar weekday flow pattern as other non-residential uses, but may have lower flows during weekends. Therefore, a separate Business Park profile was used, primarily for the Harbor Bay Business Park. **Figure 3-6** shows the diurnal profiles used in the model, which are the same patterns as used for the 2010 study.

Legend

- Future Developments or Redevelopments
- Other Vacant Parcels
- Alameda City Limit

City of Alameda
Sewer Master Plan

Figure 3-5a
Future Developments
(Alameda Island)

Sources: ESRI Basemap

Legend

- Future Developments or Redevelopments
- Other Vacant Parcels
- Alameda City Limit

0 1,000 2,000 Feet

City of Alameda
Sewer Master Plan

Figure 3-5b
Future Developments
(Harbor Bay Isle)

RMC water and environment

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Sources: ESRI Basemap

Table 3-3: Potential Future Developments

No.	Name	Description
1	Coast Guard Housing	This parcel is the site of the former Coast Guard housing development. It is proposed for redevelopment to single-family residential. The size of the development area is approximately 36 acres and zoned for a maximum of 435 DUs.
2	Alameda Landing Phase II	Located north of Mitchell Avenue. Proposed redevelopment to approximately 400,000 SF of office space and 20,000 SF of commercial uses
3	Alameda Landing Resid. Phase II	Located north of Mitchell Avenue and currently vacant. Proposed for development of 56 DUs to be completed in 2016
4	Alameda Landing Resid. Phase I	Located west of Fifth St. and north of Willie Strargell Ave. 220 residential DUs (partially completed).
5	Shipways	Located at 1200 Marina Village Parkway, east of Invincible. Planned for residential development up to 30 DUs/acre, which may yield up to 146 DUs.
6	Del Monte	Planned for 380 residential DUs and 30,000 SF of commercial uses.
7	Encinal Terminal	Located north of Entrance Rd. Currently low intensity industrial uses. Potential redevelopment as mixed use with 234 residential DUs (likely multi-family) and 50,000 SF of non-residential uses.
8	Marina Cove II	Approximately 89 residential DUs (in construction)
9	City Maintenance Yard	Planned for redevelopment with 41 residential DUs.
10	Pennzoil Site	Located at Fortman Way and Grand St. Currently used as low intensity industrial uses. Size of redevelopment area is approximately 4.1 acres. Planned for future residential development at 21 DU/acre, yielding 78 units.
11	Alameda Marina	1801 Clement. Planned for 156 DUs on 8.66 acres.
12	Alameda Marina	2033 Clement. Planned for 240 DUs on 13.34 acres.
13		2100 Clement. Planned for 52 single family attached townhouse units.
14	Boatworks	Located north of Clement between Park and Blanding. Currently used as low intensity industrial uses. Proposed redevelopment as residential with 182 single-family DUs by 2017.
15	Former Ron Goode Toyota	1801 and 1825 Park St. Total of 20 residential units.
16	Housing Authority	2437 Eagle Ave. Affordable housing project with 22 single family attached units.
17	Mapes Ranch	11 single family DUs.
18	Esplanade	Located in Harbor Bay Business Park. Approximately 110,000 SF of business park office development on 9.2 acres.
19	VF Outdoor	55,288 SF service facility on 2.8 acres
20	Marriott Hotel	100-room hotel
21	Hampton Inn	New 72-room hotel expansion in detached building.
22	Potential hotel	Located West of Harbor Bay between Maitland and Garden. Currently vacant, approximately 5 acres. Potential hotel development (about 200 rooms) by 2020.

Note: Table does not include development on Alameda Point.