COLLECTION SYSTEM MODELING

5.1 INTRODUCTION

A collection system model is a simplified representation of the physical collection system. In general, collection system models can assess the current level of performance for the collection system based on population and land use. In addition, collection system models can perform “what if” scenarios to project the anticipated performance considering future developments, population and/or land use changes, and various wet weather conditions. This chapter details the collection system model used for this study.

5.2 COLLECTION SYSTEM FACILITIES

The City’s collection system serves the City and some additional areas outside the City limits. The collection system consists of approximately 1,350 manholes and 66 miles of public sewer, most of which are more than 30 years old. The central and western areas of the City are relatively flat, but the ground terrain changes considerably to the east and south.

The City’s wastewater is treated at the SC-OR WWTP located on 5th Avenue in Oroville. The SC-OR was formed through a Joint Powers Agreement by the City, TWSD, and LOAPUD, the member agencies. Figure 5.1 presents an overview of the City’s collection system facilities.

5.2.1 Pipelines

The collection system pipe diameters range from 4 to 36 inches. The larger interceptors are generally owned by SC-OR and range in diameter from 18 inches to 36 inches; they are the major pipes tributary to the WWTP. The City has three major trunk sewers that are tributary to either the SC-OR interceptors or the WWTP and are described below. Table 5.1 presents the pipeline statistics for the existing collection system.

5.2.1.1 <u>Downtown Trunk Sewer</u>

The Downtown Trunk Sewer serves Basins 4A, 4B, 5, 6, and C2, which comprises the downtown area and northern portion of the City. The trunk sewer begins at the intersection of Montgomery Street and Myers Street as an 18-inch pipe and continues west along Montgomery Street before turning south on 1st Avenue. At 1st Avenue, the sewer becomes a 20-inch pipe and continues west to Feather River Boulevard. At Feather River Boulevard and Robinson Street, the sewer becomes a 27-inch pipe and continues south before heading east on Mitchell Avenue. The sewer then turns south on 5th Avenue and ends at Oroville Dam Boulevard, where it connects to the 5th Avenue Interceptor.

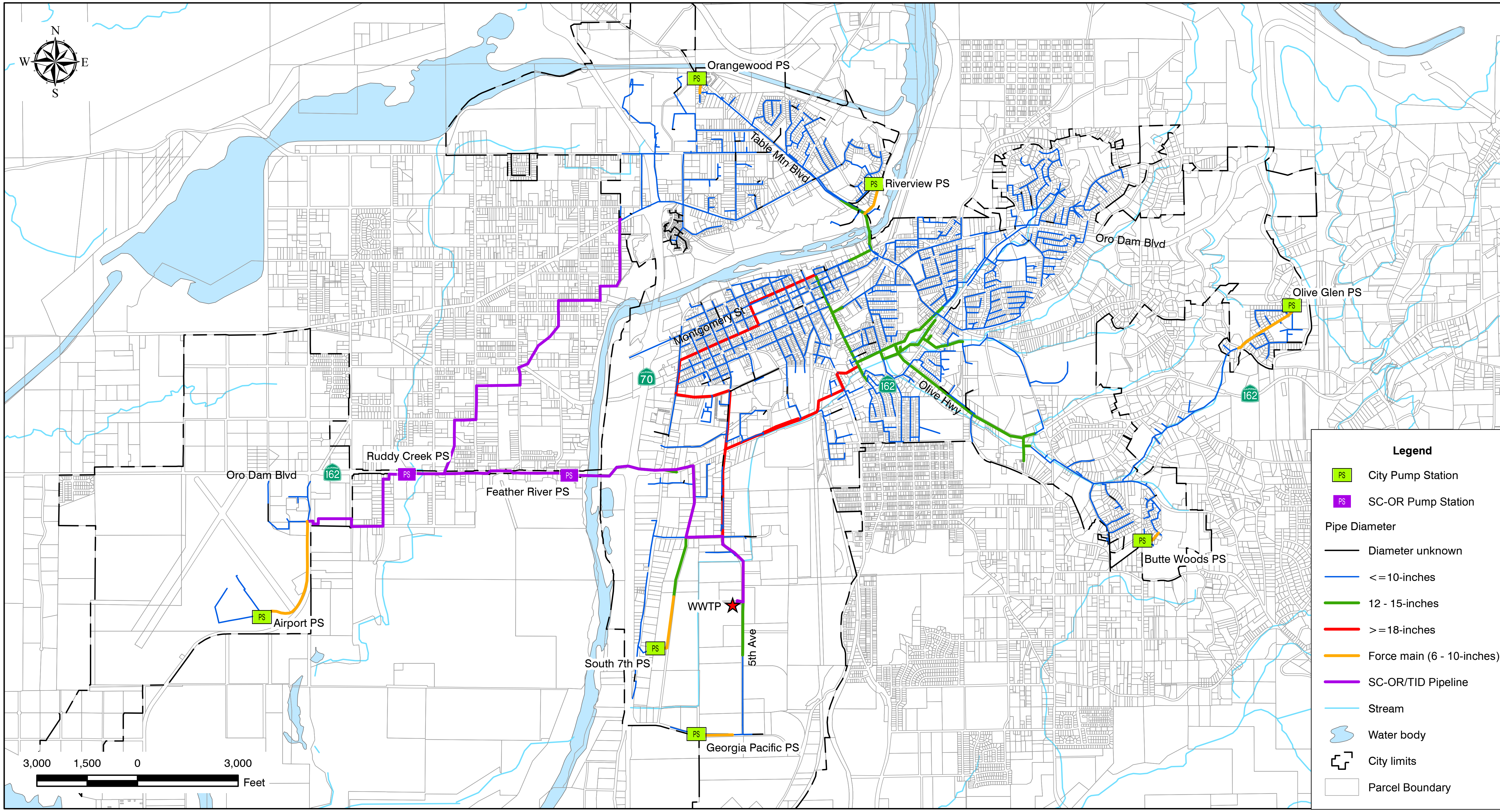

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Figure 5.1
COLLECTION SYSTEM FACILITIES
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

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5/3/2012

Table 5.1 Pipe Statistics
Sanitary Sewer Master Plan
City of Oroville

	Entire System		Modeled System	
Diameter	**Gravity Length (Feet)**	**Force Main Length (Feet)**	**Gravity Length (Feet)**	**Force Main Length (Feet)**
Unknown	7,414	---	---	---
4	164	1,607	---	---
6	230,189	4,333	5,681	4,177
8	52,723	3,780	14,859	3,780
10(1)	19,435	1,896	17,022	1,884
12(1)	13,155	---	12,448	---
15(1)	9,934	---	9,543	---
18(1)	6,902	---	6,960	---
20(1)	2,574	---	2,573	---
21	1,204	---	1,204	---
27	4,364	---	4,410	---
36	2,592	---	2,592	---
Total (feet)	**350,648**	**11,616**	**77,293**	**9,840**
Total (miles)	**66.4**	**2.2**	**14.6**	**1.9**

Notes:
1. Differences between physical and modeled system lengths due to modifications in model to accommodate pump stations, structures, or other hydraulic conditions.

5.2.1.2 Oroville Dam Boulevard Trunk Sewer

The Oroville Dam Boulevard Trunk Sewer serves the eastern portions of the City (Basins 3, 7, 8, and 9). The trunk sewer begins at Mitchell Avenue and Myers Street as an 18-inch pipe and heads west to Lincoln Avenue. The sewer continues south along Lincoln Avenue before heading west along an easement. The sewer joins Oroville Dam Boulevard at the Union Pacific Railroad tracks and continues west to 5th Avenue, where it connects to the 5th Avenue Interceptor. The sewer is 21 inches in diameter for the final 1,204 feet.

5.2.1.3 5th Avenue Interceptor

The 5th Avenue Interceptor begins where the Downtown and Oroville Dam Boulevard trunk sewers end. The 36-inch sewer heads south along 5th Avenue and ends at Cal-Oak Road where it enters the SC-OR Main Interceptor. The SC-OR Main Interceptor continues 1/2 mile to the treatment plant.

5.2.2 Pump Stations

The City currently operates and maintains seven wastewater pump stations, five of which were incorporated into the collection system hydraulic model. The pump stations owned and operated by the City are located on the fringes of the collection system and are therefore relatively small. Figure 5.1 presents the location of the pump stations and highlights their associated force mains. Table 5.2 summarizes the existing pump stations and their capacities.

Table 5.2 Pump Stations
Sanitary Sewer Master Plan
City of Oroville

	Firm Capacity[1]		Total Capacity	
Pump Station	**(gpm)[2]**	**(mgd)[3]**	**(gpm)[2]**	**(mgd)[3]**
Airport	325	0.47	650	0.94
South 7th	650	0.94	1,300	1.87
Georgia Pacific	250	0.36	500	0.72
Orangewood[4]	300	0.43	600	0.86
Butte Woods[4]	310	0.45	620	0.90
Riverview	350	0.50	700	1.00
Olive Glen	700	1.00	1,400	2.00

Notes:
1. Firm capacity assumes the largest pump is out of service.
2. gpm = gallons per minute.
3. mgd = million gallons per day.
4. Pump station not modeled.

5.3 HYDRAULIC MODEL SELECTION

There are several hydraulic modeling software packages on the market capable of meeting City and project needs. During the selection process, Carollo evaluated seven hydraulic modeling software packages based on the following criteria:

- Ability to provide a quality calibration of the sewer basins
- Ability to accurately model pump stations
- Ability to accurately model diversion manholes
- GIS interface capabilities
- Established, time-tested software with excellent technical support
- User-friendly software
- Cost (both acquisition and maintenance fees)

A recommendation was made to select MWH Soft's (now Innovyze InfoWater) H2OMAP Sewer model version 8.0 for the collection system master plan. The H2OMAP Sewer model routes flows through the collection system in order to examine the capacity of existing pipes and show where flow restrictions occur. The H2OMAP Sewer software performs this routing technique through use of the Muskingum-Cunge explicit diffusive wave method. The diffusive wave method is a simplified version of the Saint Venant, one-dimensional equations of fluid flow. H2OMAP Sewer provides multiple WWF generation techniques. The tri-triangle synthetic unit hydrograph method was chosen. A detailed description of this method is provided in the next chapter. The H2OMAP Sewer model provides seamless database and GIS interfacing of facility data, simulation results, and background GIS layers. Details of the hydraulic model software evaluation are documented in a hydraulic model selection letter, dated July 11, 2007 (Appendix B).

5.4 HYDRAULIC MODEL DEVELOPMENT

The H2OMAP Sewer model was developed based on the City's GIS database, survey data collected during the scope of this project regarding manhole rim and selected invert data, and additional input from City staff. The collection system data was imported directly into the model in GIS format. The collection system model includes pipes with a diameter of 10 inches or greater, all associated manholes, and diversion structures and lift stations. In some instances, 6- and 8-inch diameter pipes were included in the model to further define a specific area of interest. Inclusion of 10-inch and greater diameter pipes serve the purpose of minimizing model analysis run time while retaining the hydraulic integrity of the collection system. It was assumed that all pipes 8 inches in diameter and below have the capacity to service local areas. See Table 5.1 for the pipeline statistics for the modeled collection system.

The data from the GIS database was input into the H2OMAP Sewer hydraulic model and included pipe length, diameter, invert elevations, and rim elevations. Slopes in the hydraulic model were calculated based on invert elevations and pipe length. As part of the master plan project, Rolls, Anderson & Rolls (RAR) was retained to provide a comprehensive survey of the collection system's manholes. Both horizontal and elevation data was collected for the manhole rims throughout almost all of the system. Invert data was also collected at select manholes to aid in model construction. Survey detail sheets for these manholes are located in Appendix C. Where rim elevations were unobtainable due to access restrictions, they were interpolated using the City's 2-foot contour layers. Missing invert elevations were resolved by assuming a constant slope upstream and downstream of the invert in question or following ground slope. Data resolution methods for model data are presented in Table 5.3. A Mannings "n" value of 0.013 was used for all pipes based on a typical roughness value for vitrified clay pipe.

Table 5.3 Data Resolution Sanitary Sewer Master Plan City of Oroville		
Data Type	**Initial GIS Completeness**	**Data Resolution**
Manhole Rim Elevation	Poor	– RAR Survey – Interpolate using 2-foot contours
Manhole Invert Elevation	Poor	– RAR Survey – Interpolate using constant pipe slope – Interpolate using ground slope
Pipe Diameter	Good	– Use upstream/downstream diameter
Pipe Length	None	– Calculate shape length once manhole locations surveyed

The model also includes pump stations, which are defined by the appropriate parameters to describe the physical and operational characteristics. A pump station is defined in the model based on the maximum pump discharge capacity, pump discharge elevation, pump on and off volumes, wet well volume, force main invert elevation, and whether a pump operates as a variable or a constant speed pump. City staff provided this necessary data for pump station operation.

Figure 5.2 illustrates the City's modeled collection system. The ranges of pipe diameters in the modeled collection system are highlighted along with the location of the pump stations.

5.5 DRY WEATHER FLOW LOADING

A land use and ADWF analysis was performed to correlate the measured ADWF at each of the 14 basins with the land use characteristics of each individual basin. Parcel based land use data was used as the basis for developing the quantity of ADWF generated within the City. The accurate estimation of the quantity of wastewater is an important process in maintaining and sizing collection system facilities, both for existing conditions and future developments. The estimation of ADWF is necessary to calibrate existing and project future ADWF. To input the ADWF into the model, each parcel was assigned a loading manhole. All parcels with the same loading manhole were grouped together and their ADWFs were combined.

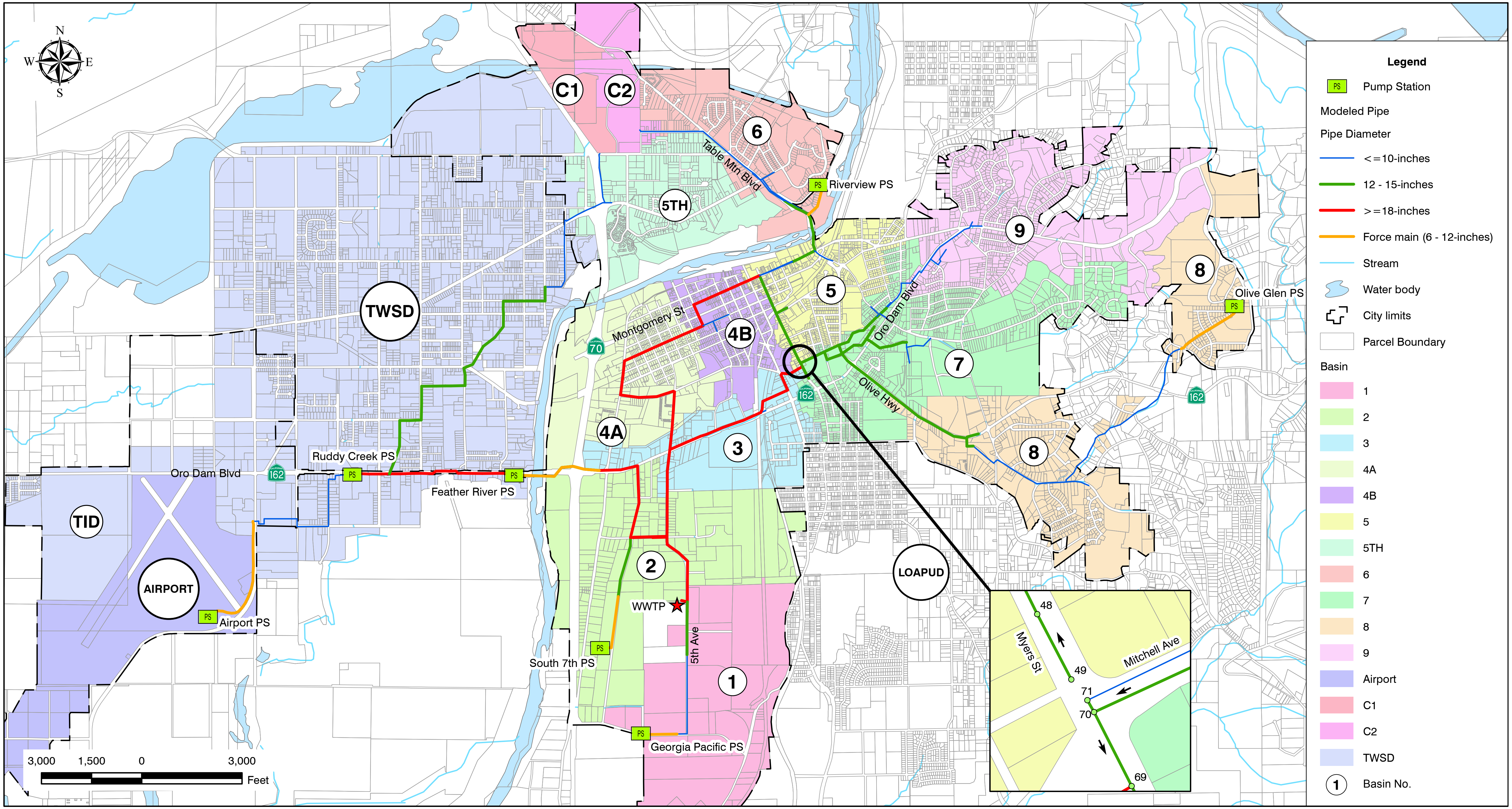

Figure 5.2
MODELED COLLECTION SYSTEM
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

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5.5.1 Existing Dry Weather Flow

The land use analysis estimated ADWFs for each metered basin. A dry weather flow (DWF) diurnal pattern was then applied to each basin ADWF and used in the collection system analysis. ADWF is estimated using the following equation:

ADWF = Area x Flow Factor

Where:			
	ADWF	=	Average dry weather flow, gallons per day (gpd).
	Area	=	Gross sewered area, acres.
	Flow Factor	=	Flow factor, gallons per acre per day (gpad).

A flow factor is unique to the basin and land use/zoning code to which it is attributed. The various zoning and land use codes are presented in Table 5.4 and are grouped into generalized categories (i.e., residential, industrial, commercial, and public).

The existing system has 4,398 residential dwellings (accounts) and 1,947 acres of sewered area. Table 5.5 presents the dwelling units and sewered area by basin for the existing system. The flow factors used in the estimation of ADWF is presented in Table 5.6. The residential flow factor of 189 gallons per dwelling unit is within industry standards. Flow factors for industrial, commercial, and public categories are also within industry standards when factors such as intensity and use are considered. A total of 1.71 mgd of ADWF was measured for the existing system. Based on the measured flow and estimated flow factors, the current number of equivalent dwelling units (EDUs) is 9,055. Table 5.7 breaks down the ADWF by basin and land use category.

5.5.2 Future Flow

Future flow estimates must balance anticipated growth with realistic expectations to prevent over or under-sizing of future facilities. Using the City’s 2030 General Plan existing flows and flow factor alternatives, a range of future flows was estimated.

5.5.2.1 <u>General Plan</u>

The City‘s 2030 General Plan Update was prepared by the City’s planning consultant, DC&E, and will guide growth in the City and surrounding area with a planning horizon of Year 2030. The following assumptions from the General Plan Update were made to define the scope of the flow calculation process:

- Planning area boundary is to be the City’s SOI (see Figure 5.1).
- Parcels with an equivalent density of 1 dwelling unit per 5 acres or more, or land use type RR1 (Rural Residential), are allowed a septic system per steering committee guidelines and are not included in flow calculations.

- All residential dwelling units that are identified as part of the build-out condition by DC&E are included in the analysis.
- Industrial and commercial areas are identified by the parcel area. If both industrial and commercial areas exist, the respective areas are calculated using the weighted averages of the allowed areas.
- Parcels with Environmental Conservation/Safety (ECS), Parks (PARK), Resource Management (RM), and State Water Project (SWP) designations were excluded from flow calculations due to the high improbability of being developed, even if residences currently exist on the parcels.

Based on the preferred land use alternative identified for the General Plan Update, the City's sewer system can be expected to expand greatly as presented in Table 5.5. The sewered area is estimated to increase from 1,947 acres to 12,035 acres (excludes TWSD and LOAPUD). Growth is expected to occur most significantly in and around the boundary of the existing system, particularly in the south, west, and east areas of the system (Basins 1, 5, 6, and 8). Figure 5.3 illustrates the change in service area.

5.5.2.2 <u>Future Flow Projection Alternatives</u>

Four alternatives were evaluated in the estimation of future DWFs. The alternatives are designed to represent a broad range of flow factors. The four alternatives are described below and a comparison of flow factors used is presented in Table 5.6.

5.5.2.2.1 *Alternative 1*

Alternative 1 is the most conservative flow calculation method. Residential flow is estimated using 100 gallons per capita per day and 2.7 persons per dwelling unit for a unit flow of 270 gallons per day per dwelling unit (gpd/du). This value is consistent with the previous master plan. Industrial and commercial flows are estimated using citywide existing flow factors. DWF at the build-out condition for this approach is estimated at 8.15 mgd (see Tables 5.7 and 5.8).

Table 5.4 General Plan and Zoning Categories
Sanitary Sewer Master Plan
City of Oroville

Generalized Category	Zoning Code	Zoning Description	GP(1) Code	General Plan Description
Residential (RES)	AR	Agriculture Residential	RHD	Residential High Density
	PD	Planned Unit Development	RLD	Residential Low Density
	R1	Single Family Residential	RMD	Residential Medium Density
	R2	Medium Density Residential	RVLD	Residential Very Low Density
	R3	High Density Residential		
	RP	High Density Residential/Professional		
	RL1	Residential Large Lot (8,000 SF)		
	SC	Senior Citizen Overlay		
	SR	Suburban Residential (10,000 SF)		
	SRH	Suburban Residential (1/2 acre)		
	SR1	Suburban Residential (1 acre)		
Industrial (IND)	M1	Limited Industrial	IND	Industrial
	M2	Industrial		
Commercial (COM)	ABP	Airport Business Park	ABP	Airport Business Park
	C1	Restricted Commercial	OFC	Office
	C2	Heavy Commercial	RBS	Retail and Business Services
	CLM	Commercial Light Manufacturing		
	HC	Highway Commercial		
	NC	Neighborhood Commercial		
Public (PUB)	C	Conditional Overlay	ECS	Environmental Conservation/Safety
	O	Open Space	PARK	Parks
	PO	Parking Overlay	PUB	Public
	PQ	Public/Quasi Public	RM	Resource Management
	U	Unclassified	SWP	State Water Project

Note:
1. GP = General Plan.

Table 5.5 Existing and Future Land Use Area by Basin
Sanitary Sewer Master Plan
City of Oroville

Basin	Existing						Future[1]						Difference						Percent Difference					
	RES[2] (DU)	RES (Acres)	IND[3] (Acres)	COM[4] (Acres)	PUB[5] (Acres)	Total (Acres)	RES (DU)	RES (Acres)	IND (Acres)	COM (Acres)	PUB (Acres)	Total (Acres)	RES (DU)	RES (Acres)	IND (Acres)	COM (Acres)	PUB (Acres)	Total (Acres)	RES (DU)	RES (Acres)	IND (Acres)	COM (Acres)	PUB (Acres)	Total (Acres)
1	0	0	87	0	0	87	4,136	1,995	1,473	1,312	66	4,845	4,136	1,995	1,386	1,312	66	4,758	New[6]	New	1589%	New	New	5456%
2	0	0	130	27	0	157	14	5	302	276	0	584	14	5	172	249	0	426	New	New	132%	912%	---	271%
3	5	0	70	83	0	153	395	161	31	251	0	443	390	161	-39	168	0	290	7794%	New	-56%	201%	---	190%
4A	659	84	0	82	20	186	819	115	0	133	0	248	160	30	0	51	-20	61	24%	36%	---	63%	-100%	33%
4B	459	57	17	37	20	131	542	65	19	51	4	139	83	8	2	14	-16	8	18%	13%	12%	37%	-80%	6%
5	624	84	0	54	26	163	1,074	516	0	56	26	598	450	432	0	3	0	435	72%	515%	---	5%	-1%	266%
6	472	95	0	23	0	118	1,500	502	0	123	30	655	1,028	406	0	101	30	537	218%	427%	---	439%	New	455%
7	700	134	0	84	36	254	1,395	549	0	166	93	809	695	415	0	82	57	555	99%	310%	---	98%	160%	218%
8	159	128	0	24	20	171	1,955	2,313	3	224	20	2,560	1,796	2,186	3	200	-1	2,388	1129%	1713%	New	849%	-3%	1393%
9	527	190	0	6	11	207	989	626	1	33	11	670	462	437	1	26	0	464	88%	230%	New	411%	0%	224%
C1	0	0	0	0	53	53	1	0	0	0	53	53	1	0	0	0	0	0	New	---	---	---	0%	0%
C2	43	7	0	0	54	61	2	0	0	0	51	51	-41	-7	0	0	-3	-10	-95%	-100%	---	---	-5%	-16%
5th	750	162	0	33	9	204	1,192	284	0	69	26	380	442	122	0	37	17	176	59%	75%	---	113%	184%	86%
City-Wide	4,398	941	304	452	249	1,947	14,013	7,132	1,829	2,694	380	12,035	9,615	6,190	1,525	2,242	131	10,089	219%	657%	502%	496%	53%	518%

Notes:
(1) Sewered area only, excludes ECS, PARK, RM, SWP, and RR land use categories.
(2) RES = Residential
(3) IND = Industrial
(4) COM = Commercial
(5) PUB = Public/Quasi-Public
(6) New = Area where land use type did not previously exist in basin.

Table 5.6 Existing and Future Flow Factors by Basin
Sanitary Sewer Master Plan
City of Oroville

Basin	Existing				Alternative 1				Alternative 2				Alternative 3				Alternative 4			
	RES(1)(2) (gpd/du)(8)	IND(3) (gpad)(9)	COM(4) (gpad)	PUB(5) (gpad)	RES(6) (gpd/du)	IND (gpad)	COM (gpad)	PUB (gpad)	RES(7) (gpd/du)	IND (gpad)	COM (gpad)	PUB (gpad)	RES (gpd/du)	IND (gpad)	COM (gpad)	PUB (gpad)	RES (gpd/du)	IND (gpad)	COM (gpad)	PUB (gpad)
1	---	25	---	---	270	551	1,028	576	189	50	600	576	189	200	1,028	576	189	513	600	576
2	---	713	636	---	270	551	1,028	---	189	713	636	---	189	713	636	---	189	713	636	---
3	---	1,007	613	---	270	551	1,028	---	189	1,007	613	---	189	1,007	613	---	189	1,007	613	---
4A	---	---	1,393	350	270	551	---	----	189	---	1,393	---	189	---	1,393	---	189	---	1,393	---
4B	---	150	969	200	270	551	1,028	576	189	150	969	200	189	150	969	200	189	150	969	200
5	---	---	697	480	270	---	1,028	576	189	---	697	480	189	---	697	480	189	---	697	480
6	---	---	2,017	---	270	---	1,028	576	189	---	2,017	576	189	---	2,017	576	189	---	2,017	576
7	---	---	923	500	270	---	1,028	576	189	---	923	500	189	---	923	500	189	---	923	500
8	---	---	1,050	980	270	551	1,028	576	189	551	1,050	980	189	551	1,050	980	189	551	1,050	980
9	---	---	2,000	1,029	270	551	1,028	576	189	551	2,000	1,029	189	551	2,000	1,029	189	551	2,000	1,029
C1	---	---	---	1,064	---	---	---	576	---	---	---	1,064	---	---	---	1,064	---	---	---	1,064
C2	---	---	---	199	---	---	---	576	---	---	---	199	---	---	---	199	---	---	---	199
5th	---	---	1,484	429	270	---	1,028	576	189	---	1,484	429	189	---	1,484	429	189	---	1,484	429
City-Wide	189	551	1,028	576	270	551	1,028	576	189	235	771	580	189	337	1,024	580	189	550	771	580

Notes:
(1) RES = Residential
(2) Existing residential flows based on area
(3) IND = Industrial
(4) COM = Commercial
(5) PUB = Public/Quasi-Public
(6) Based on 100 gal per capita per day and 2.7 persons per dwelling unit
(7) Based on 70 gal per capita per day and 2.7 persons per dwelling unit
(8) gpd/du = gallons per day per dwelling unit
(9) gpad = gallons per acre per day

Table 5.7 Existing and Future Flow by Basin
Sanitary Sewer Master Plan
City of Oroville

Basin	Existing					Alternative 1					Alternative 2					Alternative 3					Alternative 4				
	RES[1][2] (mgd)[6]	IND[3] (mgd)	COM[4] (mgd)	PUB[5] (mgd)	Total (mgd)	RES (mgd)	IND (mgd)	COM (mgd)	PUB (mgd)	Total (mgd)	RES (mgd)	IND (mgd)	COM (mgd)	PUB (mgd)	Total (mgd)	RES (mgd)	IND (mgd)	COM (mgd)	PUB (mgd)	Total (mgd)	RES (mgd)	IND (mgd)	COM (mgd)	PUB (mgd)	Total (mgd)
1	0.00	0.00	0.00	0.00	0.00	1.04	0.81	1.35	0.04	3.24	0.73	0.07	0.79	0.04	1.63	0.73	0.29	1.35	0.04	2.41	0.73	0.75	0.79	0.04	2.31
2	0.00	0.09	0.02	0.00	0.11	0.00	0.17	0.28	0.00	0.45	0.00	0.22	0.18	0.00	0.39	0.00	0.22	0.18	0.00	0.39	0.00	0.22	0.18	0.00	0.39
3	0.00	0.07	0.05	0.00	0.12	0.11	0.02	0.26	0.00	0.38	0.07	0.03	0.15	0.00	0.26	0.07	0.03	0.15	0.00	0.26	0.07	0.03	0.15	0.00	0.26
4A	0.11	0.00	0.11	0.01	0.23	0.22	0.00	0.14	0.00	0.36	0.15	0.00	0.19	0.00	0.34	0.15	0.00	0.19	0.00	0.34	0.15	0.00	0.19	0.00	0.34
4B	0.06	0.00	0.04	0.00	0.10	0.15	0.01	0.05	0.00	0.21	0.10	0.00	0.05	0.00	0.16	0.10	0.00	0.05	0.00	0.16	0.10	0.00	0.05	0.00	0.16
5	0.05	0.00	0.04	0.01	0.10	0.28	0.00	0.06	0.01	0.36	0.20	0.00	0.04	0.01	0.25	0.20	0.00	0.04	0.01	0.25	0.20	0.00	0.04	0.01	0.25
6	0.11	0.00	0.05	0.00	0.15	0.40	0.00	0.13	0.02	0.54	0.28	0.00	0.25	0.02	0.54	0.28	0.00	0.25	0.02	0.54	0.28	0.00	0.25	0.02	0.54
7	0.11	0.00	0.08	0.02	0.20	0.38	0.00	0.17	0.05	0.60	0.26	0.00	0.15	0.05	0.46	0.26	0.00	0.15	0.05	0.46	0.26	0.00	0.15	0.05	0.46
8	0.06	0.00	0.02	0.02	0.10	0.52	0.00	0.23	0.01	0.76	0.36	0.00	0.23	0.02	0.62	0.36	0.00	0.23	0.02	0.62	0.36	0.00	0.23	0.02	0.62
9	0.30	0.00	0.01	0.01	0.33	0.27	0.00	0.03	0.01	0.31	0.19	0.00	0.07	0.01	0.26	0.19	0.00	0.07	0.01	0.26	0.19	0.00	0.07	0.01	0.26
C1	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.00	0.06	0.06
C2	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01
Airport	0.003				0.003	0.03	0.02	0.04	0.38	0.46	0.02	0.02	0.02	0.38	0.44	0.02	0.02	0.04	0.38	0.45	0.02	0.02	0.02	0.38	0.44
5th	0.25				0.25	0.32	0.00	0.07	0.02	0.41	0.23	0.00	0.10	0.01	0.34	0.23	0.00	0.10	0.01	0.34	0.23	0.00	0.10	0.01	0.34
WWTP	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01
City-Wide	1.04	0.17	0.42	0.14	1.77	3.71	1.04	2.81	0.60	8.15	2.60	0.35	2.22	0.60	5.77	2.60	0.57	2.79	0.60	6.57	2.60	1.03	2.22	0.60	6.45

Notes:
(1) RES = Residential
(2) Existing residential flows based on area
(3) IND = Industrial
(4) COM = Commercial
(5) PUB = Public/Quasi-Public
(6) mgd = million gallons per day

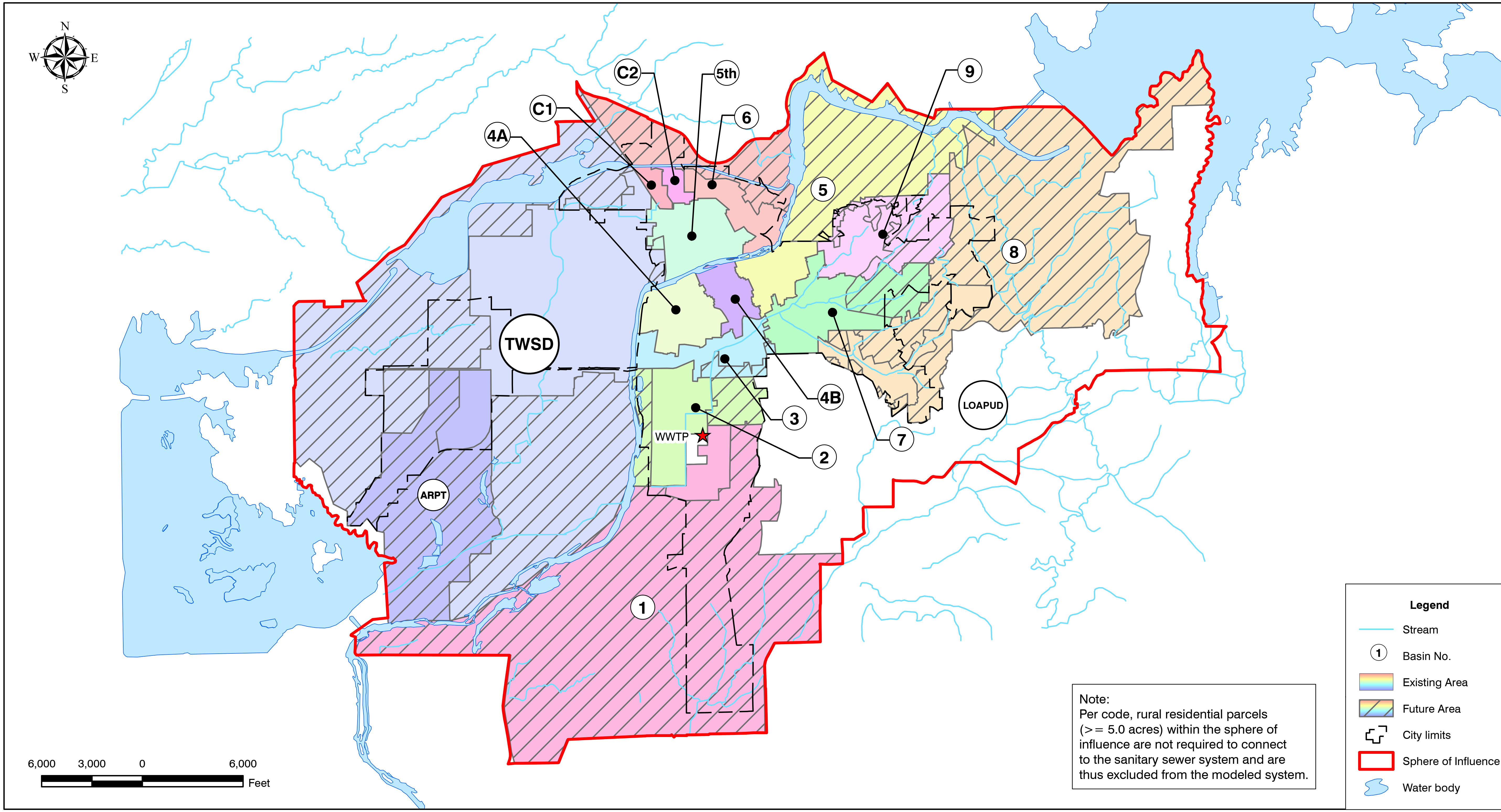

Figure 5.3
MODELED FUTURE COLLECTION SYSTEM AREA
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

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9/17/2012

Table 5.8 Existing and Future Flow Summary
Sanitary Sewer Master Plan
City of Oroville

Alternative	Residential Flow (mgd)[1]	Industrial Flow (mgd)	Commercial Flow (mgd)	Public Flow (mgd)	Total ADWF[2][3] (mgd)	I/I[4] (mgd)	PWWF[5] (mgd)
Existing	1.04	0.17	0.42	0.14	1.77	8.88	11.27
Alternative 1[6]	3.71	1.04	2.81	0.60	8.15	12.36	23.37
Alternative 2[7]	2.60	0.35	2.22	0.60	5.77	12.36	20.15
Alternative 3[8]	2.60	0.57	2.79	0.60	6.57	12.36	21.23
Alternative 4[9]	2.60	1.13	2.22	0.60	6.45	12.36	21.07

Notes:
1. mgd = million gallons per day.
2. ADWF = Average Dry Weather Flow.
3. Sewered area only, excludes ECS, PARK, RM, SWP, and RR land use categories.
4. I/I under 10-year, 24-hour Design Storm for existing development, future development estimated at 400 gpad.
5. PWWF = Peak wet weather flow = I/I + peak dry weather flow. Approximate estimates only. PWWF = ADWF x 1.35 + I/I.
6. Alternative 1: RES @ 270 gpd/edu, IND, COM, & PUB Citywide averages. Excludes TWSD.
7. Alternative 2: RES @ 189 gpd/edu, IND & COM basin averages, except Basin 1 where low flow factors are used. Basin averages for PUB, all basins. Excludes TWSD.
8. Alternative 3: RES @ 189 gpd/edu, IND, COM, & PUB basin averages. Excludes TWSD.
9. Alternative 4: RES @ 189 gpd/edu, IND & COM basin averages, except Basin 1 where low flow factors are used. Basin 1 industrial 50 percent wet industry. Basin averages for PUB, all basins. Excludes TWSD.

5.5.2.2.2 *Alternative 2*

Alternative 2 is the least conservative flow calculation method. Residential flow is estimated using a unit flow of 189 gpd/du. The method for calculating this value is presented below. Industrial and commercial flow is estimated using basin level flow factors from existing flow calculations. Consistent with measured flows, it is assumed that in Basin 1 industrial uses will produce little wastewater flows (e.g., warehousing, dry industry). However, since measured flows in Basin 1 were dramatically below typical ranges, it was determined that increasing this extremely low flow factor by at least two times was necessary to conduct a reasonable analysis. Commercial flow factors for Basin 1 and TWSD are estimated at 600 gpad, consistent with the values identified for adjacent Basins 2 and 3 (636 and 613 gpad, respectively). This estimate is based on attempting to provide a less conservative approach and similar development characteristics. Except for TWSD and Basin 1, where existing commercial and industrial flow factors are missing for a particular basin, the citywide existing flow factor is used. The resulting DWF at the build-out condition is estimated at 5.77 mgd.

The flow factors for Alternative 2 were calculated as follows. This method results in an accurate, but least conservative, approach to flow estimation. The current dwelling unit flow was calculated using existing zoning, population, and flow data. This value was then applied in estimating future flow projections.

- Step 1: The GIS database was queried to determine the existing area for the City's zoning categories for each flow monitoring basin (see Table 5.9 Section A).
- Step 2: For each basin, unit flow rates were adjusted for each zoning category (see Table 5.9 Section B) to match measured flow (see Table 5.9 Section C).
- Step 3: Once unit flow rates were "calibrated" to the measured flow, the residential flow component was isolated. Zoning categories R1, R2, R3, RP, SR, and SRH were used to calculate residential flow. Based on these assumptions, approximately 0.93 mgd or 54 percent of the City's 1.71 mgd of ADWF is residential. Flows may not exactly match those in Table 5.8 due to minor differences between the model and spreadsheet calculations.
- Step 4: A per capita flow rate was calculated by dividing the residential flow component by the estimated existing sewered population of 13,300. The resulting calculated per capita flow rate of 70 gpcd is consistent with industry standards and other communities in northern California.
- Step 5: A dwelling unit flow was calculated by multiplying the per capita flow rate by 2.7 persons per household. This resulted in a value of 189 gpd/du. This value is consistent with existing flow calculations and the temporary flow monitoring program conducted as part of the Project.

Table 5.9 **Dwelling Unit Flow Calculation**
Sanitary Sewer Master Plan
City of Oroville

Section A: Zoning Area

Basin	C1	C2	CLM	HC	M2	NC	O	PQ	R1	R2	R3	RP	SR	SRH	U	Total	Residential	% Res by Basin
	Zoning Category																	
	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(Acres)	(%)
1	0.0	0.0	0.0	0.0	87.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.2	0.0	0.0%
2	0.0	24.8	2.5	0.0	130.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	157.4	0.0	0.0%
3	0.0	62.9	20.3	0.0	69.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	152.8	0.0	0.0%
4A	2.9	72.2	6.5	0.0	0.0	0.0	1.4	20.4	14.9	55.7	4.7	8.9	0.0	0.0	0.0	187.6	84.2	44.9%
4B	9.4	8.6	18.9	0.0	17.0	0.0	0.0	19.9	18.8	8.8	18.1	11.9	0.0	0.0	0.0	131.3	57.5	43.8%
5	15.4	21.3	12.9	0.0	0.0	3.9	4.0	25.8	55.3	26.4	0.0	2.2	0.0	0.0	0.0	167.3	83.9	50.1%
6	19.6	0.0	0.0	0.0	0.0	3.3	0.0	0.0	56.6	36.2	0.0	2.4	0.0	0.0	0.0	118.1	95.2	80.6%
7	46.5	35.2	1.7	0.0	0.0	0.7	0.0	36.0	89.0	16.3	7.4	21.4	0.0	0.0	0.0	254.2	134.1	52.8%
8	0.0	23.6	0.0	0.0	0.0	0.0	0.0	20.3	90.1	0.4	0.0	1.6	26.4	9.1	0.0	171.5	127.6	74.4%
9	0.0	0.0	0.0	0.0	0.0	6.4	0.0	10.7	129.4	24.3	2.2	4.4	29.5	0.0	0.0	206.7	189.7	91.8%
C1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.0	0.0	0.0%
C2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.6	0.0	7.3	0.0	0.0	0.0	0.0	0.0	60.9	7.3	12.0%
Airport	0.0	0.0	0.0	0.0	0.0	0.0	307.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	307.7	0.0	0.0%
5th	1.2	29.4	0.0	0.2	0.0	1.9	0.0	9.3	66.4	90.7	0.0	4.9	0.0	0.0	3.8	207.7	161.9	78.0%
Total	**95.0**	**278.0**	**62.8**	**0.2**	**303.9**	**16.3**	**313.1**	**249.1**	**520.4**	**266.1**	**32.3**	**57.8**	**55.9**	**9.1**	**3.8**	**2,263.6**	**941.5**	**41.6%**

Section B: Unit Flow Factors

Basin	C1	C2	CLM	HC	M2	NC	O	PQ	R1	R2	R3	RP	SR	SRH	U
	Zoning Category														
	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)	(GPAD)
1	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0
2	0	650	500	0	713	0	0	0	0	0	0	0	0	0	0
3	0	650	500	0	1,007	0	0	0	0	0	0	0	0	0	0
4A	1,467	1,470	500	0	0	0	0	350	1,000	1,300	1,500	1,600	0	0	0
4B	1,600	1,967	200	0	150	0	0	200	0	1,300	1,500	1,600	0	0	0
5	680	680	500	0	0	1,500	0	480	500	600	800	1,000	0	0	0
6	2,088	0	0	0	0	1,600	0	0	1,000	1,300	0	1,600	0	0	0
7	796	1,100	500	0	0	1,500	0	500	700	800	900	1,200	0	0	0
8	0	1,050	0	0	0	0	0	980	500	600	0	800	300	300	0
9	0	0	0	0	0	2,000	0	1,029	1,650	1,700	1,800	2,000	1,200	0	0
C1	0	0	0	0	0	0	0	1,064	0	0	0	0	0	0	0
C2	0	0	0	0	0	0	0	199	0	300	0	0	0	0	0
Airport	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
5th	1,000	1,500	0	2,000	0	1,500	0	429	700	1,000	0	1,200	0	0	50
Average	**1,146**	**1,087**	**410**	**2,000**	**551**	**1,717**	**10**	**576**	**896**	**1,105**	**1,383**	**1,404**	**775**	**300**	**50**

Section C: Calculated Dry Weather Flow

Basin	C1	C2	CLM	HC	M2	NC	O	PQ	R1	R2	R3	RP	SR	SRH	U	Total	Measured	Difference	% Difference	Residential
	Zoning Category																			
	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(GPD)	(%)	(GPD)
1	0	0	0	0	2,180	0	0	0	0	0	0	0	0	0	0	2,180	2,151	29	1.3%	0
2	0	16,127	1,243	0	92,793	0	0	0	0	0	0	0	0	0	0	110,162	110,137	25	0.0%	0
3	0	40,913	10,157	0	70,027	0	0	0	0	0	0	0	0	0	0	121,097	121,105	-9	0.0%	0
4A	4,270	106,063	3,249	0	0	0	0	7,157	14,854	72,461	7,020	14,315	0	0	0	229,390	229,388	2	0.0%	108,650
4B	14,995	16,987	3,776	0	2,555	0	0	3,987	0	11,384	27,086	19,050	0	0	0	99,819	99,815	4	0.0%	57,519
5	10,505	14,481	6,436	0	0	5,892	0	12,400	27,673	15,833	0	2,159	0	0	0	95,378	95,368	10	0.0%	45,665
6	40,854	0	0	0	0	5,328	0	0	56,609	47,034	0	3,883	0	0	0	153,708	153,698	10	0.0%	107,526
7	37,001	38,708	854	0	0	1,035	0	17,991	62,313	13,044	6,652	25,708	0	0	0	203,305	203,310	-5	0.0%	107,716
8	0	24,735	0	0	0	0	0	19,919	45,027	246	0	1,304	7,919	2,731	0	101,881	101,878	3	0.0%	57,227
9	0	0	0	0	0	12,764	0	10,974	213,429	41,235	3,904	8,870	35,356	0	0	326,532	326,522	10	0.0%	302,794
C1	0	0	0	0	0	0	0	56,420	0	0	0	0	0	0	0	56,420	56,375	44	0.1%	0
C2	0	0	0	0	0	0	0	10,665	0	2,203	0	0	0	0	0	12,868	12,871	-3	0.0%	2,203
Airport	0	0	0	0	0	0	3,077	0	0	0	0	0	0	0	0	3,077	3,000	77	2.6%	0
5th	1,194	44,063	0	318	0	2,886	0	3,978	46,456	90,681	0	5,862	0	0	191	195,629	195,625	4	0.0%	142,999
Total	**108,819**	**302,076**	**25,714**	**318**	**167,555**	**27,905**	**3,077**	**143,491**	**466,360**	**294,121**	**44,662**	**81,151**	**43,275**	**2,731**	**191**	**1,711,446**	**1,711,244**	**202**	**0.0%**	**932,300**

Population (Sewered Area) = 13,300
Household size (Persons/du) = 2.7
Per Capita Flow Rate (Total Residential Flow/Population, gpcd) = **70**
EDU Unit Flow Rate (Household size x Per capita flow rate, gpd/du) = **189**

5.5.2.2.3 *Alternative 3*

Alternative 3 provides a result between the least and most conservative flow calculation methods. Residential flow is estimated using a unit flow of 189 gpd/du, consistent with Alternative 2. Industrial and commercial flow is estimated using basin level flow factors from existing flow calculations. Where existing flow factors are missing, the citywide existing flow factors are used. The industrial flow factor for Basin 1 was increased from 25 gpad to 200 gpad to provide an approach representing a lower end of typical industrial development and an alternative that is more conservative than Alternative 2. The resulting DWF is estimated at 6.57 mgd.

5.5.2.2.4 *Alternative 4*

Alternative 4 is similar to Alternative 2 except for the allocation of the industrial flow factor in Basin 1. Based on conversations with City staff, it was requested that an alternative be developed that factored in approximately 50 percent of the industrial area in Basin 1 as wet industry. By comparison, Alternative 2 projects approximately 2.6 percent wet industry. A unit flow factor of 25 gpad is used for calculating dry industry flow and 1,000 gpad for wet industry flow. The resulting DWF is estimated at 6.45 mgd. Based on the proposed DWF of 6.45 mgd, anticipated total number of EDUs at buildout is calculated as 34,127. Subtracting the current number of EDUs (9,055 per Section 5.5.1), the future EDUs that will contribute to the collection system is estimated at 25,072.

Alternative 4 was chosen as the future flow projection alternative since it best reflects the proposed growth in the City.

5.5.2.3 Inflow and Infiltration

Inflow and Infiltration (I/I) amounts were also estimated. Based on current model results, the existing system's I/I is estimated at 8.8 mgd, excluding TWSD. I/I is based on a 10-year, 24-hour Design Storm occurring simultaneously across the City. It is anticipated that new development will have lower I/I rates and are assumed to be 400 gpad based upon industry experience modeling new collection systems utilizing contemporary pipe and manhole materials and constructed with appropriate quality control procedures. The I/I rate for new development was applied to all future sewered properties within the SOI and is estimated at 3.5 mgd. It is assumed that I/I for existing sewered areas would remain constant (i.e., the City's maintenance program results in no additional deterioration over time – further I/I condition degradation is offset with gains realized through pipeline replacement or repair). The future I/I for the City's service area is thus estimated at 12.4 mgd when existing and future I/I values are added. The estimated future I/I may differ when modeled due to flow attenuation techniques utilized by the modeling software that more accurately reflects in-field conditions. Table 5.8 summarizes the flow for both existing and future conditions.

5.6 CALIBRATION

Model calibration is a crucial component of the hydraulic modeling effort. The model must be calibrated to known flow metering data to ensure accurate predictions. The calibration process consists of matching both modeled and measured DWF and WWF events. DWF calibration ensures an accurate depiction of baseflow generated within the City. The WWF calibration consists of calibrating the hydraulic model to storm events to quantify the peak flows and volume of I/I into the collection system. The amount of I/I that enters the collection system is the difference between the total measured flow and the DWF.

5.6.1 Dry Weather Flow Calibration

The DWF calibration consists of two steps: (1) defining flow volumes for each parcel and (2) creating diurnal curves to match the temporal distribution of flow.

The first step in the calibration process is to define the flow volumes for each parcel. This was achieved using the City's land use data and flow factors. After the flow volumes are input into each parcel, diurnal curves are created for all manholes tributary to a specific flow meter. The diurnal curves depict the time variation of baseflow throughout the day. Peaks in the diurnal curve usually occur in the morning, between 8:00 a.m. and 10:00 a.m., and again in the evening, between 6:00 p.m. and 8:00 p.m. Figure 5.4 presents an example diurnal curve used for the manholes tributary to Flow Meter 7. Similar diurnal curves were developed for each of the remaining flow meters and their tributary manholes.

The calibration process compares the flow metering data with the model output. Comparisons are made for minimum, maximum, and average flows, as well as the temporal distribution, or hydrograph shape. Table 5.10 summarizes the DWF calibration results using minimum, maximum, and average flow results. An example of the DWF calibration for Flow Meter 3 is presented in Figure 5.5. The remaining DWF calibration plots are provided in Appendix D.

Industry standards indicate that dry weather calibration is considered acceptable when modeled and measured flows are within 0.1 mgd or 10 percent, whichever is more. No anomalies or difficulties were encountered during the DWF calibration process.

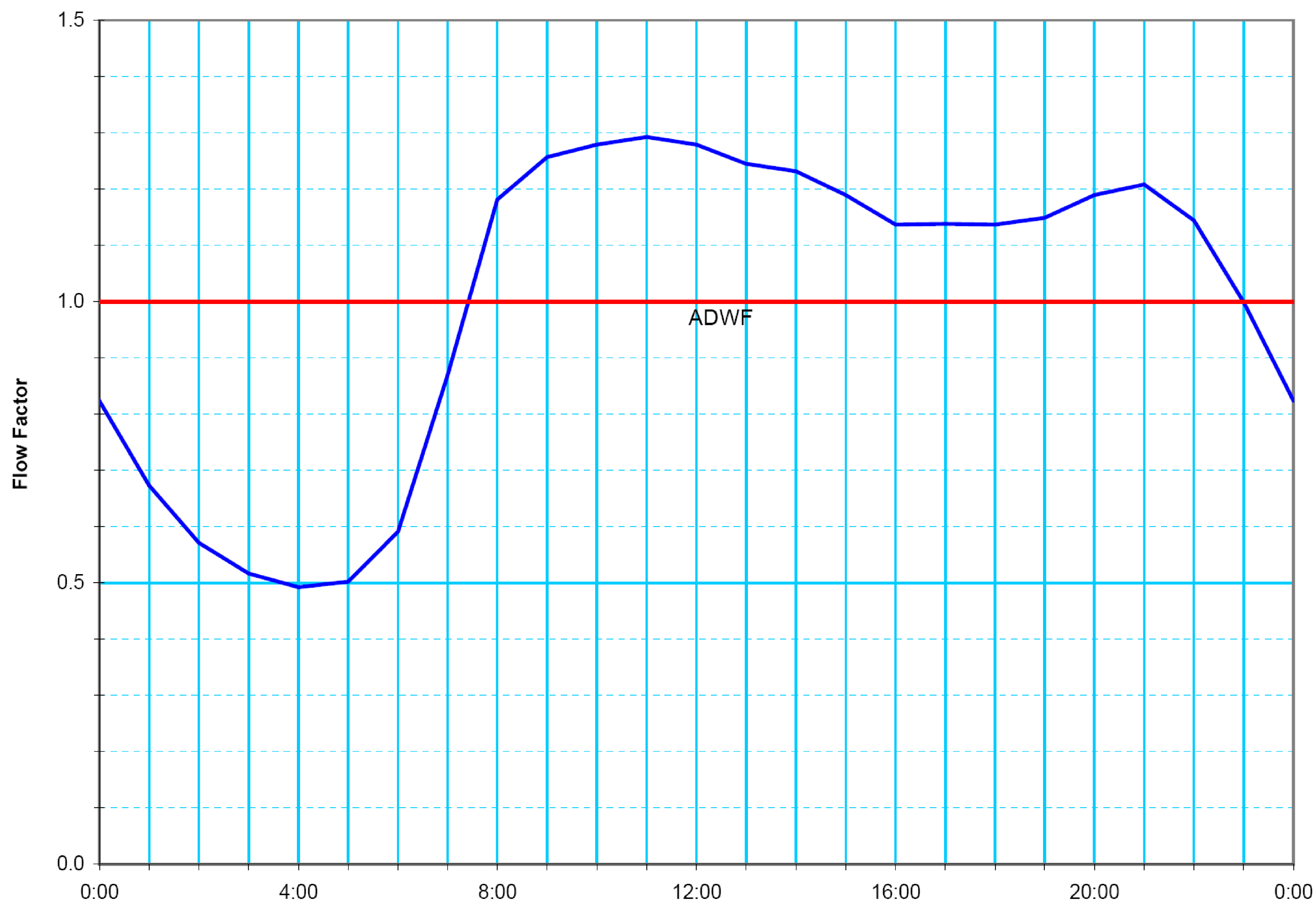

Figure 5.4
EXAMPLE DIURNAL CURVE
METER 3
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

Engineers...Working Wonders With Water™

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Table 5.10 Dry Weather Flow Calibration Summary
Sanitary Sewer Master Plan
City of Oroville

Meter I.D.	Metered ADWF[1] (mgd)[2]	Modeled ADWF (mgd)[2]	Difference (mgd)[2]	Percent Difference (%)
1	0.002	0.002	0.00	0.0
2	2.54	2.51	-0.02	-0.8
3	1.34	1.33	-0.02	-1.2
4A	0.59	0.57	-0.02	-3.7
4B	0.36	0.36	-0.003	-0.9
5	0.26	0.26	-0.003	-1.0
6	0.17	0.17	-0.001	-0.6
7	0.63	0.62	-0.01	-1.4
8	0.10	0.10	-0.002	-2.7
9	0.33	0.32	-0.01	-2.5
C1	0.056	0.056	0.00	0.0
C2	0.013	0.014	+0.001	+9.6
FRPS[3]	0.68	0.70	+0.03	+4.1
WWTP[4]	2.99	2.97	-0.02	-0.6

Notes:
1. ADWF = Average Dry Weather Flow.
2. mgd = million gallons per day.
3. FRPS = Feather River Pump Station.
4. WWTP = Wastewater Treatment Plant (includes flow from LOAPUD).

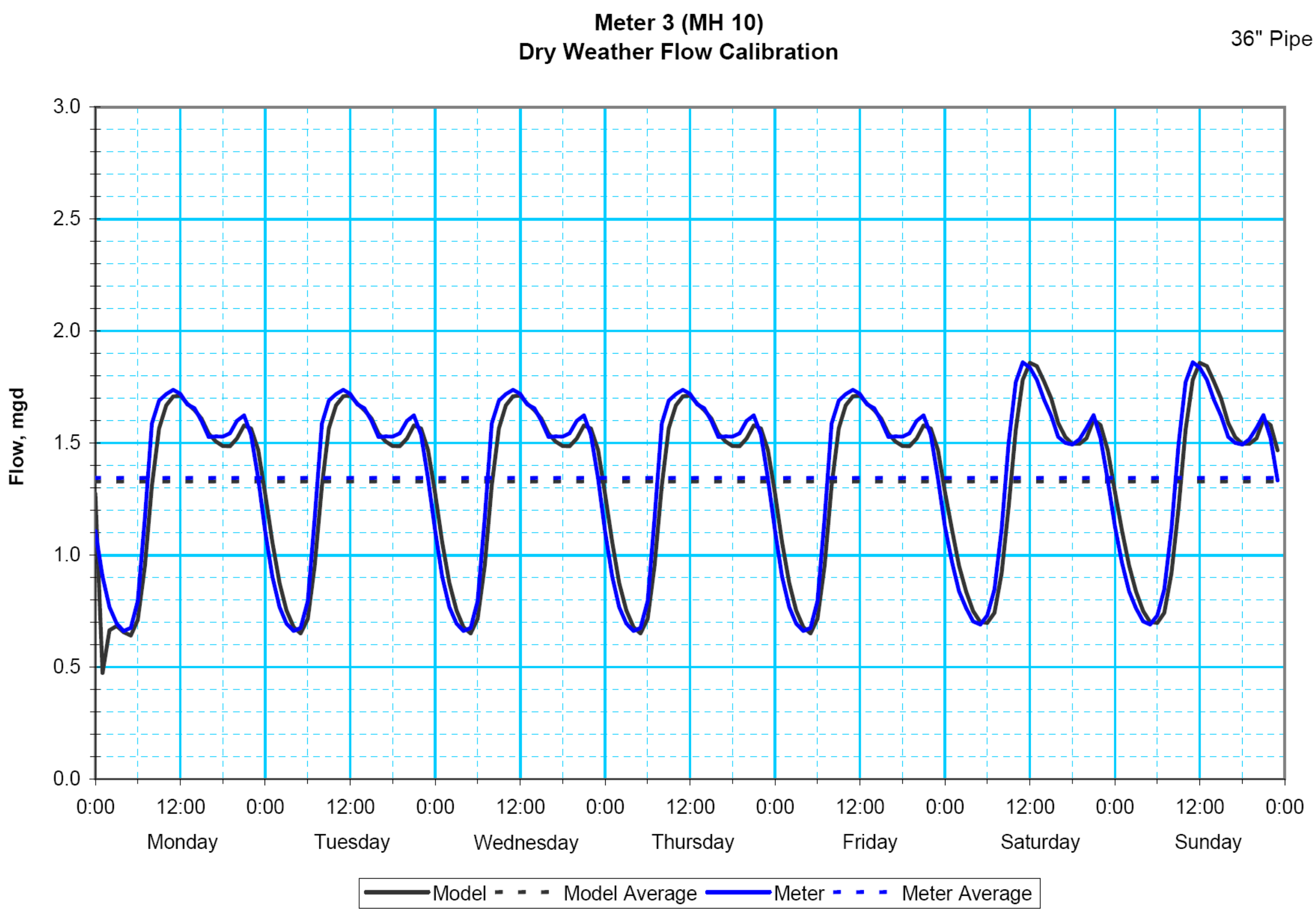

Figure 5.5
EXAMPLE DRY WEATHER FLOW CALIBRATION
METER 3
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

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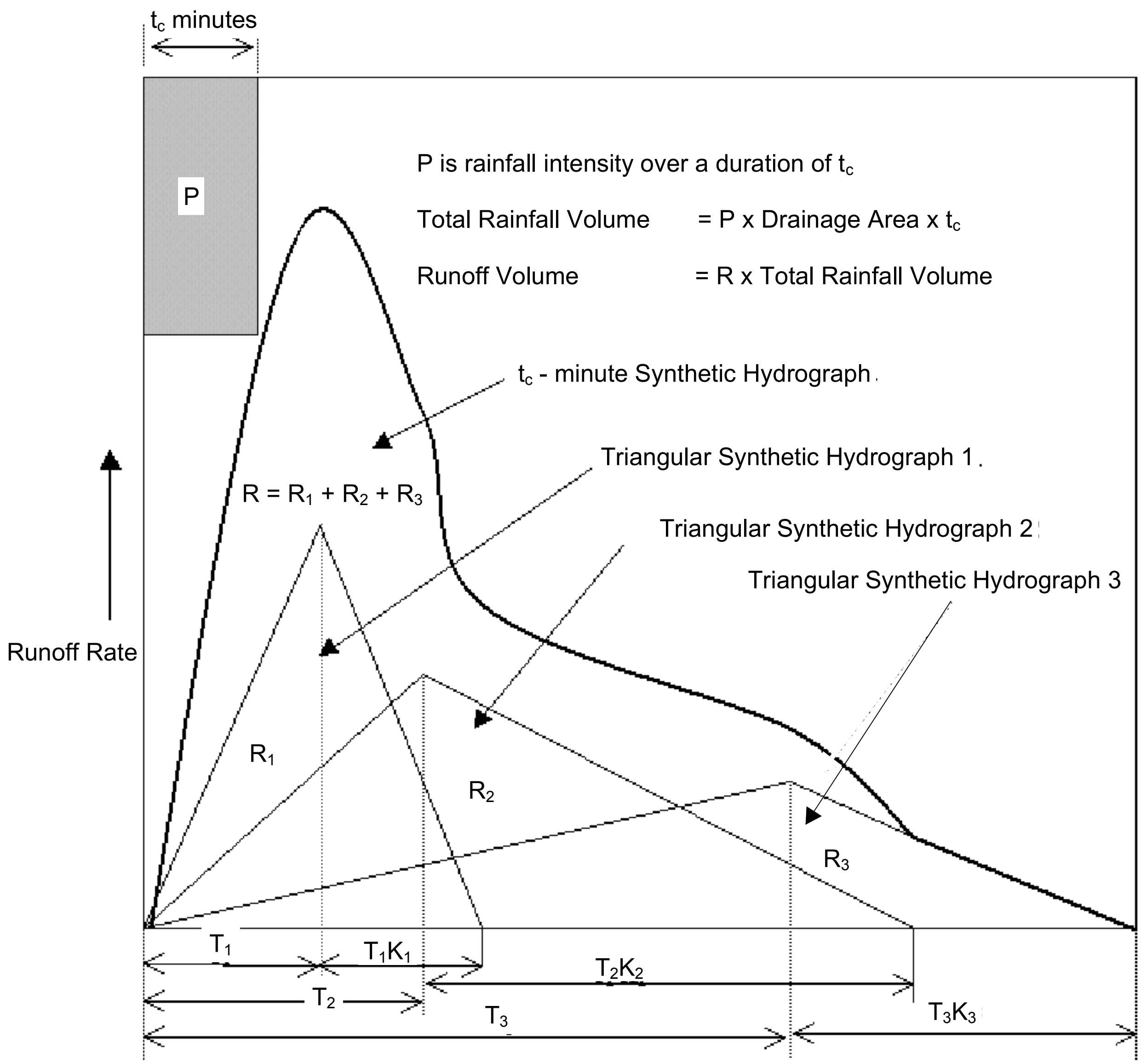
5/3/2012

5.6.2 Wet Weather Flow Calibration

WWF calibration enables the modeled collection system to accurately predict I/I entering a collection system during a storm event. WWF calibration consists of two steps: (1) determining a rainfall event that characterizes the most significant impact on the collection system facilities, preferably during wet antecedent soil moisture conditions and (2) creating a database of I/I parameters for each pipe for this rainfall event. The selected rainfall event should be representative of a typical wet weather storm. Ideally, the rainfall event will have a total volume very close to the design storm volume that is selected to assess the capacity of the collection system facilities. GWI can be an influential component of defects if the groundwater table is above the invert elevation of the pipelines. Thus, the calibration storm event should be selected such that the groundwater table is at or near its maximum height. This allows the model to be calibrated to the worst-case scenario. Other factors, such as the age and condition of the collection system facilities, will impact the quantity of I/I into the system. Typically, older sewer pipes will have a greater tendency to allow I/I into the collection system than newer pipes.

WWF was calibrated using H2OMAP Sewer's tri-triangle method. This method uses three triangular synthetic unit hydrographs to simulate I/I caused by rainfall. The first triangle represents rapid response sources usually associated with direct inflow. The second triangle represents medium response components. The third triangle represents slow response components such as groundwater and long-term infiltration. Each triangle uses three parameters in combination with an associated drainage area. The three parameters are the effective rainfall percentage, R, the time to peak, T, and the recession constant, K. The R, T, and K parameters were adjusted until I/I closely matched the metered flow. Figure 5.6 illustrates the triangular synthetic hydrograph method.

The model was calibrated to three wet weather events, two during the temporary flow monitoring period of February to May 2007 and one historical event in late December 2005. Calibration to multiple wet weather events allows the model to better predict I/I response in the system.



Source: H2OMAP Sewer User's Manual (2004).

Figure 5.6
TRI-TRIANGLE SYNTHETIC UNIT HYDROGRAPH METHOD
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

5.6.2.1 February 7-15, 2007 Calibration

The model was calibrated to WWF for the February 7-15, 2007, rainfall event. Rainfall for this event measured from 3.39 to 4.07 inches during the entire rainfall event at the four rain gauges used during the flow monitoring effort. Using historical precipitation data from the National Oceanic and Atmospheric Administration (NOAA), the peak 24-hour period during this protracted rainfall event is less than a 2-year event (a storm that has the probability to occur once every 2 years).

Table 5.11 summarizes the WWF calibration effort for the February 7-15 rainfall event. The table compares metered vs. modeled flows and lists the difference between the two in mgd units and as a percentage. Wet weather calibration is considered acceptable when modeled and measured flows are within 0.2 mgd or 15 percent, whichever is greater, in accordance with industry standards. An example calibration plot is illustrated in Figure 5.7 for Meter 3. Calibration plots for each meter are located in Appendix E.

5.6.2.2 February 21 - March 1, 2007 Calibration

The model calibration was further refined using the February 21 – March 1 rainfall event. The peak 24-hour period embedded within this protracted event also is considered to have a return period of less than 2 years. The system experienced 2.07 to 2.93 inches at the four rain gauges over the entire period. Table 5.11 summarizes the WWF calibration effort for the February 21 – March 1 rainfall event, and calibration plots are located in Appendix F.

All meter calibrations were within acceptable tolerances except for Meter 3. The February 21 – March 1 calibration underestimated measured flow by 15.6 percent. However, this was balanced by the February 7-15 calibration overestimating measured flow by 7.7 percent.

5.6.2.3 December 2005 Calibration

As a verification of the model calibration, the late December 2005 (December 29, 2005 – January 1, 2006) storm was simulated in the model. The rainfall event measured 3.24 inches within the peak 24 hours of the storm event at the Oroville Dam rain gauge. According to NOAA, a 5-year, 24-hour event has a rainfall volume of 3.5 inches. The December 2005 is thus an approximate 5-year event. Data from the WWTP, FRPS, and the 5th and Grand meter were used to verify model calibration.

Table 5.11 Wet Weather Flow Calibration
Sanitary Sewer Master Plan
City of Oroville

Meter I.D.	February 7-15, 2007 Metered PWWF[1] (mgd)[2]	Modeled PWWF (mgd)[2]	Difference (mgd)[2]	Percent Difference (%)	Model Peaking Factor	February 21 - March 1, 2007 Metered PWWF[1] (mgd)[2]	Modeled PWWF (mgd)[2]	Difference (mgd)[2]	Percent Difference (%)	Model Peaking Factor
1	0.011	0.008	-0.003	-28.3	3.7	0.009	0.007	-0.002	-22.7	3.2
2[3]	---	7.34	---	---	---	---	5.45	---	---	---
3	4.67	5.03	+0.36	+7.7	3.8	4.35	3.67	-0.68	-15.6	2.8
4A	1.83	1.90	+0.07	+4.1	3.3	1.53	1.48	-0.05	-3.0	2.6
4B	1.45	1.60	+0.15	+10.5	4.5	1.24	1.25	-0.01	-1.4	3.5
5	1.47	1.45	-0.02	-1.6	5.6	1.12	1.14	-0.02	-2.0	4.3
6	0.97	1.00	+0.03	+3.9	6.1	0.61	0.63	+0.02	+3.5	3.8
7	3.26	2.99	-0.27	-8.3	4.8	2.34	2.17	-0.17	-6.9	3.5
8	0.40	0.40	+0.001	+0.4	4.0	0.26	0.24	-0.02	-7.7	2.4
9	1.42	1.60	+0.18	+12.7	5.0	1.29	1.13	-0.16	-12.7	3.5
C1	0.12	0.14	+0.02	+17.9	2.5	0.14	0.13	-0.01	-4.3	2.4
C2	0.19	0.19	-0.001	-0.03	13.4	0.17	0.15	-0.02	-9.3	10.8
FRPS[4]	2.17	2.23	+0.01	+0.5	3.1	---[6]	1.71	---	---	2.4
WWTP[5]	11.13	10.60	+0.53	+5.0	3.7	---[6]	8.13	---	---	2.7

Notes:
1. PWWF = Peak wet weather flow.
2. mgd = million gallons per day.
3. Meter 2 collected only 2 weeks of data due to sewer work and was excluded from calibration.
4. FRPS = Feather River Pump Station.
5. WWTP = Wastewater Treatment Plant (includes flow from LOAPUD).
6. Data not available.

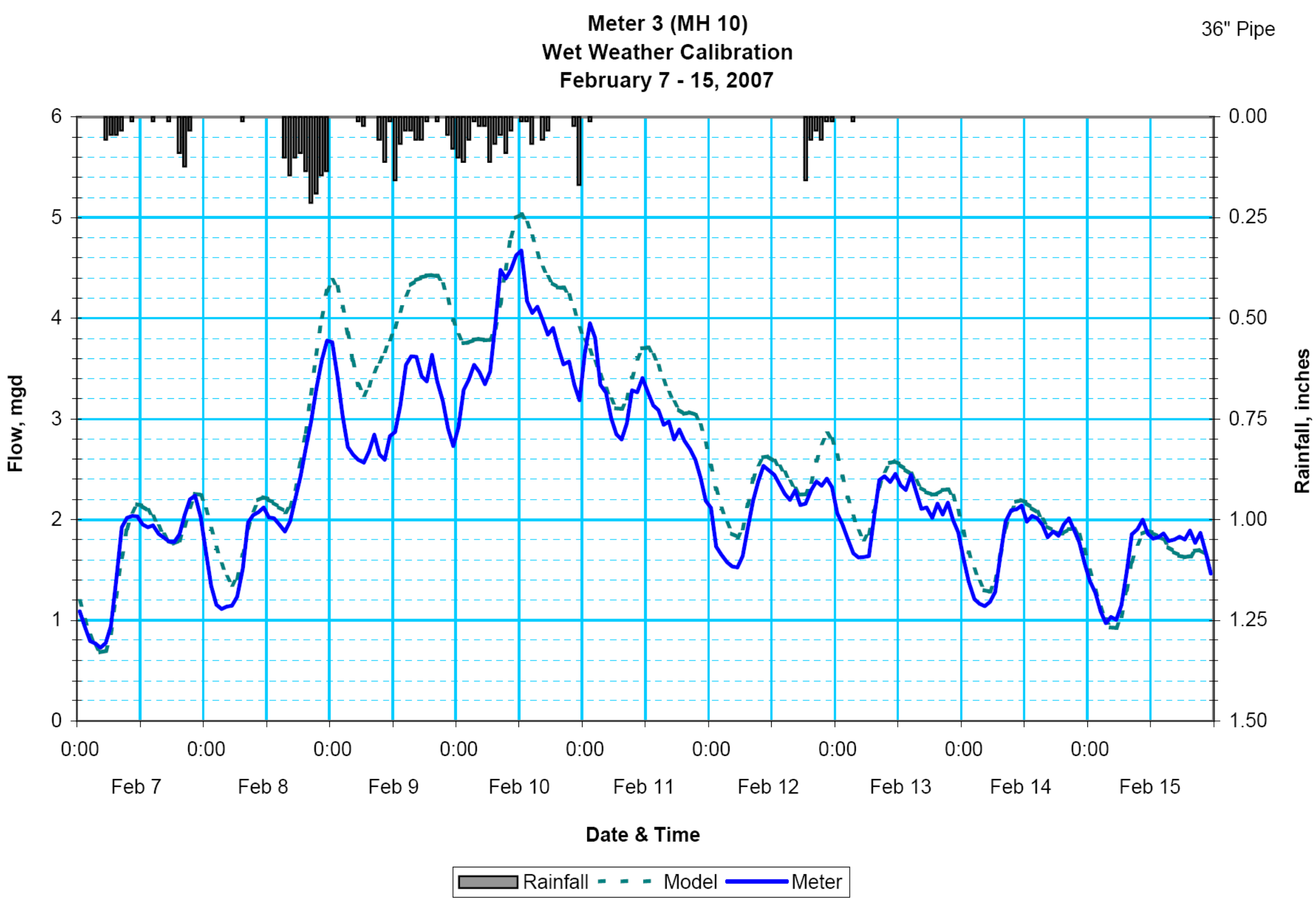


Figure 5.7
EXAMPLE WET WEATHER FLOW CALIBRATION
METER 3
SANITARY SEWER MASTER PLAN
CITY OF OROVILLE

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5/3/2012

The model closely simulated flow at the chosen locations with a maximum difference of 8.2 percent between measured and modeled flows. Table 5.12 presents the calibration results, and Appendix G contains calibration plots of all locations. The three calibration events cover a wide range of rainfall events and ensure that the hydraulic model is well suited to estimate I/I and identify capacity deficiencies.

Table 5.12 December 2005 Wet Weather Flow Calibration
Sanitary Sewer Master Plan
City of Oroville

Meter I.D.	Metered PWWF[1] (mgd)[2]	Modeled PWWF (mgd)	Difference (mgd)	Percent Difference (%)
5th[3]	0.77	0.76	-0.01	-1.2
FRPS[4]	3.82	3.92	+0.10	+2.8
LOAPUD[5]	8.44	7.80	-0.56	-8.2
WWTP[6]	15.02[7]	14.40	-0.62	-4.3

Notes:
1. PWWF = Peak Wet Weather Flow.
2. mgd = million gallons per day.
3. 5th = 5th and Grand meter.
4. FRPS = Feather River Pump Station.
5. LOAPUD = Lake Oroville Area Public Utilities District.
6. WWTP = SC-OR Wastewater Treatment Plant.
7. Approximate value. Estimated by adding plant secondary and bypass flows.