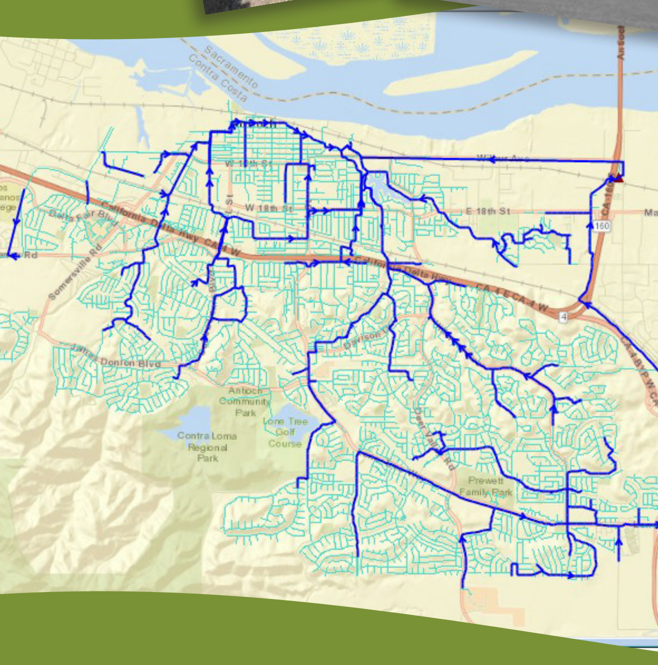
City of Antioch

Wastewater Collection System Master Plan



October 2014

Final Report

RMC water and environment

October 28, 2014

Mr. Scott Buenting, P.E.
City of Antioch
Department of Public Works
200 H Street
Antioch, CA 94531-5007

Subject: Wastewater Collection System Master Plan

Dear Mr. Buenting:

RMC Water and Environment is pleased to submit this Final Report for the City of Antioch's Wastewater Collection System Master Plan. The report updates the City's last Master Plan prepared in 2003, and presents the results of a comprehensive analysis of the wastewater collection system to support the City's ongoing efforts to upgrade its sewer infrastructure.

The study included a detailed capacity assessment of the trunk sewer system, based on sewer system flow monitoring at 20 locations, historical water use data, up-to-date land use plans for future development areas, and state-of-the art hydraulic modeling to quantify flows in the system and identify existing and future capacity requirements. In addition, the study developed a long-term projection of system renewal and replacement needs based on analysis of the age and material of sewer system pipes.

The information presented in the report will help inform City decisions on providing additional hydraulic capacity where needed and targeting sewer system renewal and replacement to maintain this valuable City asset and to extend the useful life of the system. The report also supports the City's compliance with the Sewer System Management Plan requirements of the Statewide General Waste Discharge Requirements for Sanitary Sewer Systems.

We appreciate the opportunity to have worked with the City on this challenging project and thank City staff for their assistance and guidance throughout the study.

Sincerely,

Gisa M. Ju, P.E.
Project Manager

Chris van Lienden, P.E.
Project Engineer

2175 North California Boulevard, Suite 315
Walnut Creek, CA 94596 • 925.627.4100 • rmcwater.com

Complex Challenges | Innovative Solutions

City of Antioch
Wastewater Collection System
Master Plan
Final Report

REGISTERED PROFESSIONAL ENGINEER
GISA MEI JU
No. 031823
Exp. 12-31-14
CIVIL
STATE OF CALIFORNIA

Prepared by:

RMC water and environment

REGISTERED PROFESSIONAL ENGINEER
CHRISTOPHER C. VANLIENDEN
No. 75034
Exp. 12-31-15
CIVIL
STATE OF CALIFORNIA

October 2014

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Acknowledgements

CITY OF ANTIOCH
DEPARTMENT OF PUBLIC WORKS

Ron Bernal, Public Works Director / City Engineer

Lynne Filson, Assistant City Engineer

Scott Buenting, Associate Engineer (Project Manager)

Mindy Gentry, Senior Planner

Brandon Peters, GIS Technician

Brandon Chalk, Collections Division Supervisor

RMC WATER AND ENVIRONMENT

Dave Richardson, Principal-in-Charge

Gisa Ju, Project Manager

Chris van Lienden, Project Engineer

Cathy Greenman, Technical Advisor

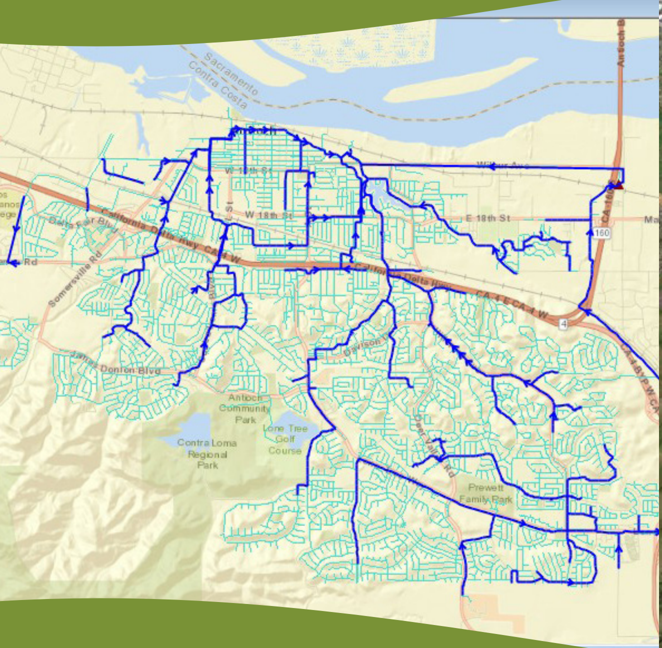
Subconsultants

V&A Consulting Engineers (Flow Monitoring)

List of Abbreviations

ACP	Asbestos Cement Pipe
ADWF	Average Dry Weather Flow
BWF	Base Wastewater Flow
CCTV	Closed-Circuit Television
CIP	Capital Improvement Program or Capital Improvement Plan
CIPP	Cured-in-Place Pipe
City	City of Antioch
d/D	Ratio of flow depth to pipe diameter
DDSD	Delta Diablo Sanitation District
DIP	Ductile Iron Pipe
DU	Dwelling Unit
DWF	Dry Weather Flow
ENR CCI	Engineering News Record Construction Cost Index
ERU	Equivalent Residential Unit
FAR	Floor-Area-Ratio
FM	Flow Meter
FUA-1	Future Urban Area-1
FUA-2	Future Urban Area-2
GIS	Geographic Information System
gpd	Gallons per day
GWI	Groundwater Infiltration
I/I	Infiltration and Inflow
LF	Lineal Feet
MFR	Multi-Family Residential
mgd	Million gallons per day
MH	Manhole
NR	Non-residential
PDWF	Peak Dry Weather Flow
PVC	Polyvinyl Chloride (Pipe)
PWWF	Peak Wet Weather Flow
RDI/I	Rainfall Dependent Infiltration and Inflow
RMC	RMC Water and Environment
R/R	Renewal/Replacement
SF	Square Feet
SFR	Single Family Residential
SP	Steel Pipe
V&A	V&A Consulting Engineers
VCP	Vitrified Clay Pipe
VCPRG	VCP with rubber-gasketed joints
VCPRJ	VCP with rigid joints
WWF	Wet Weather Flow
WWTP	Wastewater Treatment Plant

Executive Summary



City of Antioch Wastewater Collection System Master Plan

Executive Summary

This report presents the results and recommendations of the Wastewater Collection System Master Plan for the City of Antioch (City). The report was prepared by RMC Water and Environment (RMC) under an agreement with the City dated November 14, 2012. The objective of this Master Plan is to prepare a comprehensive assessment of the City's sewer collection system in order to identify system capital improvement needs.

ES-1 Background and Purpose of Study

The City's wastewater collection system encompasses the entire urbanized portion of the City of Antioch, serving a population of about 105,000. The City is anticipating significant growth in the southern and eastern portions of the City, in areas that the City's General Plan identifies as Future Urban Area-1 (FUA-1) and Future Urban Area 2 (FUA-2). In addition, the City has recently annexed the major portion of a primarily industrial area (Northeast Annexation Area) located north of the previous City limits in the east. The study area for this Master Plan consists of the City of Antioch and areas outside of the City that are planned for annexation or included in the City's development plans, as shown in **Figure ES-1**.

The City's wastewater collection system includes approximately 292 miles of gravity sewer mains. (All sewer pump stations and force mains in the City's system have been decommissioned.) The City's wastewater collection system is shown in **Figure ES-2**.

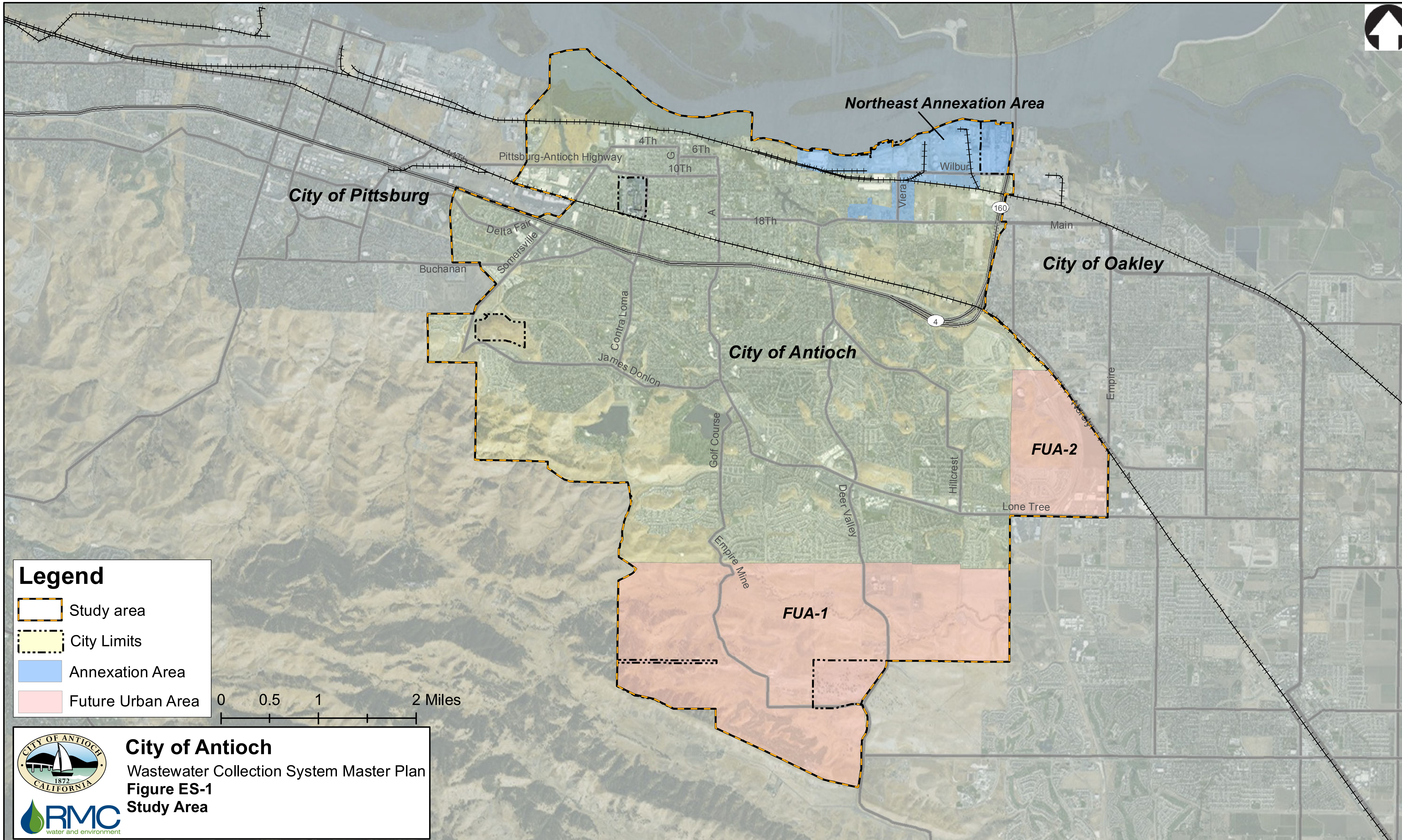
The majority of the collection system discharges to two Delta Diablo Sanitation District (DDSD) pump stations (Bridgehead Pump Station and Antioch Pump Station), from where the flow is conveyed via force main to the DDSD Wastewater Treatment Plant (WWTP). A small portion of Antioch along the border with the City of Pittsburg discharges to DDSD's Pittsburg-Antioch Interceptor. DDSD facilities were previously evaluated as part of DDSD's 2010 Conveyance System Master Plan Update.

The purpose of the Wastewater Collection System Master Plan (Master Plan) is to update the trunk system capacity assessment and recommended capacity improvement program presented in the City's 2003 Wastewater Collection System Master Plan to reflect updated land use and flow estimates and sewer projects completed since the 2003 report was developed.

To meet the project objectives, the Collection System Master Plan included the following tasks:

- Development of an updated hydraulic model of the trunk sewer system.
- Collection of flow data to verify design flow criteria and calibrate the hydraulic model.
- Refinement of the land use and flow projections to reflect the City's most current development plans.
- Identification of capacity deficiencies and development of sewer improvement solutions, if needed, to provide relief capacity.
- Assessment of potential long range sewer replacement needs.

The findings and recommendations of the Master Plan are summarized in the following sections.



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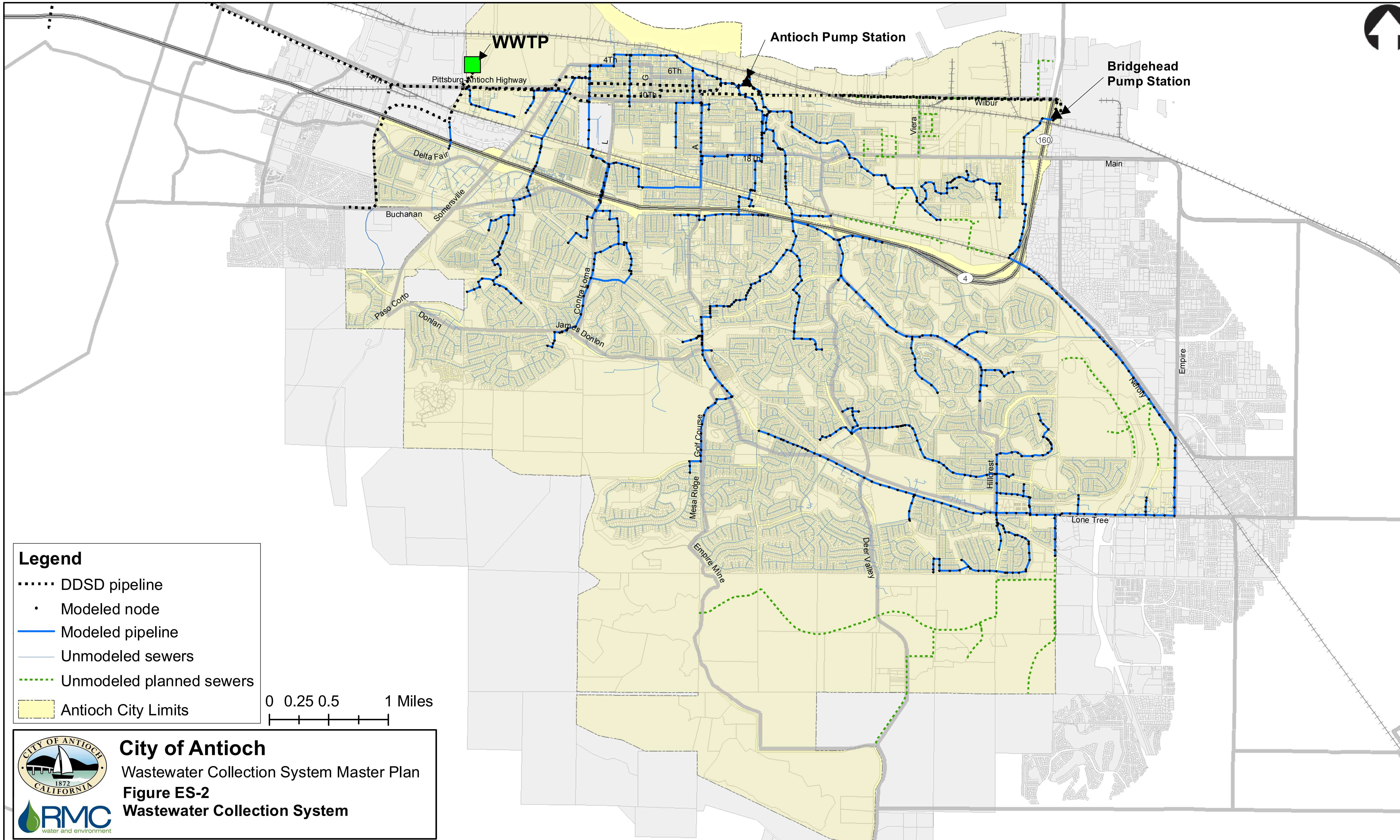

Legend

- DDSD pipeline
- Modeled node
- Modeled pipeline
- Unmodeled sewers
- Unmodeled planned sewers
- Antioch City Limits

0 0.25 0.5 1 Miles

City of Antioch

Wastewater Collection System Master Plan

Figure ES-2

Wastewater Collection System

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ES-2 Capacity Analysis and Capacity Improvement Program

The capacity of the collection system was assessed using a hydraulic model. The assessment focused on the trunk sewer network, the system of major pipes that convey flow generated throughout the area to the DDSD conveyance system. The modeled network includes all gravity sewers 10 inches in diameter and larger and additional 8-inch lines that were considered important to the system, totaling about 18 percent of the length of sewers in the collection system. The modeled network is indicated on Figure ES-2.

ES-2.1 Estimated Wastewater Flows

Estimates of existing wastewater flows for the model were developed from customer water use data provided by the City and from a flow monitoring program conducted for this study. Winter water use data typically provides an accurate estimate of base wastewater flow (BWF), as outside water use is minimal during that time of year.

Flow monitoring was conducted at 20 sites in the collection system during the winter 2012/13, with rainfall data also collected by three temporary rain gauges. The purpose of the monitoring was to obtain data to confirm base wastewater flows and diurnal wastewater flow patterns, and to quantify groundwater infiltration (GWI) and the flow response of the system to rainfall due to infiltration and inflow of storm water into the system, termed rainfall-dependent I/I (RDI/I). The flow monitoring data was used to estimate the amount of GWI and RDI/I for various areas of the system and to confirm, through model calibration, that the hydraulic model reasonably simulates the actual performance of the system during both dry and wet weather conditions.

Estimates of additional flows from potential future development and annexation areas were determined from the City's General Plan, development area specific plans, and lists of near-term planned developments provided by the City's Planning Department. The major areas of future development include FUA-1, FUA-2, Hillcrest Station Specific Plan area, and Northeast Annexation Area, with other planned development projects or potentially developable vacant land located throughout the City. An increase of 10 percent in base wastewater flows from existing developed areas was also included to account for an assumed rebound in building occupancy.

Table ES-1 summarizes the average dry weather flow (ADWF) in the Antioch collection system (including GWI as measured during the 2012/13 flow monitoring period) for existing and future conditions.

Table ES-1: Antioch Dry Weather Flow Summary

Flow Component	Flow (mgd)	
	Existing	Future[a]
Residential BWF	6.28	9.25
Non-Residential BWF	0.96	2.15
Total Average BWF	7.24	11.40
Estimated GWI[b]	0.40	0.40
Total ADWF[b]	7.64	11.80

a. Also includes a 10 percent increase in flows from existing development to account for an assumed rebound in building occupancy.
b. Representative of a relatively dry wet weather season similar to 2012/13.

The capacity of the system was assessed with respect to the peak wet weather flow (PWWF) that would be projected to occur under a design rainfall event. The City selected the rainfall event that occurred on December 31, 2005 as the design storm for this Master Plan. This storm was also used as the design event for DDSD's 2010 Conveyance System Master Plan. The design storm has a total rainfall of 2.4 inches, with a peak hour intensity of 0.37 inches per hour.

Table ES-2 summarizes the peak flows from Antioch for each of the key DDSD conveyance system locations.

Table ES-2: Antioch Peak Flow Summary

Discharge Point	Flow (mgd)					
	Existing ADWF	Existing PDWF	Existing PWWF	Future ADWF	Future PDWF	Future PWWF
Bridgehead Pump Station	2.4	3.9	5.6	4.7	7.5	12.0
Antioch Pump Station[a]	7.3	10.4	17.0	11.3	17.8	26.3
Pittsburg-Antioch Interceptor[b]	0.3	0.5	0.8	0.5	0.8	1.2

a. Includes Bridgehead Pump Station flows.
b. Flows from Antioch only.

ES-2.2 Capacity Analysis Results and Required Improvements

The hydraulic model was run with the design storm to identify areas of the collection system that would not have adequate capacity to convey the peak wet weather flows generated by the design event. Capacity was considered inadequate whenever the model predicted that the peak flows would result in surcharge (water level above the crown of sewer pipes) of more than one foot, or within four feet of manhole rims.

Because the Master Plan flow monitoring period was very dry, with the largest storm event producing only 0.4 inches of rain, a sensitivity analysis was performed as part of the capacity analysis to identify potential additional system vulnerabilities if the GWI or RDI/I during a wetter winter season or under a larger storm event were greater than predicted.

Three scenarios were evaluated:

Scenario A: Calibrated model under design storm PWWF conditions. This scenario used the GWI and RDI/I parameters determined based on calibration to the 2012/13 flow monitoring data (supplemented with DDSD flow data from recent wet weather seasons).

Scenario B: A comparison with the flow monitoring data from previous programs suggested higher GWI rates in two specific areas of the system. While the source of higher GWI in these previous years is not known, one possibility is higher groundwater levels resulting from a wetter year. Therefore, a sensitivity analysis was performed assuming higher GWI rates in these areas.

Scenario C: Because of the relatively small storm events during the 2012/13 flow monitoring period, the sensitivity of the system to the RDI/I factors was also tested by doubling the fast and medium RDI/I response components. This scenario was run with the additional GWI described above under Scenario B.

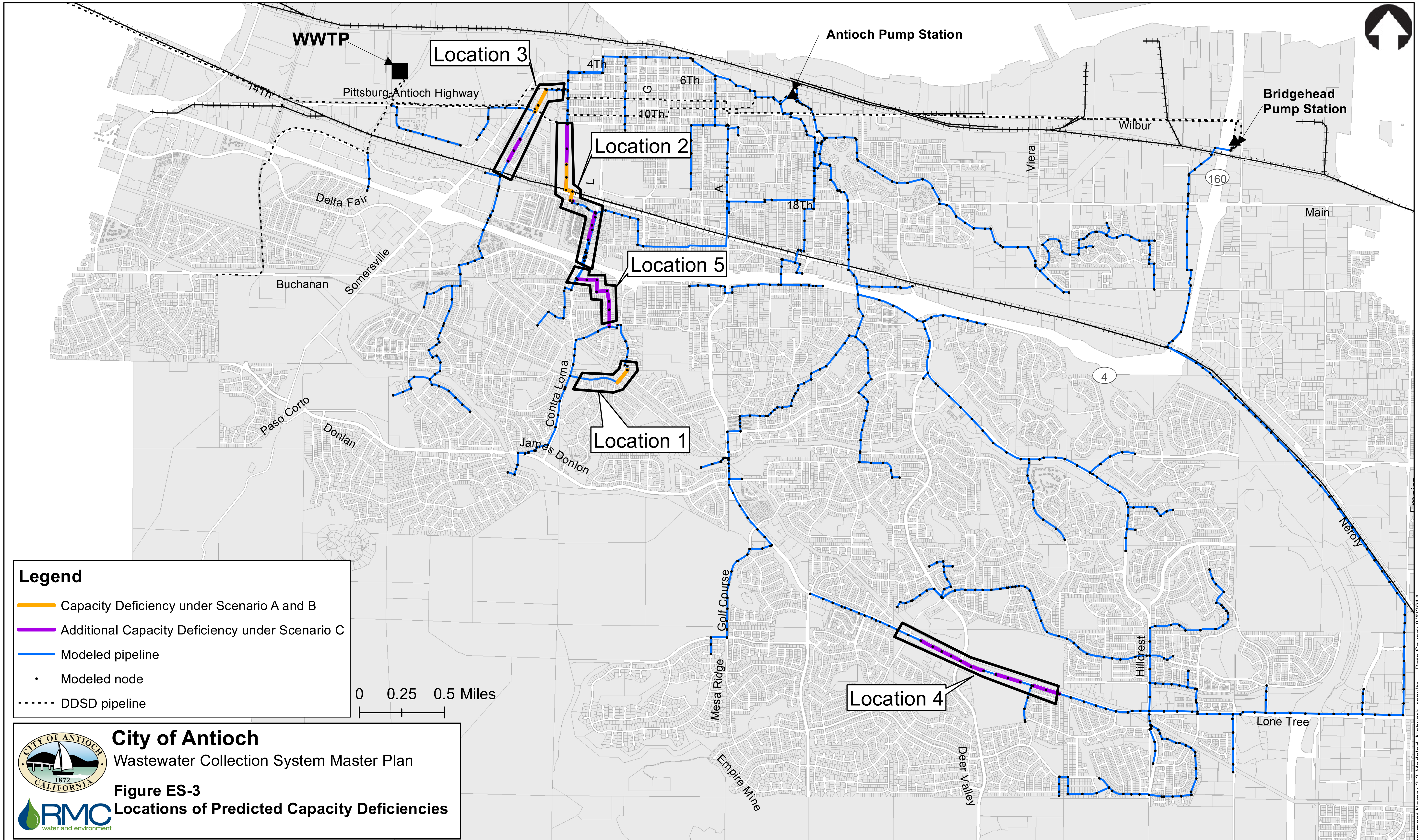
The modeling predicted gravity pipeline capacity deficiencies in only three locations of the collection system under the baseline scenario (Scenario A). Under the sensitivity scenario with the higher RDI/I response (Scenario C), two additional locations (including additional segments in two of the three Scenario A locations) were identified as potential capacity deficiencies. These five locations are shown in **Figure ES-3.** The predicted capacity deficiencies identified under each of the identified scenarios are summarized in **Table ES-3**. The table indicates the maximum surcharge and minimum freeboard, and the extent of “throttle” (length of pipe in which PWWF would exceed full pipe capacity) for each location. Note that no additional capacity deficiencies were identified as a result of the higher GWI scenario (Scenario B).

Capacity improvement projects were developed to address the capacity deficiencies predicted under all of the scenarios and are summarized in **Table ES-4** and shown in **Figure ES-4.** More detailed maps of the proposed projects are included in **Appendix G**. In general, capacity improvements assume replacement of existing deficient pipes with larger pipes; however, constructing a parallel pipe may be an option for some projects, as indicated in Table ES-4.

Estimated costs for capacity improvements were based on cost data compiled by RMC from similar projects. The costs are conceptual level estimates, considered to have an estimated accuracy range of -30 to +50 percent, suitable for use for budget forecasting, capital improvement program development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed to design and construction. All costs are presented in current (2014) dollars. Estimated construction costs include a 30 percent allowance for contingencies for unknown conditions, and estimated capital costs include an allowance of 25 percent of the estimated construction cost for engineering, administration, and legal costs.

As shown in Table ES-4, the total estimated capital cost of the capacity improvements ranges from $1.8 to $5.0 million (assuming pipe replacement) depending on I/I assumptions. As noted below under Recommendations, additional flow monitoring should be conducted to confirm the I/I rates and peak wet weather flows in the system.

As indicated in Table ES-3, Project 1 addresses a capacity deficiency under existing flow conditions under the least conservative I/I scenario (Scenario A) and is therefore considered the highest priority for construction. Projects 2 and 3 address capacity deficiencies that would occur under existing conditions only for the more conservative I/I scenario (Scenario C) or under future conditions for the least conservative scenario. Projects 4 and 5 are only needed under the more conservative I/I scenario (Scenario C), therefore would be considered lower priority for construction. However, the City should budget for all of these projects, but should monitor flows to confirm if and when they are needed.



City of Antioch
Wastewater Collection System Master Plan

Figure ES-3
Locations of Predicted Capacity Deficiencies

Table ES-3: Locations of Predicted Capacity Issues

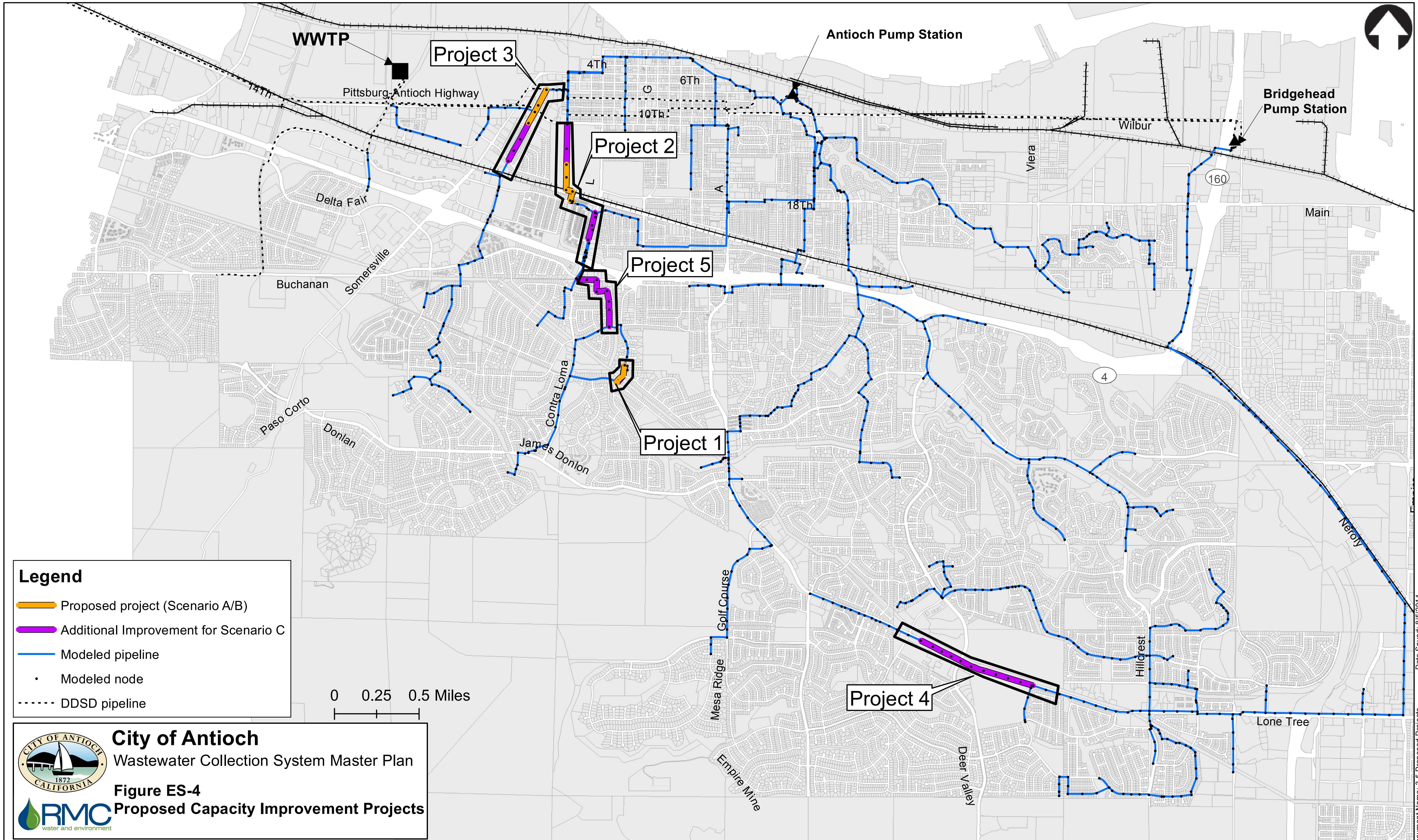
Location No.	Location	Pipe Size	Existing Conditions		Future Conditions	
			Scenarios A and B	Scenario C	Scenarios A and B	Scenario C
1	G St and Longview Rd	8- and 6-inch	**Up to 2.0 ft of surcharge** 7.3 ft freeboard. Extent of throttle: 510 lf	**Up to 7.3 ft of surcharge** **2.0 ft freeboard** Extent of throttle: 510 ft	**Up to 2.8 ft of surcharge** 6.5 ft freeboard. Extent of throttle: 510 lf	**Up to 9.2 ft of surcharge** **0.8 ft freeboard** Extent of throttle: 510 ft
2	Fairgrounds Park and L Street	15-inch	Up to 1.0 ft of surcharge 6.4 ft freeboard Extent of throttle: 1,285 lf	**Up to 7.3 ft of surcharge** **1.3 ft freeboard** Extent of throttle: 3,485 lf	**Up to 2.0 ft of surcharge** 6.4 ft freeboard Extent of throttle: 1,367 lf	**Up to 7.7 ft of surcharge** **0.7 ft freeboard** Extent of throttle: 3,485 lf
3	Sycamore Drive to Poppy Way	12-inch	No Capacity Issues	**Up to 3.2 ft of surcharge** **2.3 ft freeboard** Extent of throttle: 1,187 lf	**Up to 2.7 ft of surcharge** **3.7 ft freeboard** Extent of throttle: 1,187 lf	**Up to 5.3 ft of surcharge and potential overflow** Extent of throttle: 3,067 lf
4	Lone Tree Way	12-inch	No Capacity Issues	**Up to 1.7 feet of surcharge** 12 ft freeboard Extent of throttle: 786 lf	No Capacity Issues	**Up to 4.6 feet of surcharge** 10 ft freeboard Extent of throttle: 786 lf
5	Enea Way	12-inch	No Capacity Issues	**Up to 7.1 ft of surcharge and potential overflow**[a] Extent of throttle: 2,431 lf	No Capacity Issues	**Up to 7.1 ft of surcharge and potential overflow**[a] Extent of throttle: 2,431 lf

Note: **Bolded** results indicate capacity deficiency criteria exceedance.
a. About 4 feet of surcharge due to back-up from Location 2.

Table ES-4: Capacity Improvement Projects

Project No.[a] and Scenario	Project Name	U/S MHID	D/S MHID	Description	Estimated Capital Cost (Replace)	Estimated Capital Cost (Parallel)[b]
1 A/B/C	G Street	H22-1-029	H22-1-041	Install 630 feet of new 12" sewer in G St. from Longview Rd. to Gloucester St. and abandon existing parallel easement sewers; install 40 feet of 8" sewer in Longview Rd. in G St. to reverse flow direction.	$299,000	N/A
2 A/B	O Street	G21-7-010	G21-7-046	Replace 1,400 feet of 12" and 15" pipe with 18" pipe (or install 15" parallel pipe) from Sycamore Dr. near Manzanita Way and on O Street through Contra Costa County Fairgrounds (includes UPRR crossing).	$1,105,000	$951,000
2 C	O Street / L Street	G21-7-010 G21-8-019	F21-9-024SF G21-7-003	Replace 2,600 feet of 12", 15" and 18" pipe with 21" pipe (or install 15" parallel pipe) from Sycamore Dr. near Manzanita Way and on O Street through Contra Costa County Fairgrounds to W. 10th St (includes UPRR crossing). Replace 900 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) on L St. from Lemontree Way to Sycamore Dr.	$ 2,068,000	$1,674,000
3 A/B	Aster to 6th St. Easement	F21-9-036	F21-8-012	Replace 1,200 feet of 12" pipe with 15" pipe in an easement extending from north of Poppy Way at Astor Dr. to W. 6th St.	$435,000	N/A
3 C	Poppy Way / Aster to 6th St. Easement	G21-7-033	F21-8-012	Replace 2,500 feet of 12" pipe with 15" pipe in Poppy Way, and continuing in easement from Aster Dr. to W. 6th St.	$ 1,034,000	N/A
4 C	Lone Tree Way	J23-2-014	J23-6-005	Replace 3,800 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) in Lone Tree Way from east of Mokelumne Dr. to Sagebrush Dr.	$794,000	$1,475,000
5 C	Enea Way	G22-3-067	G21-8-032	Replace 2,400 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) in Enea Way from Putnam St. to St. Francis Dr. and continuing in easement to Fitzuren and west to Contra Loma Blvd.	$834,000	$1,115,000
				Total - Scenario A/B	$1,839,000	
				Total – Scenario C	$5,029,000	

a. Correspond to Location Nos. in Table ES-3.
b. Note that parallel pipe option would generally be more expensive if the replacement pipe option involves upsizing by pipe bursting to 15" or smaller pipe, but less expensive if the replacement pipe option involves remove and replace construction of an 18" or larger pipe.



City of Antioch
Wastewater Collection System Master Plan

Figure ES-4
Proposed Capacity Improvement Projects

ES-2.3 Recommendations

The following paragraphs provide guidelines for implementing the Master Plan.

Flow Verification

While the model was calibrated as best possible based on available data, the lack of significant rainfall during the flow monitoring period resulted in reduced confidence in the model results for peak wet weather flow conditions. While the model results indicate relatively few capacity issues in the City's collection system, the sensitivity analyses conducted for this study indicate that there could be additional capacity issues if I/I rates are actually higher than currently predicted. Therefore, it is recommended that additional investigation be conducted to further verify the flows in the system. Verification could be conducted by a future temporary flow monitoring program similar to that conducted for this study, as well as by surcharge monitoring or visual observation of flow levels during large storm events.

Investigations for Areas with Potential High Groundwater Infiltration

The flow monitoring and modeling indicated the possible occurrence of significant GWI in the monitored area that includes the 21-inch trunk sewer that parallels East Antioch Creek. It is recommended that the City televise this line to assess its condition and determine if it is the source of the high GWI. If this is determined to be the case, potential solutions may include rehabilitation of this pipeline, for example using a cured-in-place pipe (CIPP) liner. The potential cost of lining 2,400 feet of this sewer could range from about $600,000 to $800,000.

Confirmation of Reverse Slopes

The City's GIS data indicates the possible occurrence of reverse slopes in a number of sewer pipelines. While the modeling indicates that the reverse slopes in general do not cause any significant capacity issues in the system, they may result in maintenance issues due to low flow velocities caused by backwater effects. Additional verification of the apparent reverse slope in the capacity deficiency Location 3 area may be warranted; if confirmed to be accurate, replacement and realignment of this sewer may be necessary to avoid future capacity problems.

Pre-Design Activities

Pre-design work for all projects would include topographic surveys as needed to confirm new pipeline alignments, geotechnical investigations, utility research, constructability reviews, permit applications as needed, and refinement of project cost estimates.

Model and Master Plan Updates

This Master Plan has been prepared to facilitate both use of the information in capital improvement project planning and design, as well as to allow the City to update the Master Plan in the future as the need arises. The model should be kept up-to-date with new sewer improvements, rehabilitation projects, and changes in sewer system flows; and re-calibrated to new flow monitoring data when obtained. The Master Plan should be updated whenever there are major changes in planning assumptions, or at a minimum every five to ten years.

ES-3 Long-Term Sewer Renewal/Replacement Projections

While the City has conducted closed-circuit television (CCTV) inspection of sewers throughout the system over the past ten years and has identified near-term repair needs, there is currently no comprehensive database of condition data that can be used to estimate the overall long-term sewer renewal and replacement (R/R) needs for the entire systems. Rather, sewer attribute information (e.g., pipe age and material) coupled with reasonable assumptions can be used to develop a first cut at these long-term projections. Therefore, using sewer inventory information and assumptions on sewer useful life and rehabilitation and replacement methods, a budgetary cost estimate for long-term R/R of the City's wastewater collection system was developed for this report.

The average age of the collection system is 35 years old, with sewers ranging from new to about 80 years old. The predominant pipe material is vitrified clay pipe (VCP), which comprises approximately 95 percent of the system. **Figure ES-5** shows the estimated installation year of all pipes in the City's collection system. The assumed average service lives of the pipe materials in the collection system are summarized in **Table ES-5**. Since the actual service life experienced for particular assets will vary, for the analysis in this report, a service life distribution similar to a "bell" curve has been assumed, ranging from 30 years before to 30 years after the average service life indicated in Table ES-5.

Table ES-5: Assumed Average Service Life of Sewer Pipe Materials

Pipe Material	Average Service Life (yrs.)
Vitrified Clay Pipe (pre-1960)[a]	80
Vitrified Clay Pipe (1960 to present)[b]	100
Polyvinyl Chloride	100
Ductile Iron Pipe	75
Steel pipe	75
Asbestos Cement Pipe	75

a. VCP sewers constructed before 1960 are assumed to have rigid joints.
b. VCP sewers constructed from 1960 on are assumed to have rubber-gasketed joints.

Based on the available data on pipe material and installation year, and the assumed failure distribution curve, a projection of pipe lengths to be renewed or replaced annually, and associated construction costs, was developed. The projected construction costs over approximately the next 100 years are shown in **Figure ES-6** . The figure also indicates that there may be a backlog of about $6.5 million for renewal of sewer pipes that may have already reached the end of their service lives (corresponding to about 21,000 feet of sewer pipe). However, it is likely that the City has already conducted some repairs or rehabilitation of these pipes to extend their service lives.

Based on this analysis, the average annual capital expenditure over the next 20 years needed to meet the long-term R/R forecast presented in this report is approximately $1.4 million. If the 21,000 feet of sewer renewal backlog is included and renewal costs are spread evenly over the next 20 years, the average annual expenditure would increase to about $1.7 million.

Data collected through a more formal CCTV inspection and condition assessment program could be used to refine and improve the accuracy of the projections and calibrate the projections to more closely align with the actual inspection and renewal results experienced by the City. It is recommended that, as part of its continuing condition assessment program, the City consider conducting further analyses of pipe failure rates, and repair/renewal decisions and costs. Developing a more robust condition assessment database will greatly enhance the City's ability to complete these tasks.

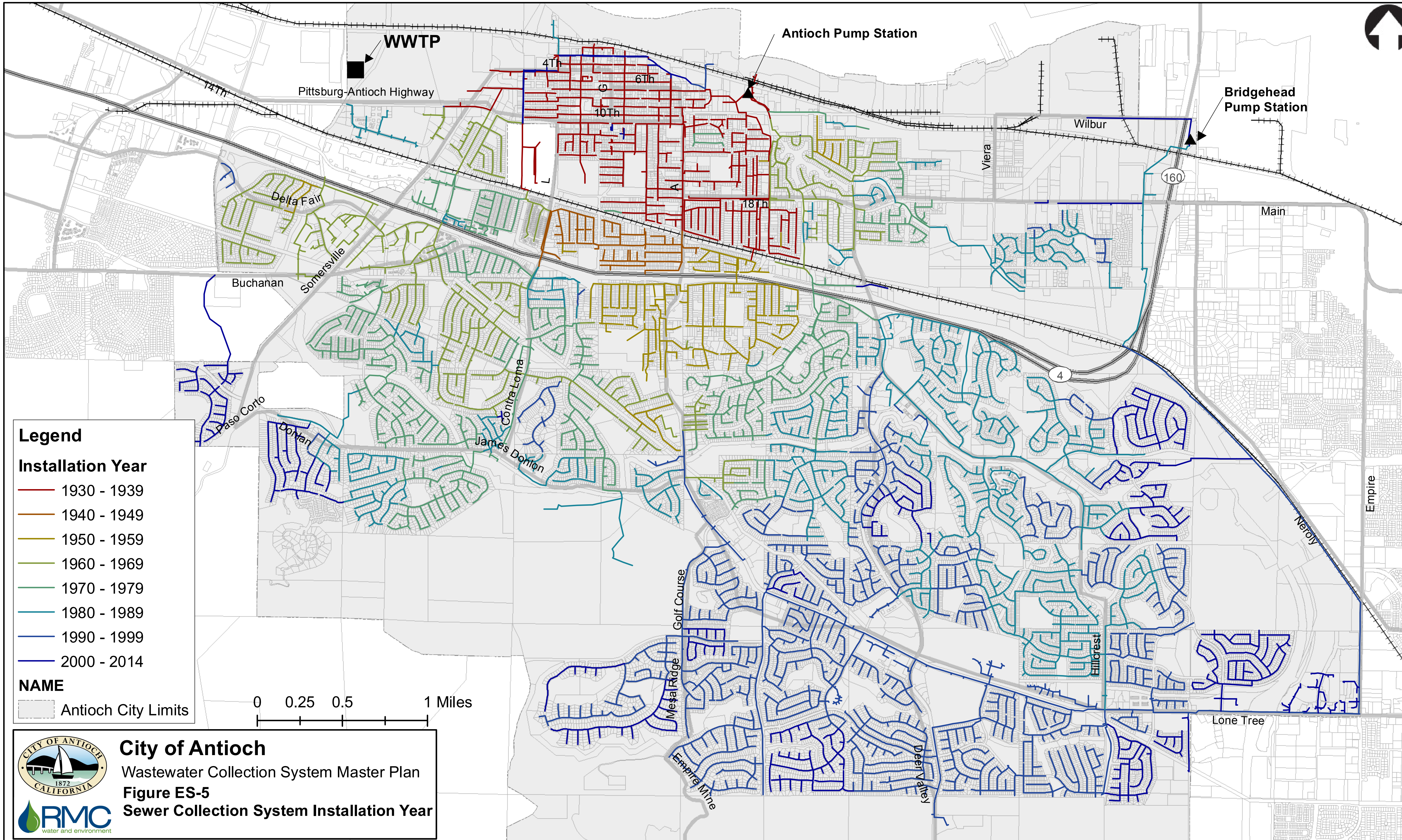


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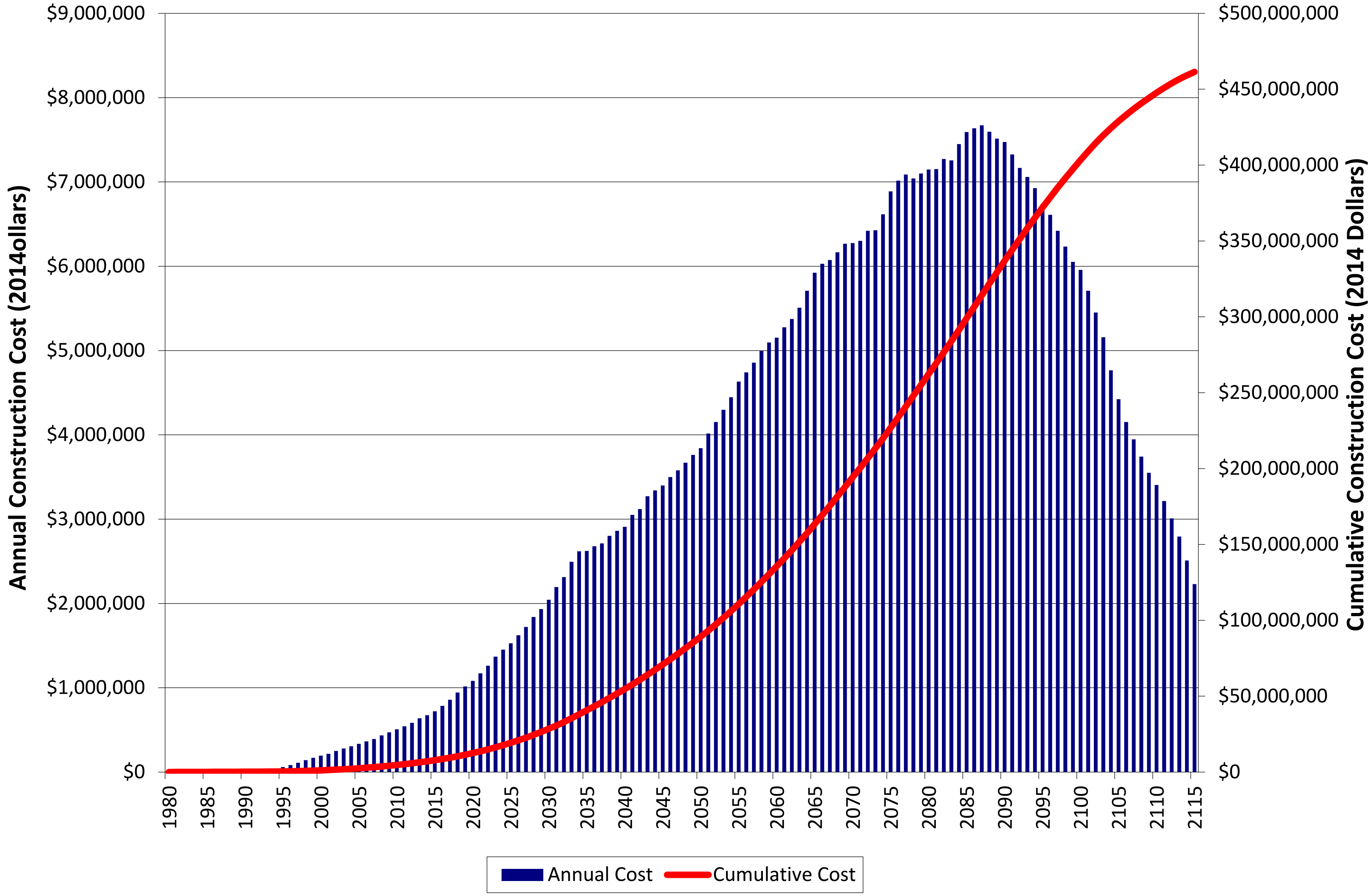
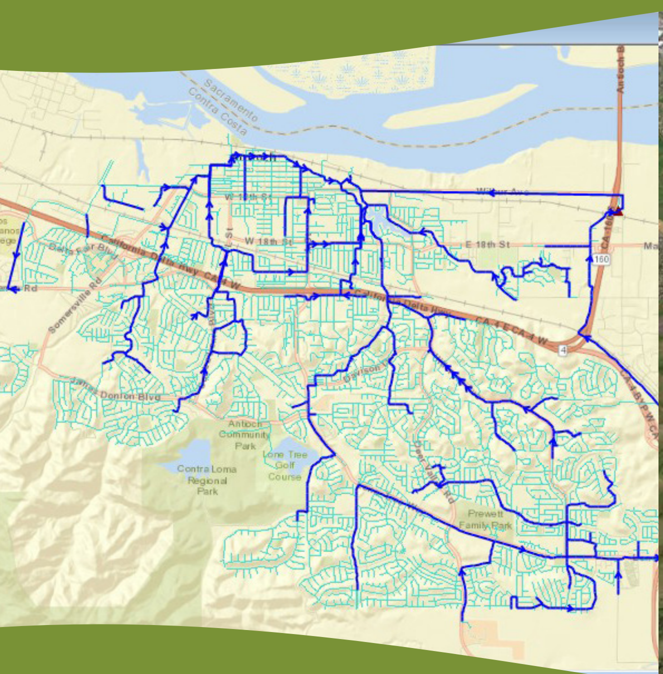
Figure ES-6: Total Projected Annual and Cumulative Costs for Renewal and Replacement



Chapter 1

Introduction



Chapter 1 Introduction

This report presents the results and recommendations of the Wastewater Collection System Master Plan for the City of Antioch (City). The report was prepared by RMC Water and Environment (RMC) under an agreement with the City dated November 14, 2012. This introductory chapter provides background information on the objectives and scope of the Master Plan, the City's sewer system and service area, and the contents and organization of the Master Plan report.

1.1 Background and Study Objectives

The purpose of the Wastewater Collection System Master Plan (Master Plan) is to update the trunk system capacity assessment and recommended capacity improvement program presented in the City's 2003 Wastewater Collection System Master Plan to reflect updated land use and flow estimates and sewer projects completed since the 2003 report was developed.

To meet the project objectives, the Master Plan included the following tasks:

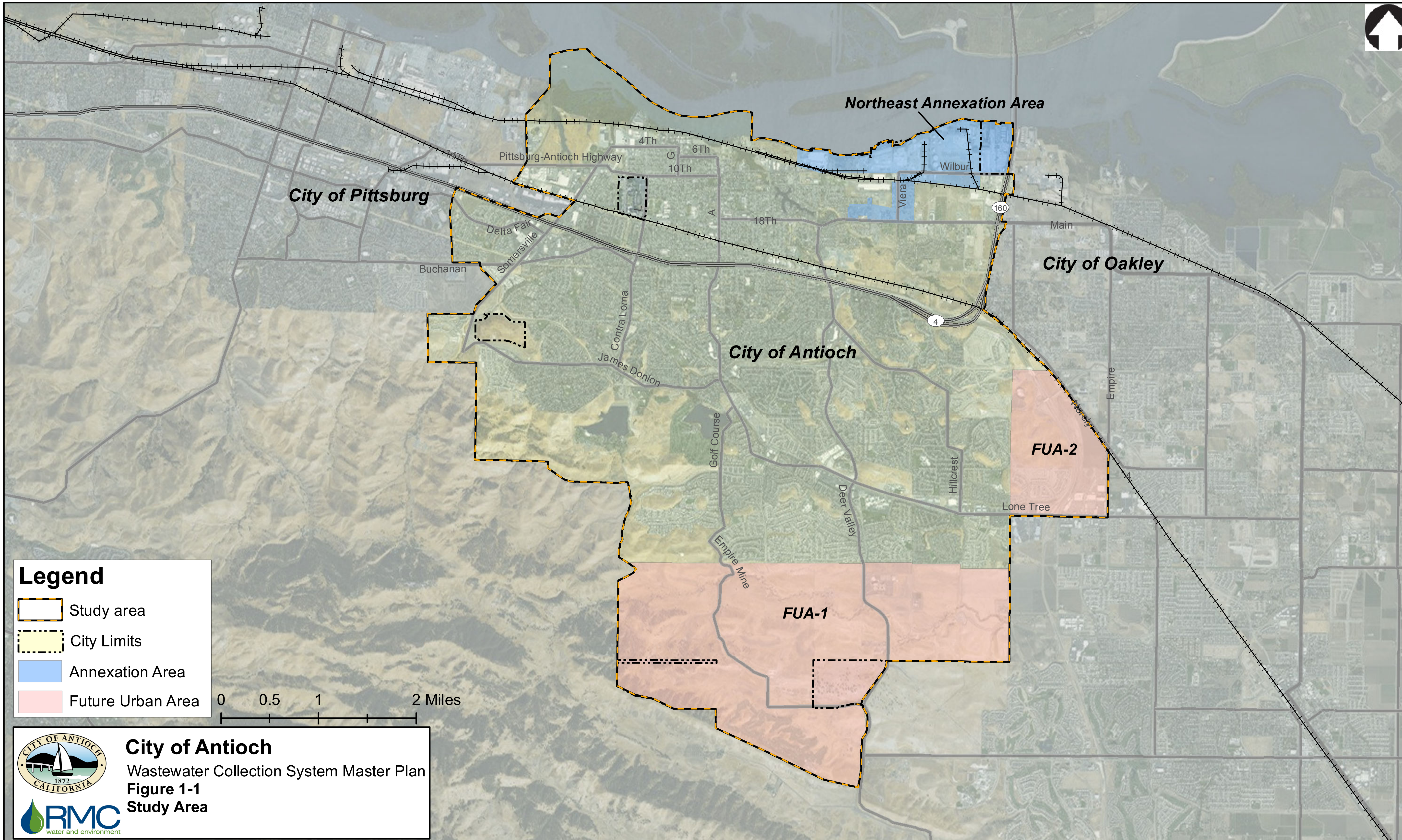
- Development of an updated hydraulic model of the trunk sewer system.
- Collection of flow data to verify design flow criteria and calibrate the hydraulic model.
- Refinement of land use and flow projections to reflect the City's most current development plans.
- Identification of capacity deficiencies and development of sewer improvement solutions, if needed, to provide relief capacity.
- Assessment of potential long range sewer replacement needs.

1.2 Study Area

The study area for this Master Plan consists of the City of Antioch and areas outside of the City that are planned for annexation or included in the City's development plans, as shown in **Figure 1-1**. The City is bounded on the north by the San Joaquin River, on the west by the City of Pittsburg, on the south by unincorporated Contra Costa County, and on the east by the City of Oakley.

The collection system serves a population of about 105,000. The City of Antioch is divided by Highway 4 with distinct development characteristics north and south of the highway. The northern portion of the City consists of the original downtown area and the older residential communities, mostly built before the 1970s. The majority of the area south of Highway 4 consists of newer developments built in the 1970s and after.

The City's General Plan identifies two significant growth areas: Future Urban Area-1 (FUA-1), located at the southern edge of the City, and Future Urban Area-2 (FUA-2), located just north of Lone Tree Way and east of Empire Avenue. While the recent economic downturn has significantly slowed development, new construction has recently started again, particularly in the FUA-2 growth area. Most of the City's recent developments are south of Highway 4. In addition to the developments within the City boundary, one future development focus area (Ginochio West) included in the study is located outside the current City limit, at the south end of the FUA-1 focus area. The City is also moving forward with annexation of a mostly industrial area in the northeastern portion of the study area.



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Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

1.3 Existing Sewer System

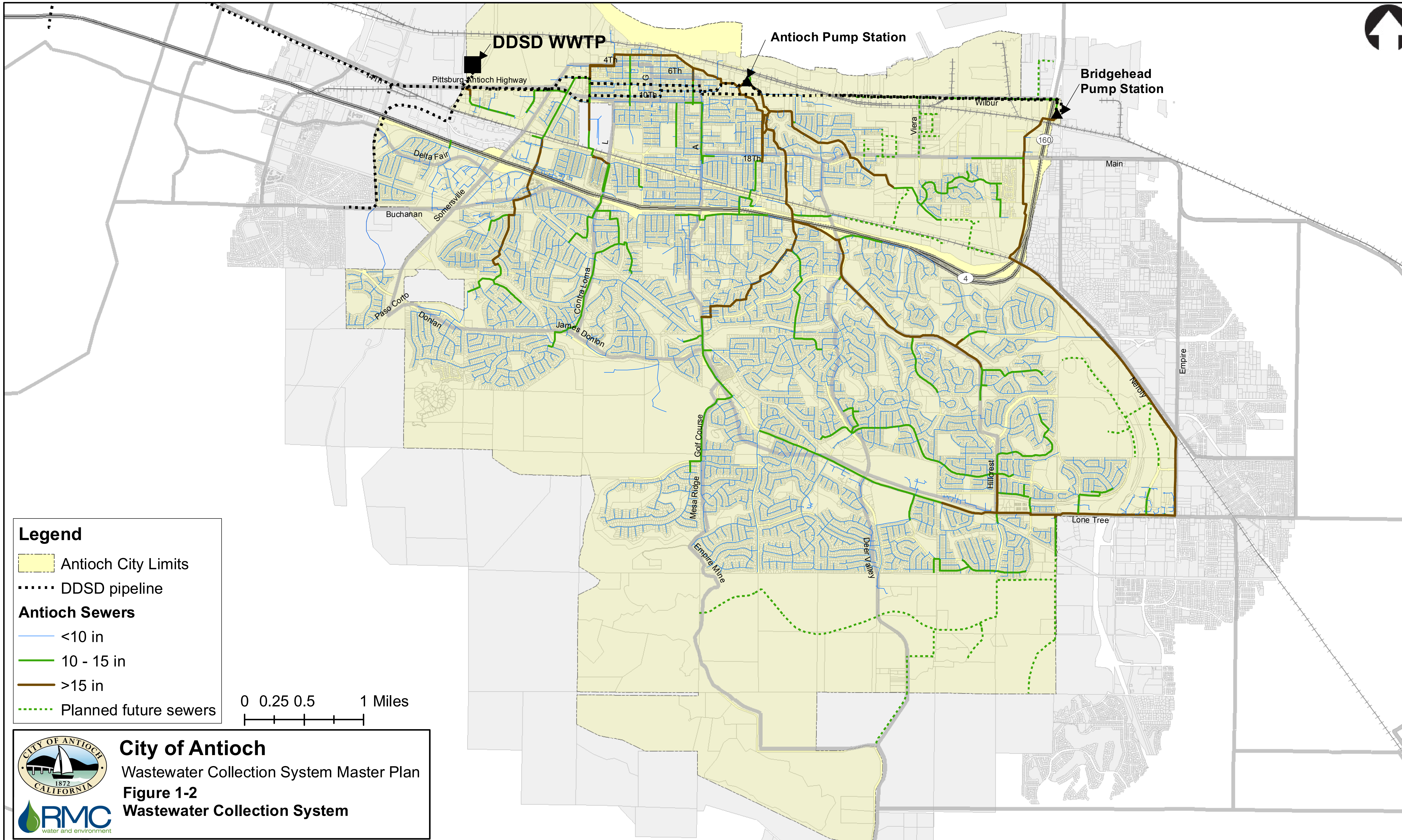
The City's sewer collection system includes approximately 293 miles of gravity sewer mains. All sewer pump stations and force mains in the City's system have been decommissioned. The majority of the City's collection system discharges to two Delta Diablo Sanitation District (DDSD) pump stations (Bridgehead Pump Station and Antioch Pump Station), from where the flow is conveyed via force main to the DDSD Wastewater Treatment Plant (WWTP). A small portion of Antioch along the border with the City of Pittsburg discharges to DDSD's Pittsburg-Antioch Interceptor. DDSD facilities were previously evaluated as part of DDSD's 2010 Conveyance System Master Plan Update.

Figure 1-2 shows the collection system layout, including existing sewers and sewers planned for the future developments and Northeast Annexation Area. **Table 1-1** tabulates the footage of existing pipe by diameter. As noted in the table, almost 50 percent of the gravity sewer mains are 6 inches in diameter, and about 85 percent are less than 10 inches.

Table 1-1: Collection System Inventory

Pipe Diameter	Total Pipe Length (miles)	Percent of System
<6	0.9	0.3%
6	140.0	47.7%
8	107.5	36.6%
10	12.3	4.2%
12	9.8	3.3%
14	0.2	0.1%
15	4.2	1.4%
16	0.3	0.1%
18	6.9	2.4%
20	0.2	0.1%
21	2.5	0.8%
24	1.6	0.6%
33	6.0	2.0%
36	0.5	0.2%
42	0.1	0.0%
48	0.2	0.1%
Unknown[1]	0.9	0.3%
Gravity Sewers	293.4	100%

1. Likely 4-inch or 6-inch pipe



City of Antioch

Wastewater Collection System Master Plan

Figure 1-2
Wastewater Collection System

1.4 Scope of Study

The scope of the Master Plan, as well as a brief discussion of work conducted under each task, is described below.

- **Task 1 – Project Coordination.**

  Periodic progress meetings and teleconferences were held with City staff to review project status and discuss project issues, and monthly status reports were prepared to document the work completed.

- **Task 2 – Data Collection and Review.**

  This task involved assembling, organizing, and reviewing maps, documents, and data related to the sewer system, including previous reports; maps and drawings of sewer system facilities and recent sewer improvement projects; water use and customer account data; the City's General Plan and other relevant planning information; and sewer design standards and specifications.

- **Task 3 – Flow Monitoring.**

  A plan for flow and rainfall monitoring in the collection system during the 2012/13 wet weather season was developed. The program included 20 flow meters and three rain gauges installed for a period of approximately two months. The monitoring was conducted by RMC's subconsultant, V&A Consulting Engineers.

- **Task 4 – Hydraulic Model Development.**

  A hydraulic model of the City's trunk sewer system was developed using InfoWorks™ CS software. Sewersheds were delineated to define areas loading to the model, and flow loads to the model were compiled using water use and land use data and flow factors representing unit base wastewater flow (BWF) rates, diurnal BWF patterns, and infiltration/inflow (I/I). The model was calibrated for dry and wet weather conditions using the flow monitoring data collected under Task 3.

- **Task 5 – System Performance Evaluation and Improvement Needs.**

  The model was used to determine sewer system capacity requirements and identify capacity deficiencies under peak wet weather flow conditions, defined based on a design storm and system performance criteria. Potential solutions to capacity deficiencies were identified and tested in the model, and capacity improvement projects and associated costs were developed based on these analyses.

- **Task 6 – Long-Range Capital Improvement Plan Development**

  As an added task to the Master Plan, potential long-range sewer replacement needs were estimated based on the age and material of sewer pipes. Results of the analysis were used to provide an estimate of long-term sewer rehabilitation costs on a year-by-year basis.

- **Task 7 – Sewer Fee Review**

  As the sewer fees are already under review by the City, this task was deleted from the Master Plan scope.

- **Task 8 – Master Plan Report Preparation.**

  This Master Plan report was prepared to present the results and recommendations of the study.

1.5 Report Organization

The contents of each of the chapters and appendices of this Master Plan report are described below.

Executive Summary

The Executive Summary provides a brief, stand-alone summary of the Master Plan report, with emphasis on the major findings and recommendations.

Chapter 1- Introduction

This introductory chapter provides background information on the objectives and scope of the Master Plan, the City's sewer system and service area, and the contents and organization of this report.

Chapter 2 – Hydraulic Model Development

This chapter describes the modeled sewer system, development of the model network and sewershed areas, the flow monitoring program and basis for estimating model flows, and the calibration of the model for dry and wet weather conditions.

Chapter 3 – Capacity Assessment and Capacity Improvement Program

This chapter defines the basis for the capacity assessment of the system, including the selected design storm and performance criteria; describes the identified capacity deficiencies based on the model results; presents the design criteria used to develop capacity improvements; and presents the recommended capacity improvement projects. Each project is documented with a general description and planning level cost estimate.

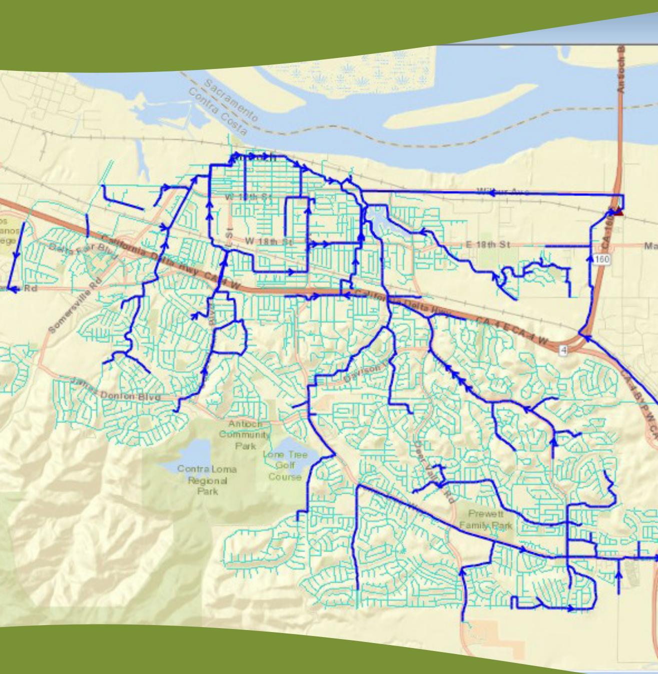
Chapter 5 – Long-Term Sewer Renewal/Replacement Projections

This chapter presents a simplified estimation of potential long-term rehabilitation and replacement costs, based on the age and material of pipes throughout the system.

The appendices to the report provide additional detailed information to support the findings and recommendations presented in the report chapters, including land use and flow estimates, plots of flow monitoring data, future development information, model hydraulic profiles, and detailed project descriptions and cost estimates for improvement projects.

Chapter 2

Hydraulic Model Development



City of Antioch Wastewater Collection System Master Plan

Chapter 2 Hydraulic Model Development

This section describes the development of the hydraulic model that was used to assess the capacity of the City's sewer system. The section provides an overview of the model development process, including descriptions of the modeled sewer network and subcatchments, the flow monitoring program conducted for this study, the basis for estimating wastewater flows, and the calibration of the model.

The modeling software used for the Master Plan was InfoWorks CS™ by Innovyze, a fully dynamic hydraulic model that has been used for many other collection systems in the Bay Area. RMC used its own licenses to InfoWorks for this work.

2.1 Modeling Terminology

Key modeling terms are defined below.

- **Network** refers to the representation of the physical facilities being modeled. Modeled network components include pipes, manholes, and pump stations.
- **Nodes** are primarily manholes, but also include pump station wet wells and outfalls (discharge points from the modeled system). Key data associated with nodes include manhole ground elevations and pump station wet well elevations and cross-sectional areas.
- **Pipes** or **conduits** are connections (links) between nodes, and include both gravity sewers and force mains. Key data associated with pipes are upstream and downstream node IDs, pipe length, diameter, roughness factor, and upstream and downstream invert elevations.
- **Pumps, gates, and overflow weirs** are represented in the model as links between nodes. Data associated with these facilities depend on the structure type. For example, data for weirs include width, elevation, and weir discharge coefficient.
- **Subcatchments** (also called sewersheds) are areas that contribute flow to the modeled sewer network and represent the unmodeled sewers in the collection system. Data associated with subcatchments include sanitary flow (computed based on population, water 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 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, inflows from other areas, etc.) that comprise a specific model scenario.

2.2 Modeled System

For Antioch, the model network includes all pipes 10 inches and larger in diameter and additional 8-inch lines that were either located downstream of larger diameter pipes, were part of a flow split and could potentially carry flows from a larger diameter pipe, or were considered important for potential future developments. In total, the model network includes about 50 miles of pipelines, or about 18 percent of the total length of sewers in the system. The City does not currently operate any pump stations.

The majority of the City's collection system discharges to two Delta Diablo Sanitation District (DDSD) pump stations (Bridgehead Pump Station and Antioch Pump Station), from where the flow is conveyed via force main to the DDSD Wastewater Treatment Plant (WWTP). A small portion of Antioch along the border with the City of Pittsburg discharges to DDSD's Pittsburg-Antioch Interceptor. DDSD facilities were previously evaluated as part of DDSD's 2010 Conveyance System Master Plan Update. For flow routing purposes, the Bridgehead Pump Station and force main are included in the Antioch collection system model, but no other DDSD sewers are included. The model network has one primary outfall at the Antioch Pump Station covering most of the modeled system; two additional outfalls for City pipes that discharge to the Pittsburg-Antioch Interceptor are also included. The modeled network is shown in **Figure 2-1**.

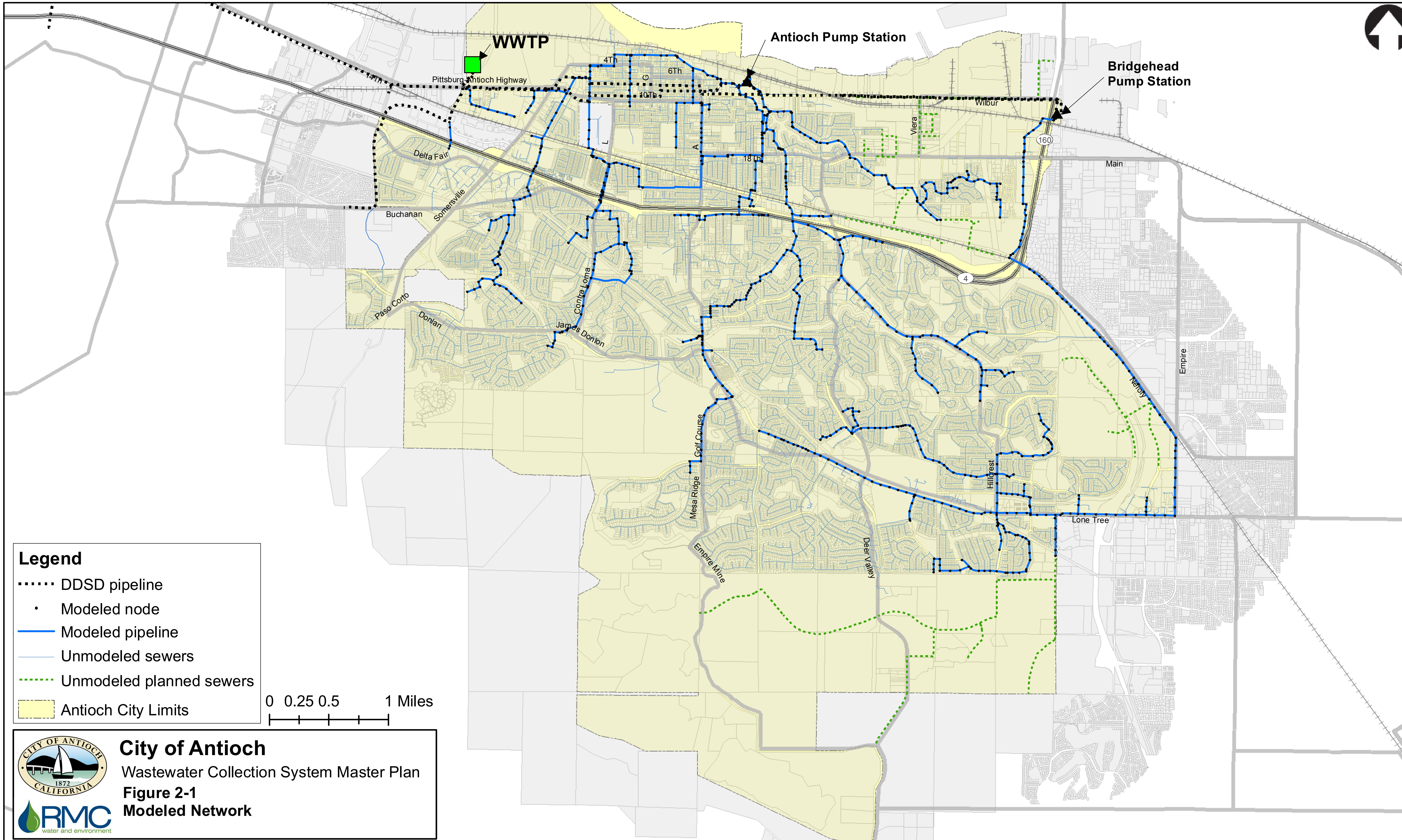
The City's existing and potential future service area was divided into 257 subcatchments, with a median size of 40 acres. Each subcatchment "loads" to a manhole in the modeled network. Subcatchments are shown in **Figure 2-2**; the figure also indicates whether the subcatchment ultimately discharges to the Bridgehead Pump Station, the Antioch Pump Station, or the Pittsburg-Antioch Interceptor. Information about each subcatchment, including size and associated loading manhole, is summarized in **Appendix A**.

2.2.1 Model Network Construction and Validation

The data used to define the model network was provided by the City in the form of GIS shapefiles of the sewer system pipelines and manholes. The pipes and manholes to be included in the modeled network, described previously, were then extracted out of those datasets; these files were imported into the modeling environment in InfoWorks.

The model construction and validation process included the following:

- The modeled network was checked for connectivity, i.e., verifying that the correct upstream/downstream manholes were identified for each pipe and that there were no missing links in the network.
- Subcatchments were delineated, and model loading manholes were assigned to all subcatchments.
- Manhole rim elevations, depths, and pipeline sizes extracted from the GIS data were generally assumed to be accurate. Much of the data were originally developed for the City's 2003 Wastewater Collection System Master Plan. The data were refined based on the following additional data sources:
    - In select locations, record drawings for several pipelines were provided by the City and were used to refine elevation, size, and connectivity information.
    - All flow split manholes were visually inspected and photographed by RMC's subconsultant, V&A Consulting Engineers (V&A), and depths to each pipe invert were measured. The manhole inspection reports have been included in **Appendix B**.
    - Where rim elevations were missing or inconsistent with nearby elevations, values were populated using Contra Costa County's LIDAR dataset (available at http://projects.atlas.ca.gov/projects/coco-county/)
    - Invert elevations were calculated based on manhole rim and depth data in the GIS. Where data were missing or inconsistent with nearby elevations, and not available from as-built or survey information, invert elevations from the Hydra model used for the 2003 Master Plan or interpolated values between known values were used as appropriate.
- Based on the data provided by the sources above, profiles were plotted for each series of pipe segments in the modeled network to visually check for missing or suspect data. Where data indicated a discrepancy (e.g., reverse slope), record drawings or other information was requested.
- The sources of model data (e.g., GIS, record drawings, field verification) were documented using "flags" in the model database.
- All gravity pipelines are modeled assuming a Manning's n of 0.013.



City of Antioch
Wastewater Collection System Master Plan
Figure 2-1
Modeled Network

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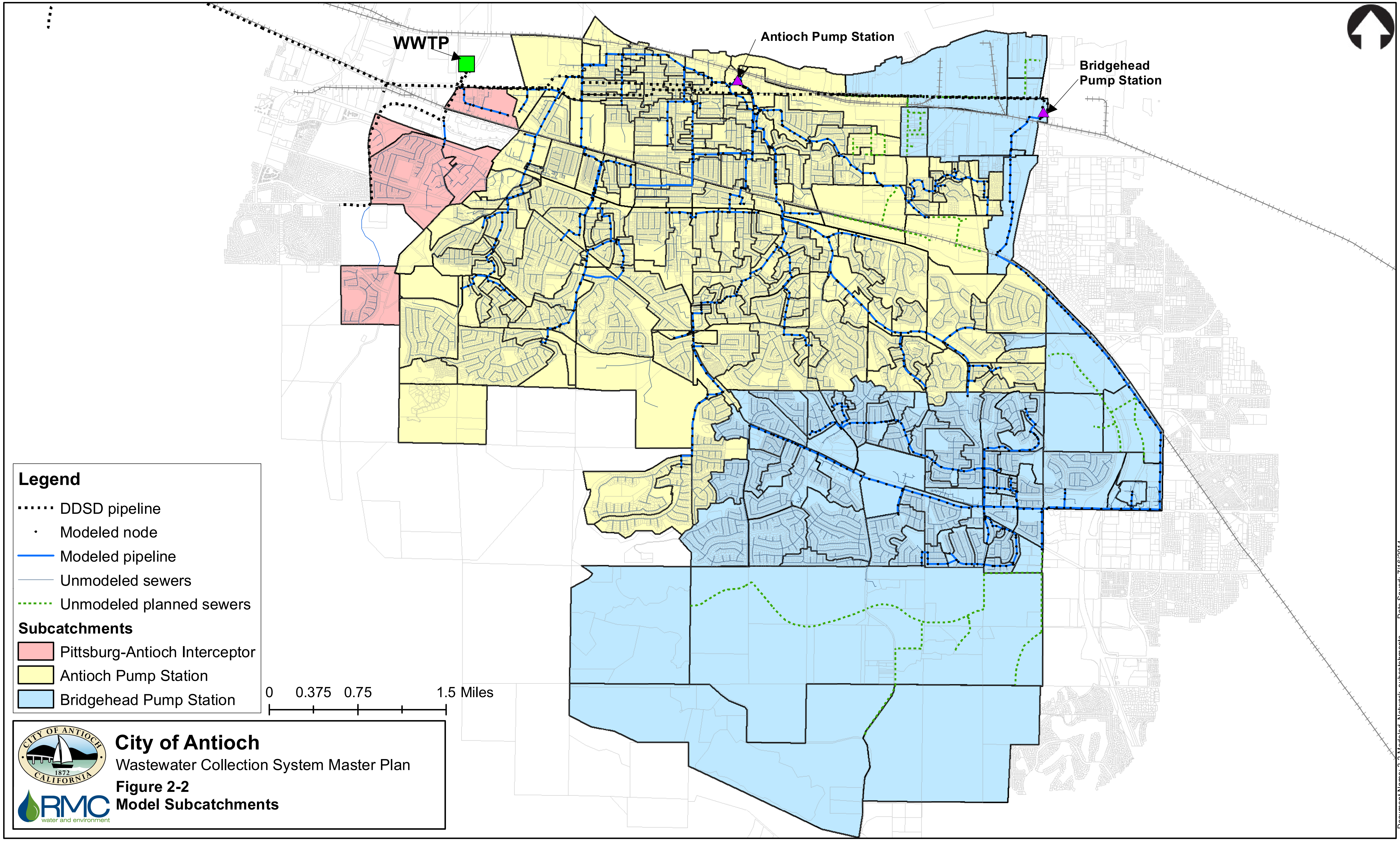

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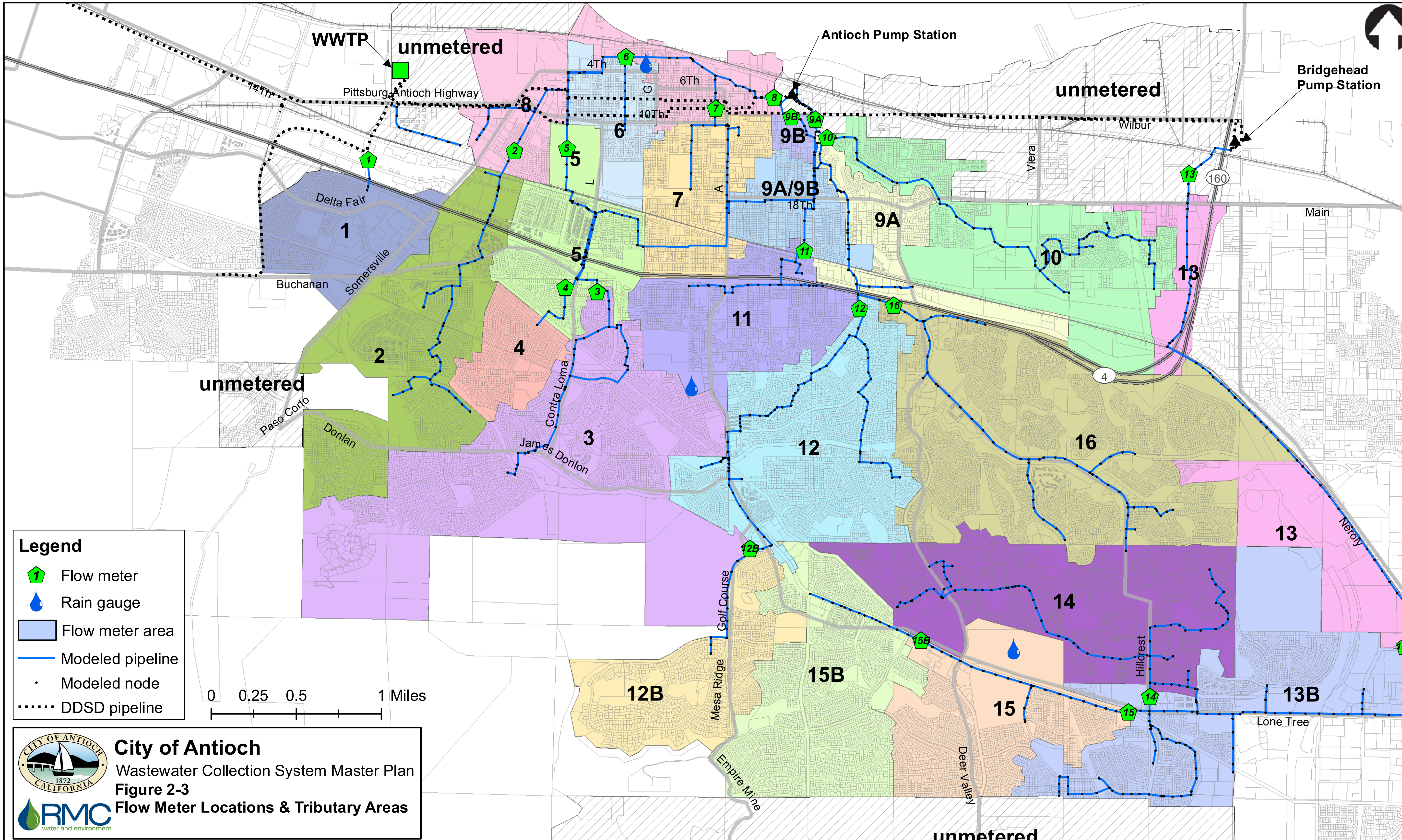
2.3 Flow Monitoring Program

To support the development of the hydraulic model and flow projections for the Master Plan, a temporary flow monitoring program was conducted as part of this study during the 2012/2013 wet weather season. V&A, under sub-contract to RMC, conducted the monitoring at 20 sites in the trunk sewer system. In addition, three recording rain gauges were also installed. The location of the flow monitoring sites and rain gauges are shown in **Figure 2-3**. The locations of the flow meters relative to flow splits within the collection system are shown schematically in **Figure 2-4**. Figure 2-3 also shows the associated tributary area (basin) for each flow meter. There were a few areas not monitored during the program; however unmonitored basins were generally small and/or not heavily developed. Note that eight of the meters were located downstream of other meters; therefore, the tributary areas shown for each of these meters are the "incremental" areas between the flow meter and tributary basins of the upstream flow meters. **Table 2-1** lists the flow meter locations, pipe diameters, and upstream meters. In addition to the data from the temporary meters, DDSD provided flow data for the Antioch and Bridgehead Pump Stations.

Table 2-1: Flow Meter Locations

Flow Meter ID (FM ID)	Manhole ID	Diameter (in)[c]	Downstream Meters	Upstream Meters
1	G21-1[a]	12	DDSD	
2	F21-9-034	12	8	
3	G21-9-001	12	5	
4	G21-9-074	10	5	
5	F21-9-025	18	8	3,4
6	F22-2-03B	15	8	
7	F22-6-088	14	8	
8	F22-6-066	30	DDSD	2,5,6,7
9A	F22-9-046	42	DDSD	10,11, 12,16
9B	F22-6-061	21	DDSD	11
10	F22-9-042	24	9A	
11	G22-8-009	12	9A/9B[b]	
12	G22-9-006	21	9A	12B
12B	J22-4-006	12	12	
13	G24-1-010	33	DDSD	13B
13B	J24-8-004	33	13	14,15
14	J23-9-021	18	13B	
15	J23-9-065	18	13B	15B
15B	J23-2-014	12	15	
16	G22-9-005	18	9A	

a. Manhole located in Pittsburg, pipe belongs to DDSD. All flow originates from Antioch.
b. Two flow splits are located downstream of FM 11, at manhole G22-7-020SF and G22-7-058SF. These flow splits allow flow past FM 11 to reach either FM 9A or FM 9B.
c. Actual measured diameter used for meter flow calculations may be slightly different than pipe nominal diameter.



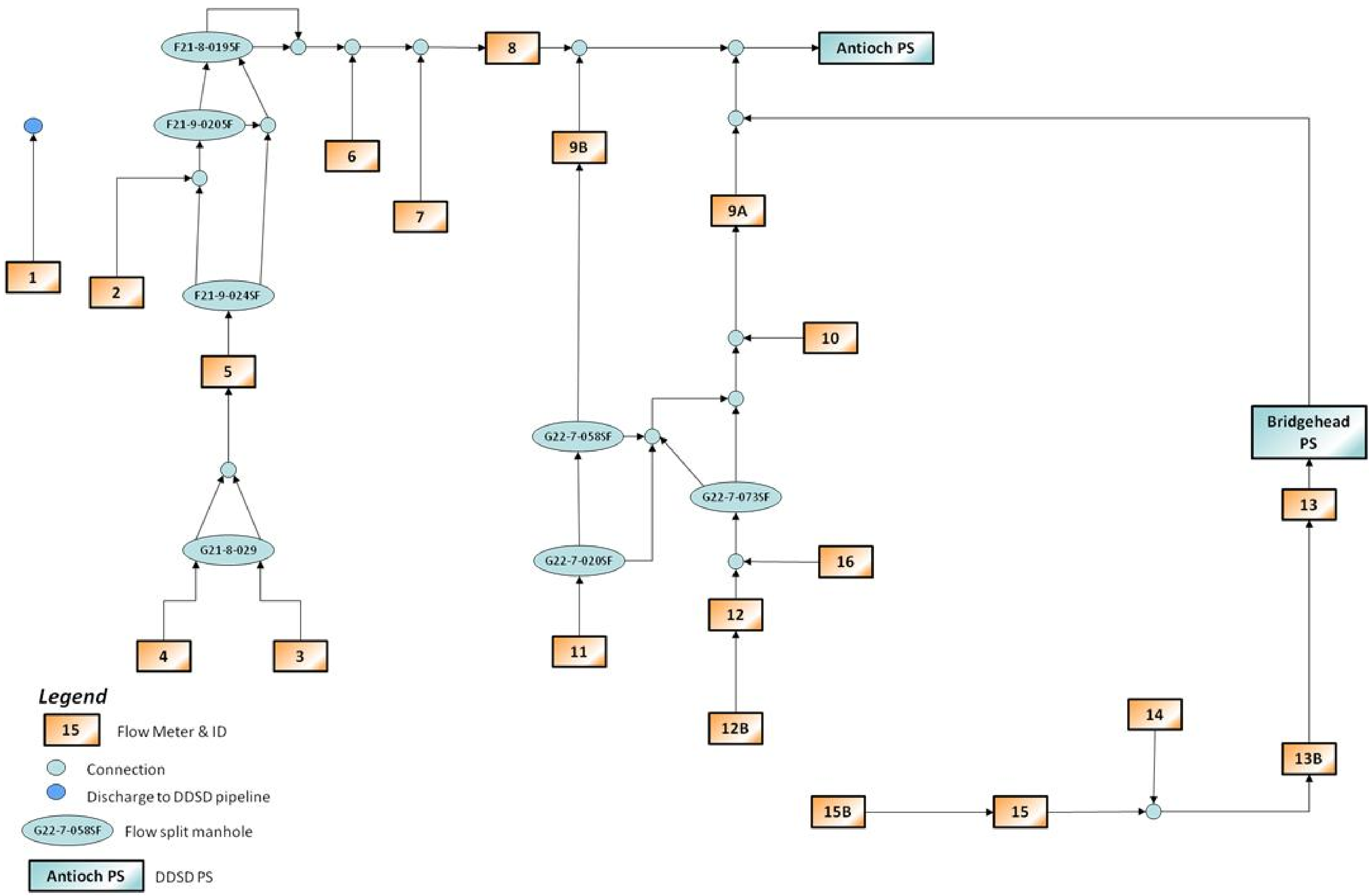
City of Antioch

Wastewater Collection System Master Plan

Figure 2-3

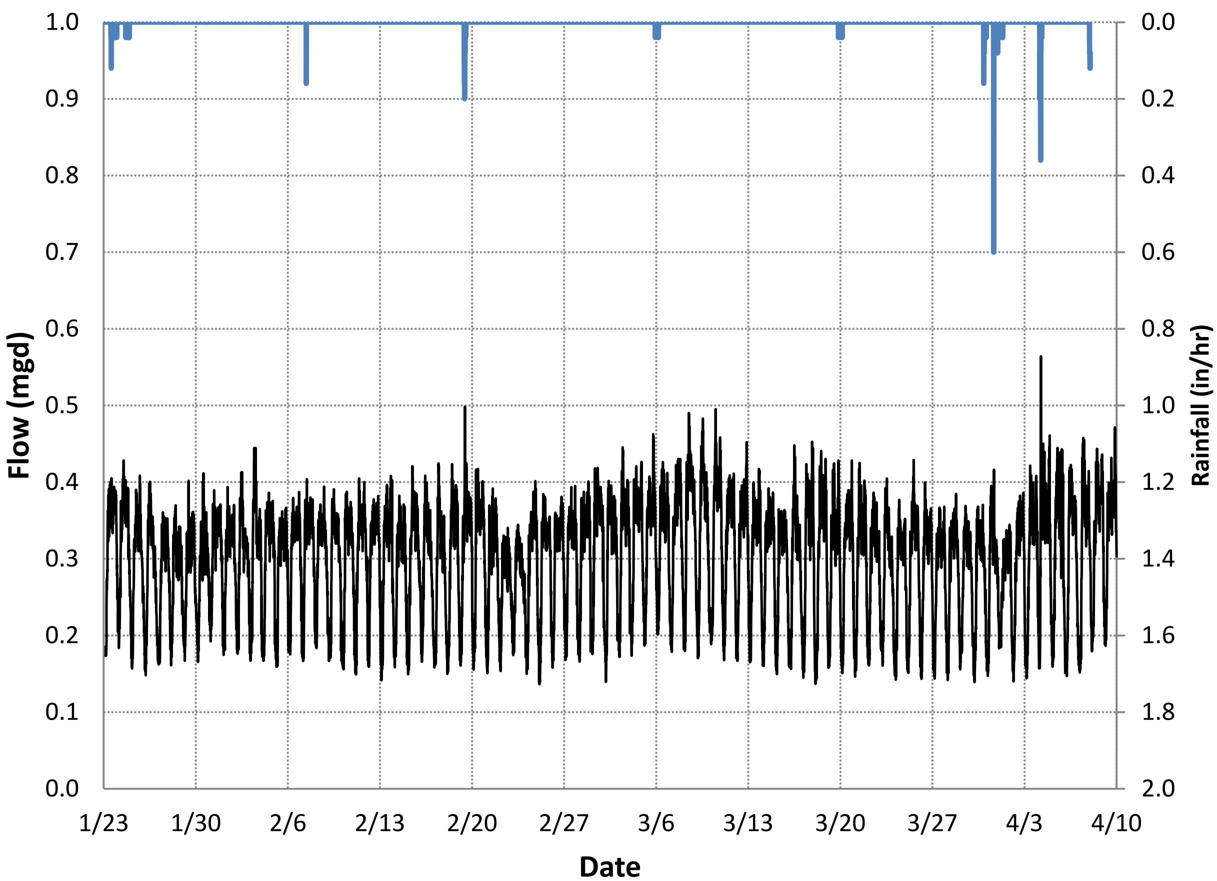
Flow Meter Locations & Tributary Areas

Figure 2-4: Flow Meter and Flow Split Schematic



The meters and rain gauges were installed for a 2-1/2-month period from late January through early April 2013 to capture the flow from the tributary areas. The purpose of the flow monitoring program was to quantify the flows in the system to provide data with which to calibrate the hydraulic model (discussed later in this chapter), and to quantify the I/I response to storm events in various areas of the system. However, the monitoring period was very dry, with a total of only about 1.5 inches of rainfall. The largest storm event, on April 4, 2013, produced about 0.4 inches of rain. (Further discussion of the implications of the lack of rainfall during the flow monitoring period is provided later in this chapter and in Chapter 3.) **Figure 2-5** shows a typical plot of measured flow and rainfall for one flow meter. **Appendix C** includes plots of the rainfall and flow data for all of the rain gauges and meters.

Figure 2-5: Plot of Typical Flow Data for Flow Monitoring Period (Meter 6)



2.4 Flow Estimating Methodology

2.4.1 Wastewater Flow Components

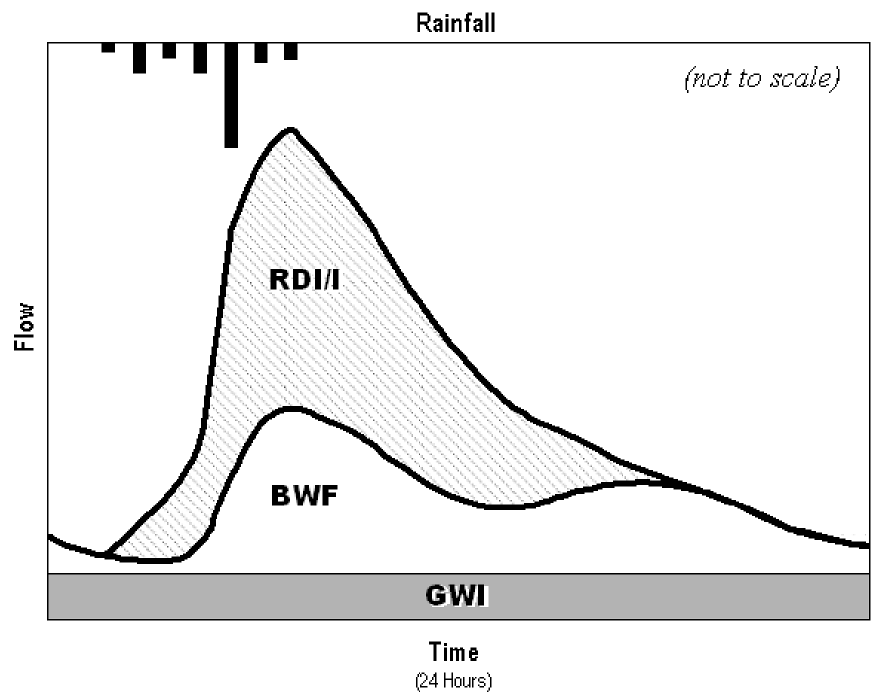
Wastewater flows include three components: base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall-dependent infiltration/inflow (RDI/I), as illustrated conceptually in **Figure 2-6**.

BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the system. BWF varies throughout the day, but typically follows predictable diurnal patterns depending on the type of land use.

GWI is groundwater that infiltrates into defects in sewer pipes and manholes, particularly in winter and springtime in low-lying areas. GWI is typically seasonal in nature and remains relatively constant during specific periods of the year. However, rainfall typically has long-term impacts on GWI rates, as evidenced by measurable increases in GWI after prolonged periods of rainfall.

RDI/I is storm water inflow and infiltration that enter the system in direct response to rainfall events, either through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains, or, more commonly, through defects in sewer pipes, manholes, and service laterals. RDI/I typically results in short term peak flows that recede relatively quickly after the rainfall ends. The magnitude of RDI/I flows are related to the intensity and duration of the rainfall, the relative soil moisture at the time of the rainfall event, and the condition of the sewers.

Figure 2-6: Wastewater Flow Components



2.4.2 Base Wastewater Flow

Existing residential and non-residential base wastewater flows were estimated using information compiled at the parcel level (approximately 33,000 parcels) and then aggregated into the 257 model subcatchments. The total residential and non-residential BWF for each model subcatchment were calculated by summing the BWF for all parcels within that subcatchment.

Existing BWF Loads

Existing BWF was determined based on water billing data provided by the City. Metered water use during the winter months most closely approximates wastewater generation, since outdoor water use is at a minimum. Therefore, meter readings averaged over winter months from 2010 through 2012 were used as the basis for estimating residential and non-residential BWF. Winter months used included February and March in 2010 and 2011, and February in 2012; March 2012 was excluded, as the lack of rainfall in 2012 resulted in additional irrigation water use.

A sewer return rate of 90 percent was assumed for most of the system, based on comparison of water to wastewater flow rates during model calibration. Water usage appeared higher in the southern part of the system (flow meter areas 13B, 15, and 15B), potentially reflecting larger yards and greater irrigation usage. A sewer return rate of 70 percent was therefore assumed for this part of the system, estimated during model calibration.

All water billing records were geocoded according to address and assigned a land use type based on the record data available. A visual assessment of the City using aerial photos confirmed that data were available for all significant developed parcels. **Figure 2-7** shows the geocoded water billing data by customer type (residential or non-residential). Customer types were selected based on service class in the water billing data; irrigation classes were not included in the analysis.

Future BWF Loads

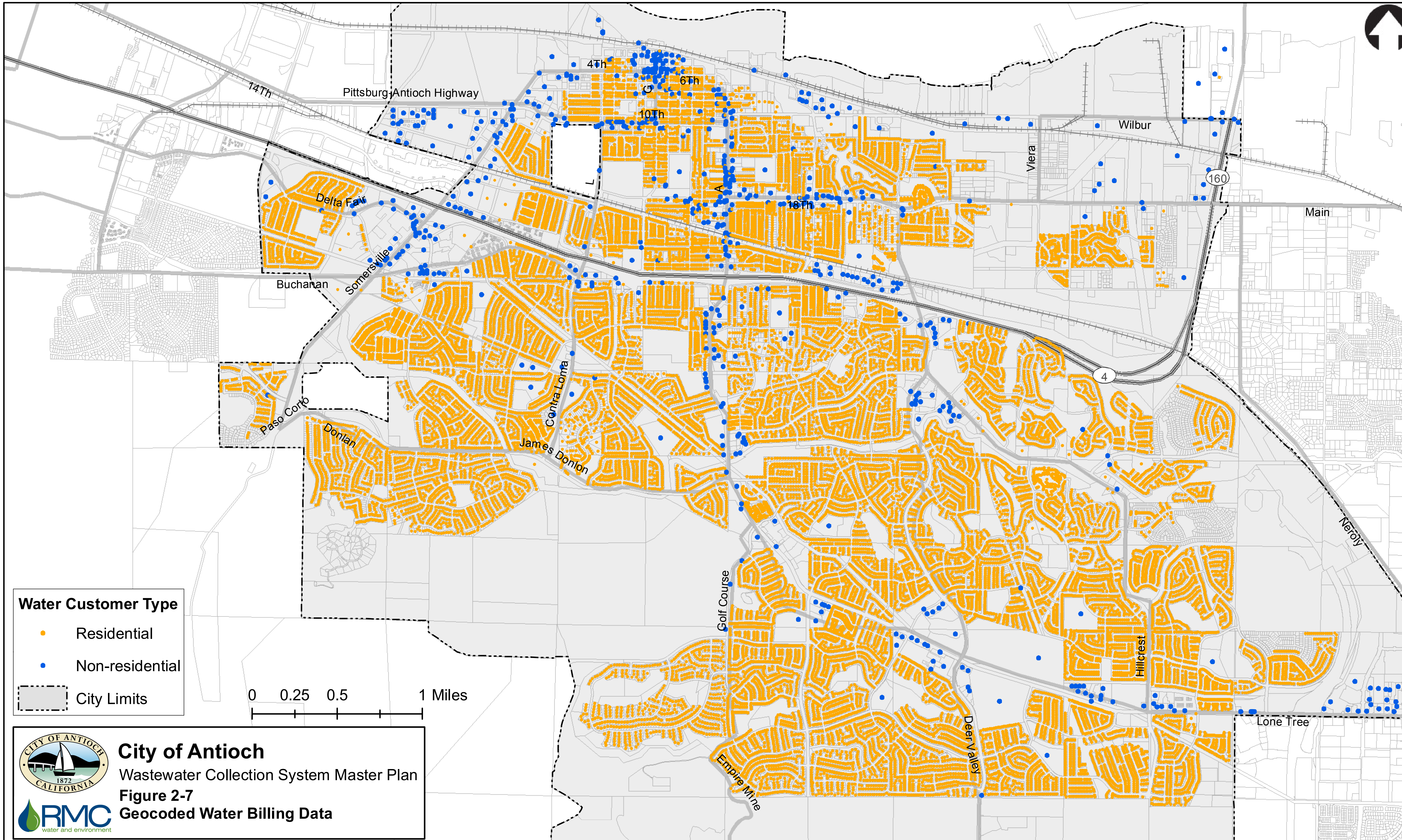
In addition to the existing BWF loads described above, future BWF was estimated based on planned developments, as well as an assumed potential increase in occupancy rates across the City. Based on review of the City's water production data from 2000 to 2013, water use has decreased by about 10 percent as a result of the economic recession in 2008 to 2010. To account for a potential return to higher occupancy levels, base wastewater loads estimated for existing development were increased by 10 percent in the future scenario. This percentage is similar to the increase assumed in the DDSD's 2010 Conveyance System Master Plan Update.

The development areas are shown in **Figure 2-8**, and the planned configuration of future sewers in each area, as proposed by the respective developers' engineers, are shown in **Figure 2-9**. The basis for future loads from each area is described below.

Future Urban Area 1 (FUA-1) or Sand Creek Focus Area: At the direction of the City, unit counts and development acreages used to develop future model loads in this area were based on the Property Summary on "Cost Allocation Exhibit" from Carlson, Barbee & Gibson, Inc., dated June 20, 2007. This map has been included in **Appendix D**. As the map does not separate residential and commercial unit counts, it was assumed that development in all areas except for the Kaiser Medical Center would be residential units. Based on the "FUA 1 Sanitary Sewer Master Plan" map dated November, 2012, all loads from the FUA-1 are were assigned to manhole K24-1-021 on Heidorn Ranch Road at the eastern edge of the development. Unit counts for this area are still under review and differ from (are generally higher than) the 2007 "Cost Allocation Exhibit" and the 2012 "FUA 1 Sanitary Sewer Master Plan" map. The estimates presented in the 2007 "Cost Allocation Exhibit" are consistent with planning estimates used in the development of the City's Water System Master Plan, and were therefore preferred by the City for use in the Collection System Master Plan.

FUA-2: Unit counts used to develop future model loads for the FUA-2 area (also known as East Lone Tree Specific Plan Area) were based on the maximum development intensity allowed in the City of Antioch's 2003 General Plan. The East Lone Tree Specific Plan Area section of the General Plan has been included in **Appendix D**. Some portions of this area have already been developed. Existing sewer flows from developed parcels were estimated based on water billing data as described above. The remaining allowable residential dwelling units and non-residential square footage were spread evenly across parcels within the developable portion of the Specific Plan (i.e. excluding areas designated for Open Space).

Hillcrest Station Area: Future sewer flows from the Hillcrest Station Area were estimated based on information in the City's Hillcrest Station Area Specific Plan. Unit counts are based on buildout projections documented in Section 3.2 of the Hillcrest Station Area Specific Plan. This section has been included in **Appendix D**.



City of Antioch
Wastewater Collection System Master Plan
Figure 2-7
Geocoded Water Billing Data

Document Name: 2-7 Billing_Data
Date Saved: 7/8/2014

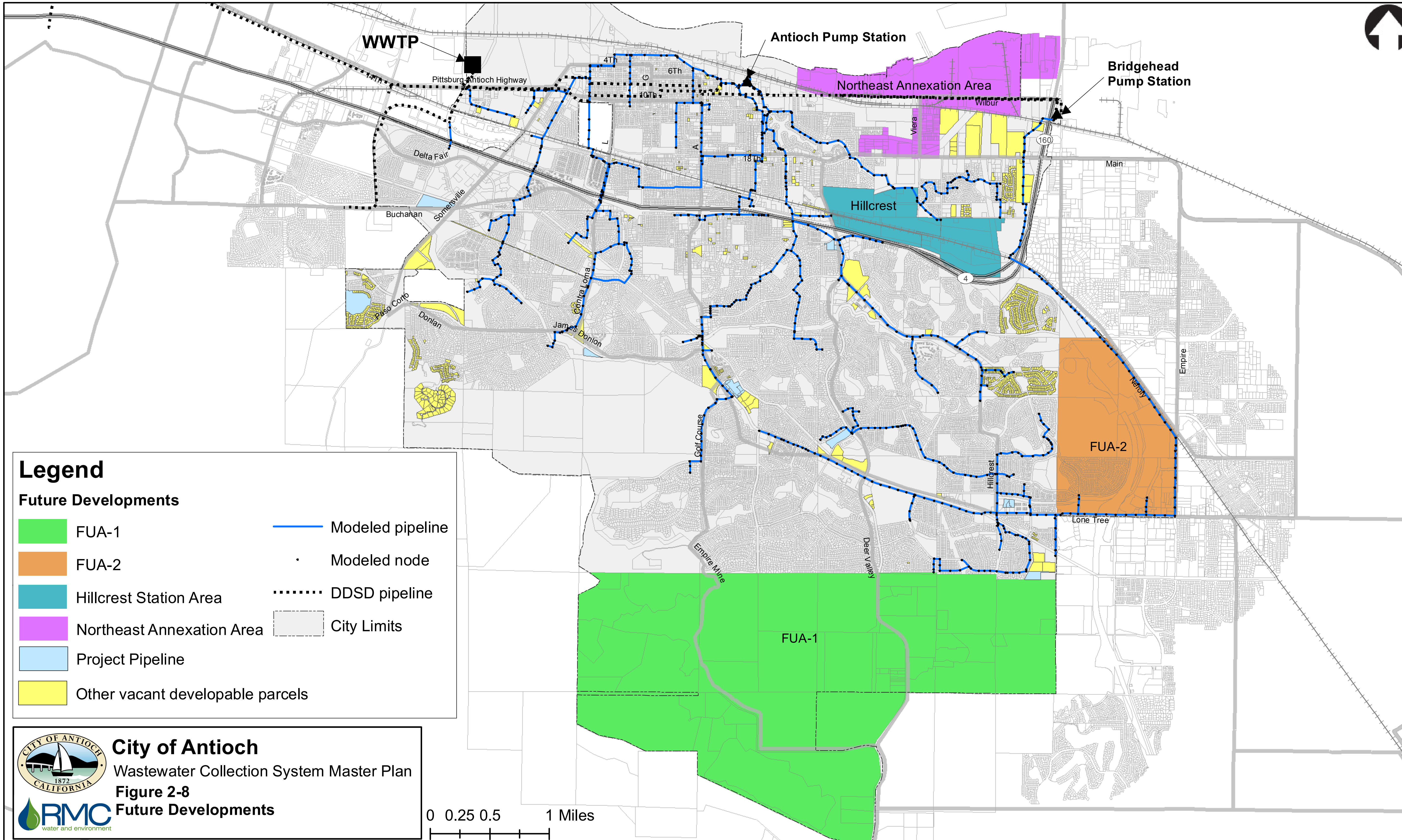


Figure 2-8
Future Developments

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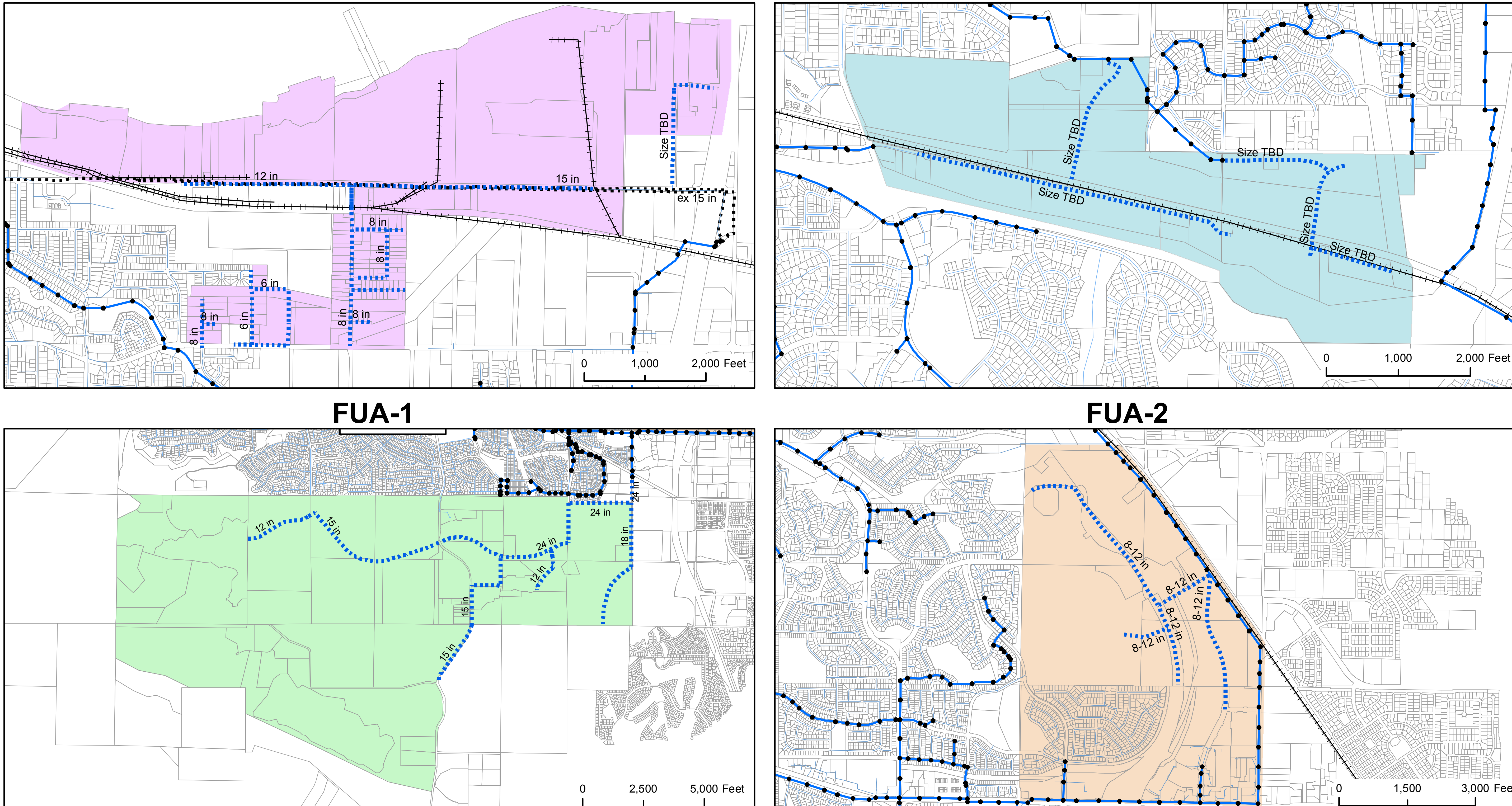


Figure 2-9
Planned Sewers in Future Development Areas

Legend

- FUA-1
- FUA-2
- Hillcrest Station Area
- Northeast Annexation Area
- Unmodeled sewers in future developments
- Modeled node
- Modeled pipeline
- DDSD pipeline
- Other unmodeled sewers

City of Antioch

Wastewater Collection System Master Plan

Date Saved: 7/15/2014
Document Name: 2-9 Future Sewers

Northeast Annexation Area: Sewer flows from the Northeast Annexation Area were estimated based on information in the "The Fiscal Impacts of the Northeast Antioch Annexation" (Gruen Gruen & Associates, 2009), an appendix to the "Northeast Antioch Area Reorganization Area Mitigated Negative Declaration" (CirclePoint, 2010). The report summarizes projected number of households and square footage of building space at buildout for each area in Table II-4. Chapter II of this report has been included in **Appendix D**.

Project Pipeline: The City provided a document titled "City of Antioch Project Pipeline" on May 7, 2013 (relevant projects are included in **Appendix D**). Projects in this list that had not already been developed or subdivided and were not part of other development areas were identified and assigned future sewer flows based on unit counts specified in the document. Subdivided but vacant parcels identified in the project pipeline were identified by assessor parcel code, as described below.

Other Vacant Parcels: All other vacant developable parcels were identified by the assessor parcel code in the parcel data (assessor codes used to identify vacant parcels used are summarized in **Table 2-2**). Vacant parcels were assigned unit counts based on the underlying general plan land use and land use density, as summarized in **Table 2-3.**

Table 2-2: Vacant Assessor Codes

Assessor Code	Assessor Description
17	Residential Vacant, 1 site (includes PUD sites)
18	Residential Vacant, 2 or more sites
20	Multiple Residential, Vacant
30	Commercial, Vacant
50	Industrial, Vacant Land

Table 2-3: Land Use Density on Vacant Parcels

Flow Factor Group	Data Unit	Flow Factor Group[a]	Assumed Density or FAR[b]
Estate Residential	Dwelling Unit	SFR	1 DU/Acre
Low Density Residential	Dwelling Unit	SFR	4 DU/Acre
Medium Low Density	Dwelling Unit	SFR	6 DU/Acre
Medium Density Residential	Dwelling Unit	SFR	10 DU/Acre
High Density Residential	Dwelling Unit	MFR	20 DU/Acre
Convenience Commercial	Square Feet	NR	0.5
Neighborhood Commercial	Square Feet	NR	0.4
Regional Commercial	Square Feet	NR	0.25
Office	Square Feet	NR	0.5
Business Park	Square Feet	NR	0.5

a. SFR = single family residential; MFR = multi-family residential; NR = non-residential
b. FAR = floor area ratio (ratio of building floor area to parcel area)

To convert future land uses into flows, standard unit flow factors were applied. The unit flow factors used for this study, listed in **Table 2-4**, are based on the flow factors used in DDSD's 2010 Conveyance System Master Plan. These factors represent average BWF, and may be assumed to include some nominal amount of dry weather GWI. As described the DDSD's 2010 Conveyance System Master Plan, the factors presented in Table 2-4 reflect an approximate 10 percent increase over current flows. These flow factors are therefore conservative and considered appropriate for planning purposes.

Table 2-4: Base Wastewater Unit Flow Factors Used for Future Development

Flow Factor Group	Unit	Flow Factor (gpd)
Single Family Residential (SFR)	Dwelling units	220
Multi-family Residential (MFR)	Dwelling units	170
Non-Residential (NR)	Square feet of floor space	0.1

Future BWF loads for each future development area are summarized in **Table 2-5**. Existing and future average base wastewater flows in each subcatchment are tabulated in **Appendix A**.

Table 2-5: BWF Loads from Future Development

Future Development Area	Single Family Residential (DU)	Multi-Family Residential (DU)	Non-residential (SF)	Total BWF (mgd)
FUA 1	5,445	0	687,000	1.27
FUA 2	1,100	250	1,135,000	0.33[b]
Hillcrest Station Area	0	2,825[a]	2,200,000	0.71[b]
Northeast Annexation Area	216	0	2,756,000	0.32
Project Pipeline	91	85	388,000	0.07
Other Vacant Parcels	1,390	118	4,944,000	0.82
Total	8,242	3,278	12,110,000	3.53

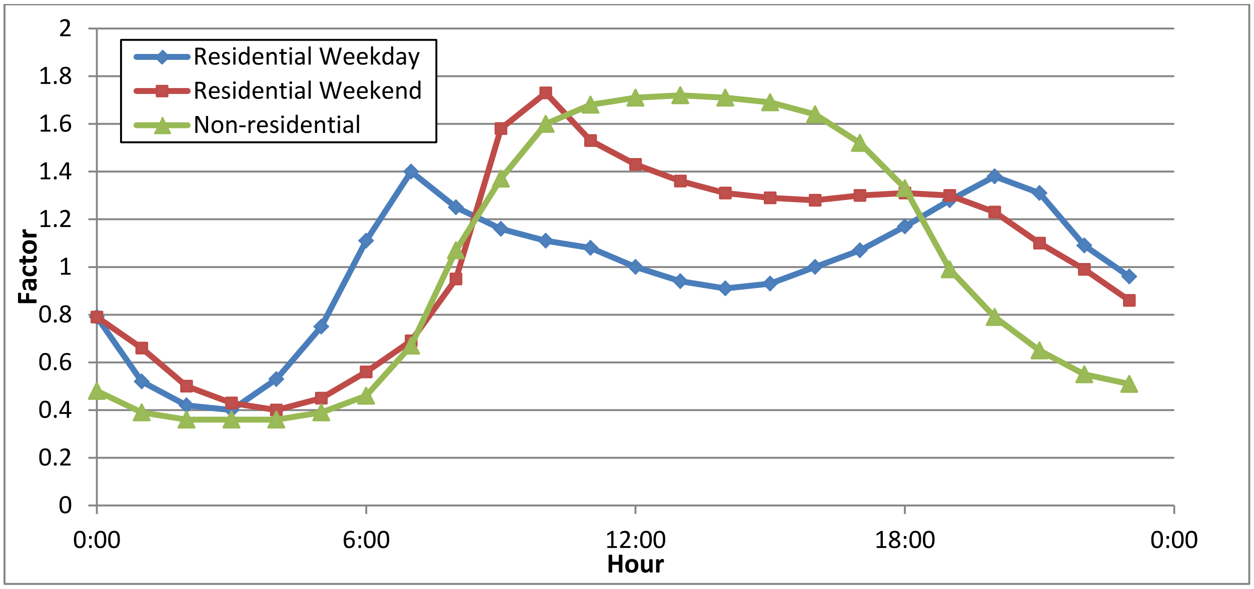
a. Includes 325 hotel rooms.
b. Includes some flow from existing developed parcels in these areas based on winter water use.

Diurnal Profiles

BWF varies throughout the day in a typical way, generally peaking early in the morning in upstream sewers and later and less sharply in larger downstream sewers. Typical hourly peaks from small residential areas tend to be about twice the average flow, whereas peak flows further downstream may be less than 1.5 times average flows due to flow attenuation in the collection system. Higher peaks can occur on atypical days of the year (e.g., on major holidays such as Thanksgiving or at halftime on Super Bowl Sunday).

For the City of Antioch, typical diurnal profiles were developed for residential and commercial/industrial (non-residential) wastewater flow, for both weekend and weekday conditions. The profiles are applied to the subcatchment BWF in the model. The residential profiles were developed based on monitored flows for smaller, primarily residential meter areas, and the non-residential profile is based on typical non-residential flow profiles for similar areas. The diurnal profiles used in the model are shown in **Figure 2-10**.

Figure 2-10: Diurnal Profiles



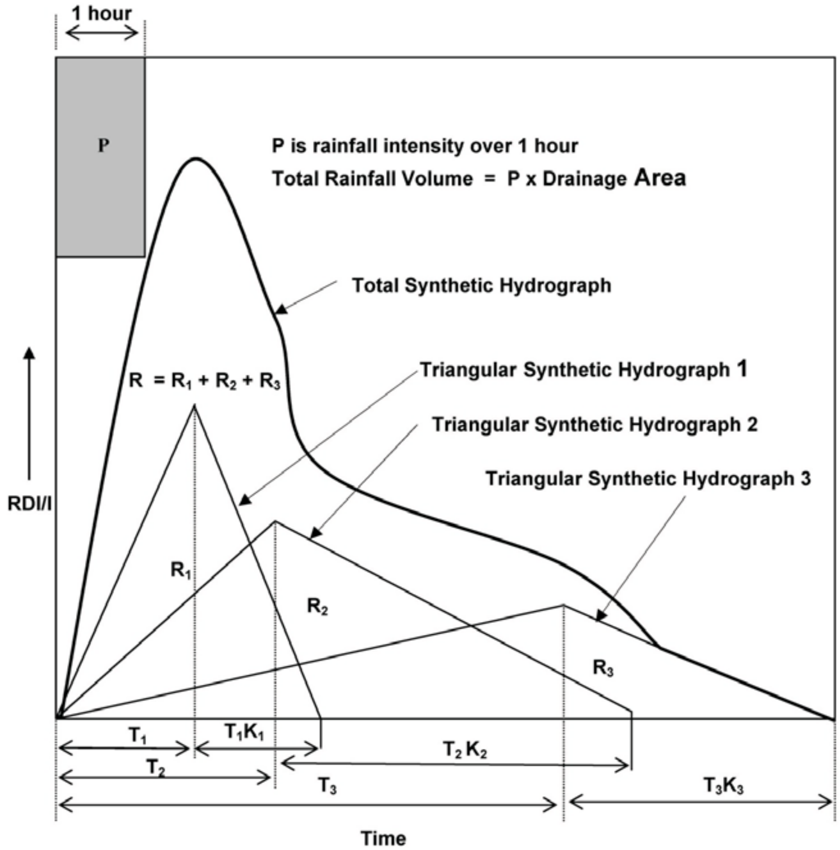
2.4.3 Groundwater Infiltration

GWI is typically applied in the model as a constant load in addition to the BWF. The amount of GWI in any particular area is determined during model calibration by comparing the modeled flows to actual observed dry weather (non-rainfall period) flows at points in the system where flow meter data are available. Where modeled BWF is less than monitored dry weather flow, the difference is assumed to represent GWI. The GWI determined at the monitoring location is then distributed to the meter tributary area on a per-acre basis. Note that because GWI is seasonal in nature, the modeled GWI is intended to represent a typical GWI rate during the wet weather season rather than a dry season (summertime) GWI.

2.4.4 Rainfall-Dependent I/I

RDI/I flows result from rainfall events that produce infiltration and inflow of storm water runoff into the sewer system. RDI/I flows are defined by the magnitude, shape, and timing of the RDI/I response. RDI/I varies depending on many factors, including the magnitude and intensity of the storm event, area topography, type of soil, and the condition of the sewers, manholes, and sewer service laterals. In a dynamic model, RDI/I is typically computed as a percentage of the rainfall (sometimes referred to as the "R value") falling on the contributing area of a subcatchment for each of three or more hydrograph components, representing different response times to rainfall, e.g., fast, medium, and slow, as illustrated in **Figure 2-11**. (The contributing area is assumed to be the sum of the area of all developed parcels, except for large open areas such as parks and parking lots.) Summing all of the component hydrographs for the entire duration of the rainfall event results in the total RDI/I hydrograph for the event for that subcatchment. Note that although the "slow" RDI/I component can contribute significantly to the total RDI/I volume, the "fast" component has the biggest impact on the magnitude of the peak wet weather flow.

Figure 2-11: RDI/I Hydrograph Components



2.5 Model Calibration

2.5.1 Dry Weather Calibration

The 14-day dry period from January 30 to February 13, 2013 was used as the dry weather calibration period for comparing flow data to the model results. This period was selected because it was not impacted by previous rainfall and a majority of the meters showed consistent readings.

The primary focus of the dry weather calibration was to confirm that the calculated average BWF based on winter water consumption was consistent with the measured flows at the meter locations. The other objectives of the dry weather calibration were to confirm the flow routing in the system, particularly in areas where flow can be diverted in more than one direction (flow splits), as well as to confirm the diurnal profiles used to represent the hourly variations in BWF. The diurnal curves shown in Figure 2-10 were developed based on the calibration.

GWI was added when the observed (metered) dry weather hydrographs were greater than the model-simulated hydrographs by a relatively constant value throughout the day. GWI was applied in only three of the flow meter areas: estimated rates of 325, 7,000, and 320 gpd/acre were applied in flow meter area 6, 9B, and 15, respectively.

Note that the DDSD Conveyance Master Plan estimated a GWI rate of 550 gpd/acre in the East Antioch area (flow meter areas 9A, 9B, 10, and 11), for a total GWI of 1 mgd (based on the flow monitoring conducted in the winter 2008/09). The 2012/13 flow monitoring suggests that total GWI in this area is approximately 200,000 gpd, and is located primarily in flow meter area 9B; this calculates to a rate of 7,000 gpd/acre in this area, which is very high. GWI was not observed in the other flow meter areas in

East Antioch (9A, 10, and 11). Note that the flow monitoring conducted in 2002 for the City's 2003 Master Plan did not measure flows at the FM 9B meter location so a comparison to flows in that year is not possible. The high GWI rate for FM 9B may suggest a localized source; for example, the 21-inch pipeline upstream of FM 9B could be receiving infiltration or inflow from East Antioch Creek. As the 2012/2013 water year was dry relative to 2008/09, the higher GWI estimated for the 2010 DDSD Master Plan could have resulted from higher groundwater levels.

It should be noted that it may be difficult to assess the actual amount of GWI, as the relative accuracy of the flow monitoring data, water consumption data, and other model assumptions will affect the amount of flow attributed to GWI. However, this methodology is considered adequate for modeling purposes.

Because the 2012/13 flow monitoring period was very dry, the GWI rates estimated for the model may not be representative of maximum rates during wetter years. For this reason, sensitivity analyses were conducted to assess the impact on system flows and capacity under higher GWI. The results of the sensitivity analyses are discussed later in this report.

Table 2-6 summarizes the estimated dry weather flow (DWF) in the Antioch collection system based on the model calibration and estimated future loads described previously. Note that future DWF flows also include an assumed 10 percent increase in BWF in existing developed areas to account for currently unoccupied homes and vacant commercial building space.

Table 2-6: Dry Weather Flow Summary

Flow Component	Flow (mgd)	
	Existing	Future[a]
Residential BWF	6.28	9.25
Non-Residential BWF	0.96	2.15
Total Average BWF	7.24	11.40
Estimated GWI[b]	0.40	0.40
Total Average DWF[b]	7.64	11.80

c. Also includes a 10 percent increase in flows from existing development to account for an assumed rebound in building occupancy.
d. Representative of a relatively dry wet weather season similar to 2012/13.

2.5.2 Wet Weather Calibration

During wet weather calibration, parameters are adjusted to simulate the volume and timing of RDI/I for monitored storm events. Rainfall was assigned to subcatchments using data from the closest of three rain gauges maintained by V&A during the monitoring period. During the flow monitoring period, the largest storm occurred on April 4, 2013, which generated approximately 0.4 inches of rainfall over a 12-hour period and a peak hour intensity of 0.2 inches. Because of the small size of this event, and the lack of other significant storms during the monitoring period, DDSD flow data at the Antioch and Bridgehead Pump Stations during the 2010 to 2012 wet seasons, as well as temporary flow monitoring data from 2008/09 collected for the DDSD Conveyance System Master Plan and 2002 flow data obtained for the 2003 Antioch Collection System Master Plan were also reviewed to refine RDI/I hydrograph parameters.

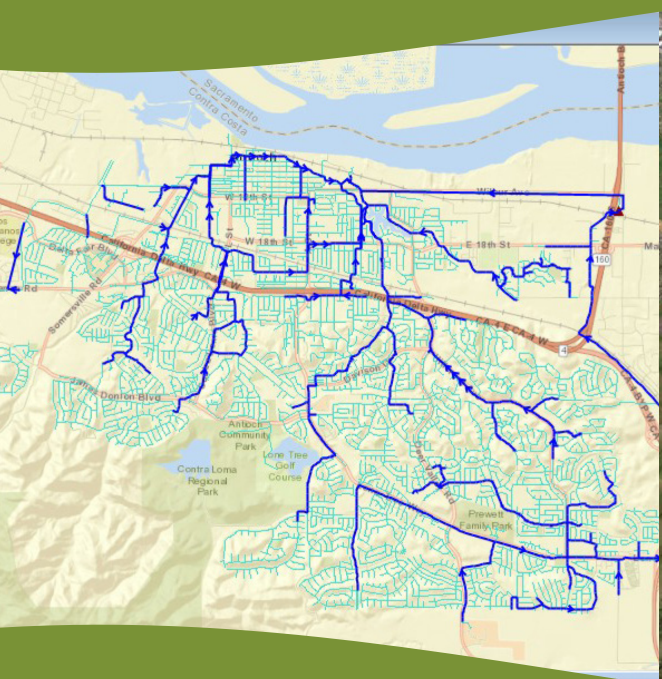
Through the wet weather calibration process, RDI/I hydrograph parameters were developed for each metered area. For currently undeveloped, unmetered basins, low RDI/I values were assigned, as these areas are expected to have less relative I/I. These low values were based on the calibrated parameters for the meters with the lowest RDI/I response.

Note that design peak RDI/I rates (based on the design storm described in the subsequent subsection) would range from about 370 gpd/acre in relatively new areas of the system to about 1,700 gpd/acre near downtown (FM 6). The overall wet weather peaking factor, or ratio of peak wet weather flow (PWWF) to average BWF was determined to be about 3.4 at Antioch Pump Station (including Bridgehead flows); the highest peaking factor is approximately 7.2 at FM 6.

As with GWI, the RDI/I parameters developed for this study may underestimate the RDI/I response during wetter years or larger storm events. Therefore, similar sensitivity analyses were conducted to evaluate the potential impact of higher RDI/I, as described later in this report.

Chapter 3

Capacity Analysis



Chapter 3 Capacity Analysis

The capacity performance of the system and potential need for capacity improvements were evaluated using the calibrated hydraulic model described in Section 2. This section discusses the criteria on which the capacity assessment was based and presents the model results.

3.1 Design Flow and Performance Criteria

Sewer system capacity is assessed with respect to the system's performance under a design flow condition. The subsections below define the design flow criteria used for the capacity assessment and the criteria for assessing system performance and identifying system capacity deficiencies.

3.1.1 Design Storm Condition

The use of wet weather design events as the basis for sewer capacity evaluation is a well-accepted practice. The approach is to first calibrate a hydraulic model of the system to match wet weather flows from observed storm(s), and then apply the calibrated model to a design rainfall event to identify capacity deficiencies and size improvement projects. The design event may be synthesized from rainfall statistics, or may be an actual historical rainfall event of appropriate duration and intensity. Other considerations for the design event include the spatial variation of the rainfall and the timing of the storm relative to the diurnal base wastewater flow pattern.

Selection of a design rainfall event is typically based on an allowable level of risk, often expressed as the return period. It is recognized that while wet weather overflows are highly undesirable, it is not cost-effective to provide capacity for the largest possible storm event. Regulatory agencies have not adopted standard criteria for return periods, so each agency must choose a target return period based on desired level of service, potential impacts of overflows, and cost.

The City selected the rainfall event that occurred on December 31, 2005 as the design event for this Master Plan. This event is comparable in size to a 5-year SCS Type 1A synthetic 24-hour rainfall event (USDA, 1996), and was also used for DDSD's 2010 Conveyance System Master Plan. **Figure 3-1** shows the design storm rainfall hyetograph for Antioch.

Figure 3-2 shows a comparison of the selected design storm with the SCS Type 1A 5-year and 10-year events. This comparison indicates that the December 31, 2005 design storm is at least as intense as the 5-year SCS Type 1A event for all durations, and comparable to the 10-year event for some durations.

The December 31, 2005 design storm for Antioch has the following characteristics:

- Total rainfall 2.4 inches
- Peak hour intensity 0.37 inches/hour

Figure 3-1: December 31, 2005 Event for Antioch

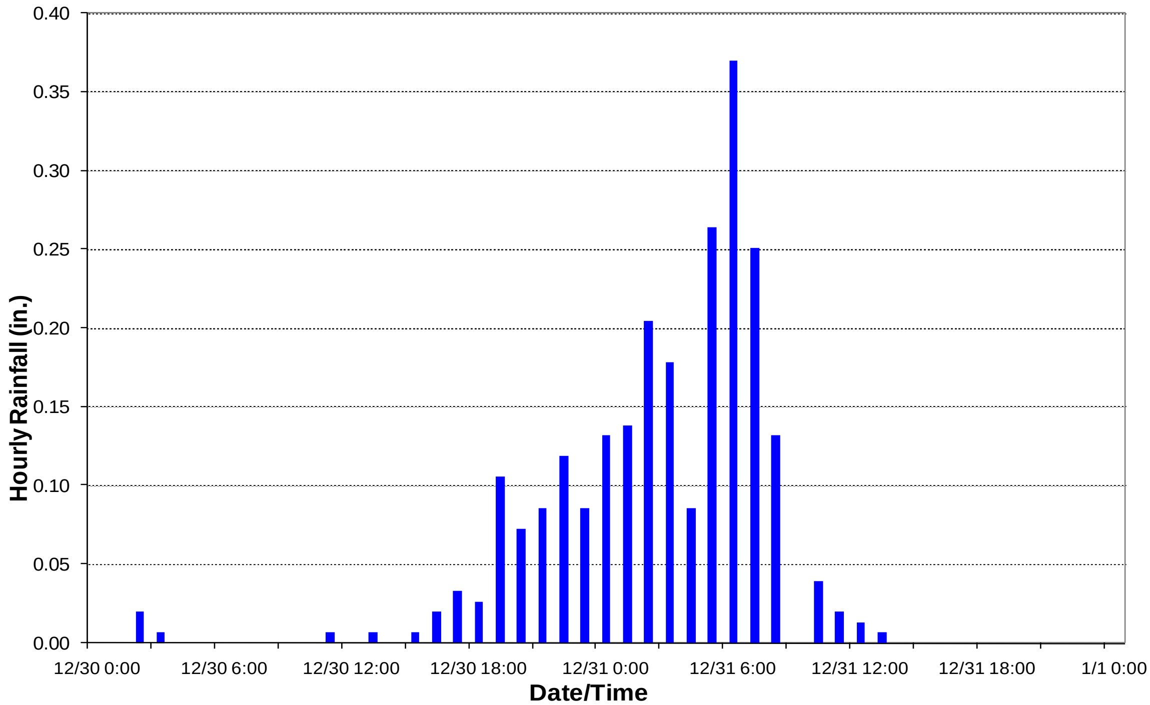
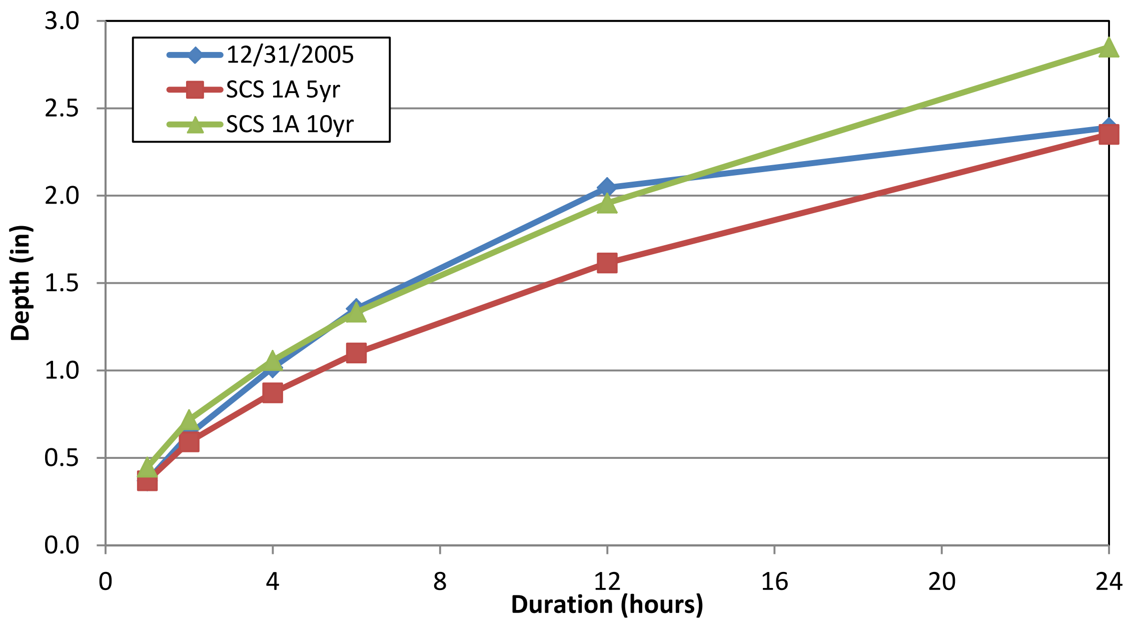


Figure 3-2: Depth-Duration Comparison of 12/31/2005 Event with SCS Type 1A 5-Year & 10-Year Events



The timing of the design storm also affects the resultant peak wet weather flows. If the design storm is timed such that the peak RDI/I occurs at the same time as the peak BWF ("peak-on-peak"), the total PWWF will be higher than if the design storm occurs under average or minimum BWF conditions. Timing the storm to produce peak-on-peak results is generally thought to create a return period of the peak wastewater *flow* that is greater than the return period of the design rainfall event. For this reason, the timing of the December 31, 2005 event, which occurred on a weekend, was offset by 2 hours to align peak RDI/I flows with the weekend diurnal peak BWF. This results in a peak RDI/I and peak BWF occurring at approximately 11:00 am. Note that as a result of the offset timing, this design storm is a more extreme event within the City of Antioch's collection system than the design event used for DDSD's 2010 Conveyance System Master Plan.

For future scenarios, the sewer system's response to rainfall is assumed to remain the same as under existing conditions (other than the nominal additional I/I from new development areas). This implies that any increase in I/I due to deterioration of existing sewers will be offset by a decrease due to sewer rehabilitation or replacement, and that new sewers and laterals will contribute minimal I/I flows.

The estimated peak flows to each DDSD discharge location are summarized in **Table 3-1**. Note that these estimates are generally lower than estimated in DDSD's 2010 Conveyance Master Plan Update or the City's 2003 Collection System Master Plan. These differences are due to the use of water billing data and additional flow metering data available for the current Master Plan to estimate existing loads, and a different approach used for development of future loads.

Table 3-1: Antioch Peak Flow Summary

Discharge Point	Flow (mgd)					
	Existing ADWF	Existing PDWF	Existing PWWF	Future ADWF	Future PDWF	Future PWWF
Bridgehead Pump Station	2.4	3.9	5.6	4.7	7.5	12.0
Antioch Pump Station[a]	7.3	10.4	17.0	11.3	17.8	26.3
Pittsburg-Antioch Interceptor[b]	0.3	0.5	0.8	0.5	0.8	1.2

c. Includes Bridgehead Pump Station flows.
d. Flows from Antioch only.

3.1.2 Capacity Deficiency Criteria

Capacity deficiency or performance criteria are used to determine when the capacity of a sewer pipeline is exceeded to the extent that a capacity improvement project (e.g., a relief sewer or larger replacement sewer) is required. Capacity deficiency criteria are sometimes called "trigger" criteria in that they trigger the need for a capacity improvement project. These criteria may differ from "design criteria" that are applied to determine the size of a new facility, which may be more conservative than the performance criteria.

It is important that the capacity deficiency criteria be coordinated with the peak design flow criteria. For example, if the peak design flow considers only peak dry weather flow and little or no I/I, the deficiency criteria should be conservative (e.g., require pipes to flow less than full under dry weather flow to allow capacity for I/I that may increase the flow under a wet weather condition). On the other hand, if the peak design flow includes I/I from a large, relatively infrequent design storm event, it is appropriate to allow the sewers to flow full or even surcharged to some extent, since the peak flows will be infrequent and brief in duration.

For Antioch, since the design storm PWWF represents a relatively infrequent event, the City considers it acceptable to allow surcharging of up to one foot over the pipe crown, provided the hydraulic grade line (water level) remains at least four feet below the ground surface (i.e. four feet of freeboard).

3.2 Capacity Analysis Results

The calibrated model was run for existing and future conditions to identify areas of the system that fail to meet the specified performance criteria under design storm peak wet weather flows.

Because available data for wet weather calibration was limited, three model scenarios were developed to evaluate the sensitivity of the system to potential variations in I/I.

Scenario A: Calibrated model under design storm PWWF conditions. The scenario used the GWI and RDI/I parameters described in Section 2.

Scenario B: A comparison with the flow monitoring data from 2002 suggested higher GWI rates in FM 9A and FM 14 areas. While the source of higher GWI in 2002 compared to 2013 is not known, one possibility is higher groundwater levels resulting from a wetter year. Therefore, a sensitivity run was performed with the addition of 3,200 gpd per acre GWI in FM 9A area (500,000 gpd total), and 300 gpd per acre GWI in FM 14 area (200,000 gpd total).

Scenario C: Because of the limited available flow monitoring data during storm events during the 2012/13 flow monitoring period, the sensitivity of the system to the RDI/I factors was also tested by doubling the fast and medium response components (R1 and R2). This scenario was run with the additional GWI described above under Scenario B.

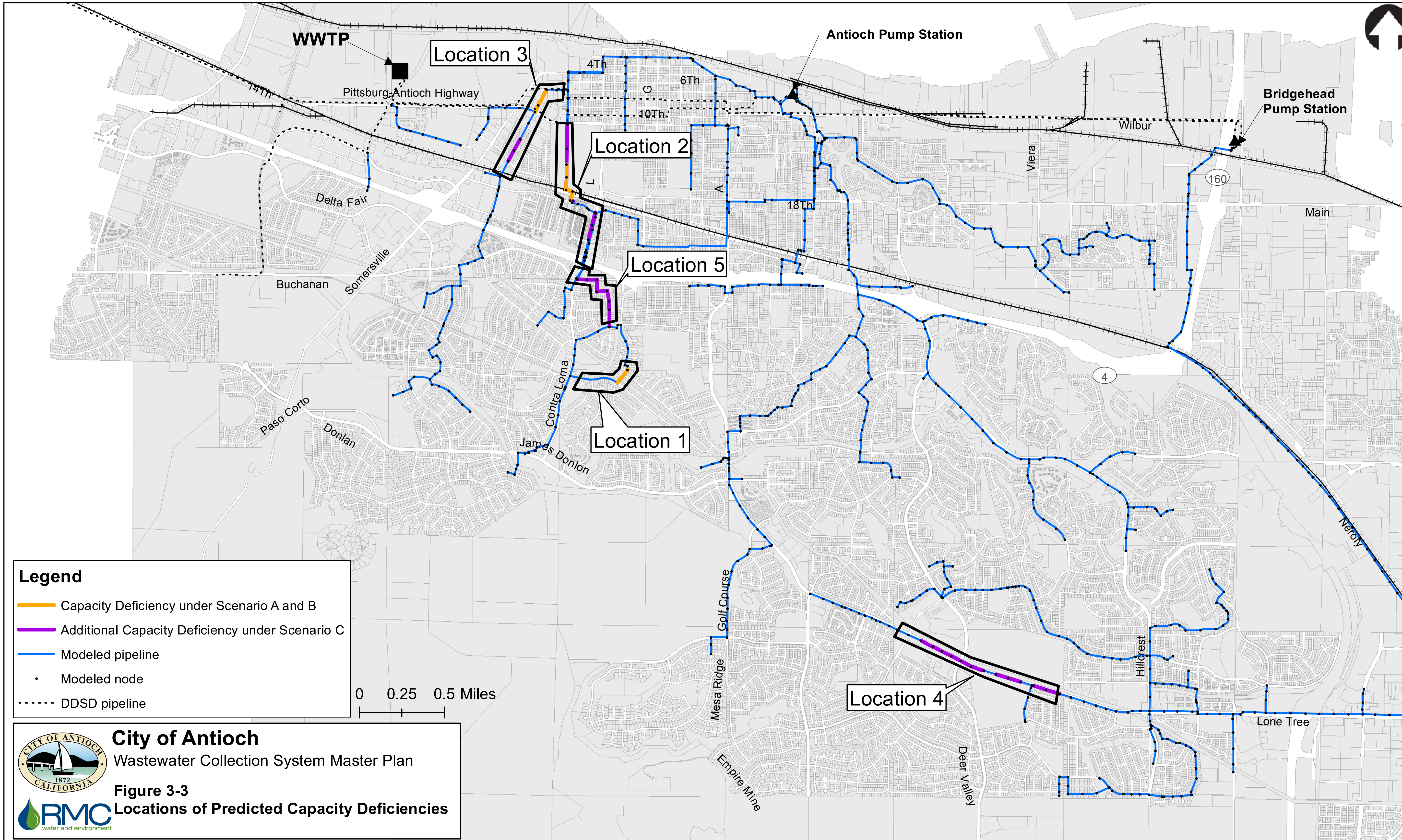
3.2.1 Predicted System Deficiencies under Model Scenarios

The model indicates that the existing system would exceed capacity at only one location under Scenario A for existing flow conditions – an 8-inch pipe between G Street and Longview Road. Under the existing system scenario, this pipe is predicted to surcharge up to 2 feet (however, with more than 7 feet of freeboard). This location is identified as Location 1 in **Figure 3-3** and **Figure 3-4**.

Under future conditions, two additional locations of predicted capacity deficiencies (Locations 2 and 3) were identified under Scenario A. Under Scenario C, Locations 1, 2, and 3 (including additional segments in Locations 2 and 3) plus two additional locations (Locations 4 and 5) would exceed the City's surcharge or freeboard criteria under both existing and future flow conditions. These locations are also shown in Figure 3-3 and Figure 3-4.

Table 3-2 indicates the maximum surcharge and minimum freeboard, and the extent of "throttle" (length of pipe in which PWWF would exceed full pipe capacity) for each location under each scenario. Hydraulic profiles of these locations under each scenario are included in **Appendix E**.

Note that the surcharge at Location 3 is partially due to a reverse slope from MH F21-9-036 to MH F21-9-037; if the GIS elevation data is not correct and this pipe is not actually constructed at adverse slope, then the surcharge would be less, but would still exceed the City's deficiency criteria. Note also that none of the five locations are downstream of the added GWI under Scenario B (in the FM 9A and FM 14 areas); therefore the hydraulic profiles under Scenario A and Scenario B are identical at all five locations. No additional deficiencies were identified as a result of the increased GWI in FM9A and FM14 areas.



City of Antioch

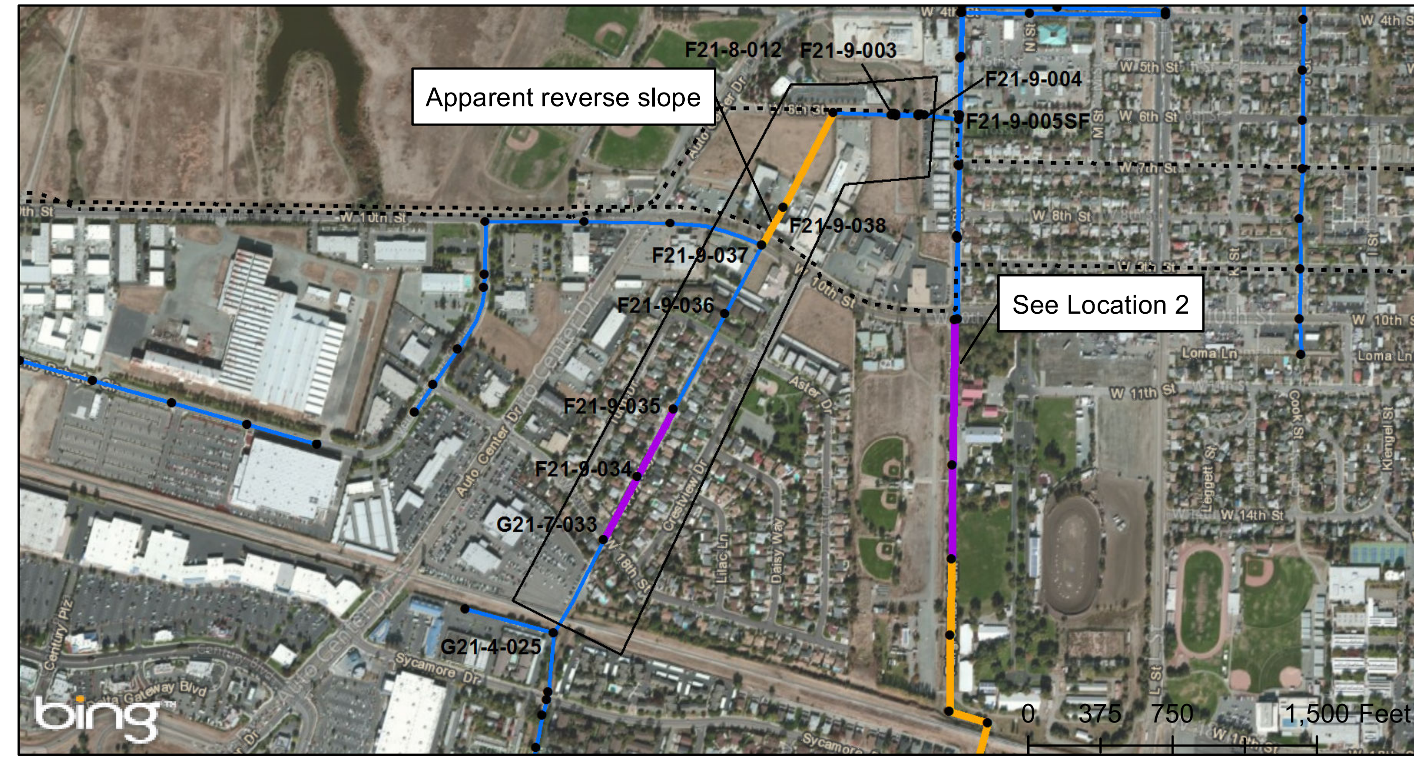
Wastewater Collection System Master Plan

Figure 3-3

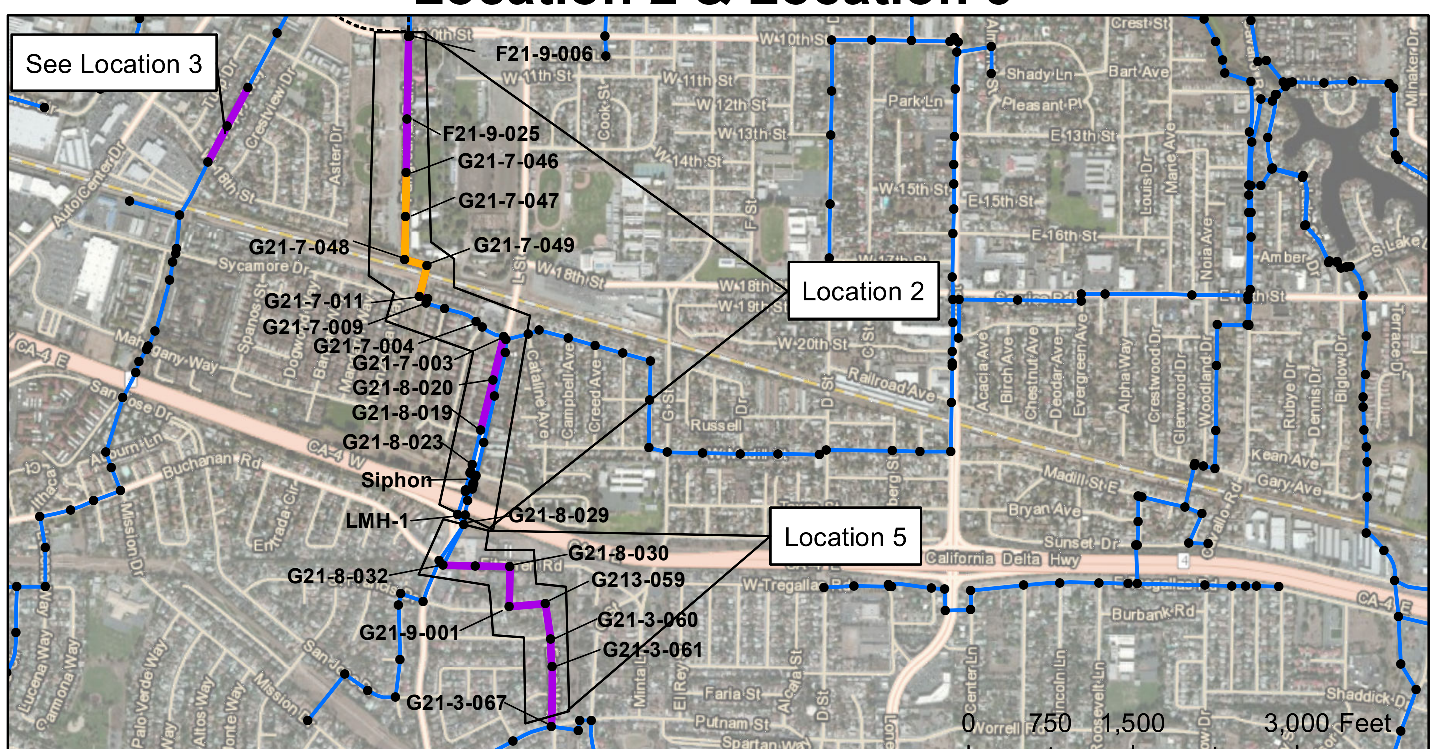
Locations of Predicted Capacity Deficiencies

Location 1

Location 3



Location 2 & Location 5



Location 4

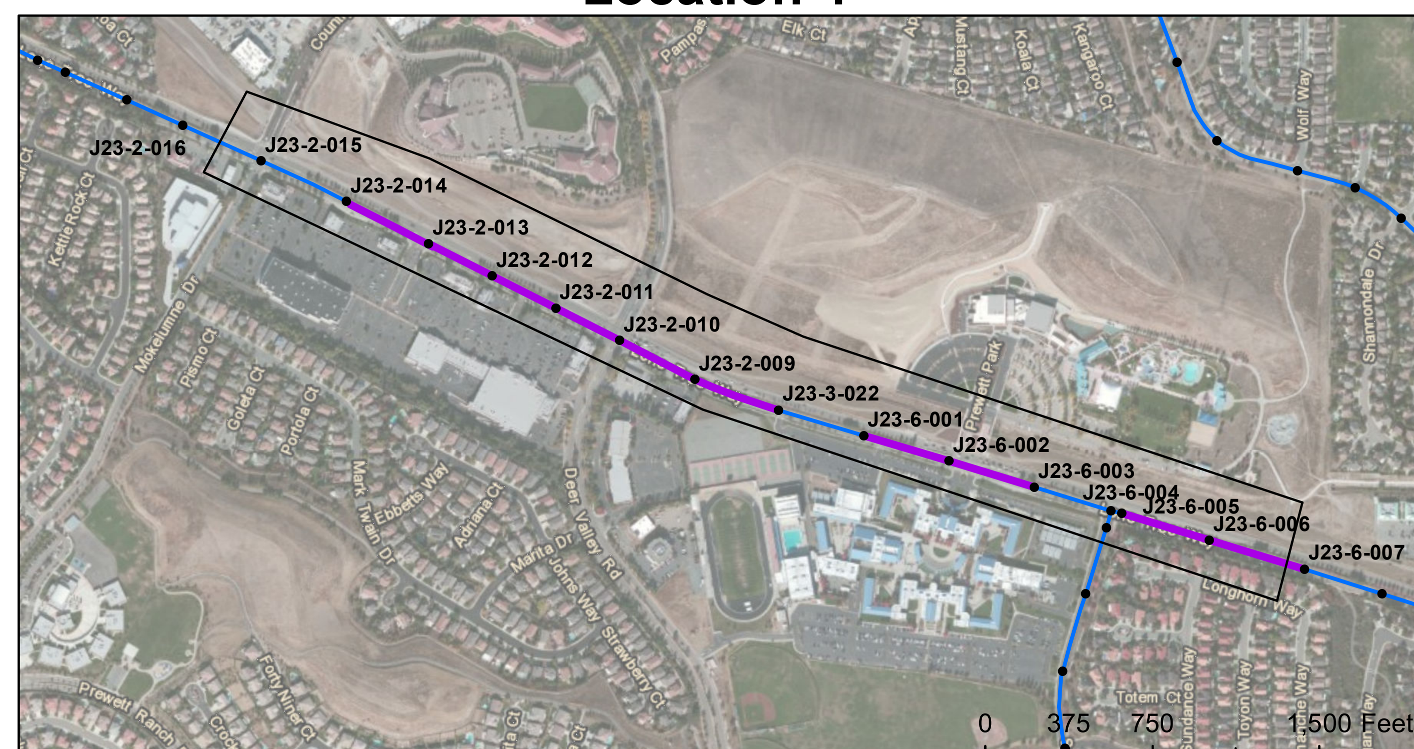


Figure 3-4
Capacity Deficiency Location Details

Legend

- Capacity Deficiency under Scenario A and B
- Additional Capacity Deficiency under Scenario C
- Modeled pipeline
- Modeled node
- DDSD pipeline

City of Antioch
Wastewater Collection System Master Plan

Document Name: 3-4 Location Details_28Mar14 Date Saved: 10/21/2014

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Table 3-2: Locations of Predicted Capacity Issues

Location No.	Location	Pipe Size	Existing Conditions		Future Conditions	
			Scenarios A and B	Scenario C	Scenarios A and B	Scenario C
1	G St and Longview Rd	8- and 6-inch	**Up to 2.0 ft of surcharge** 7.3 ft freeboard**.** Extent of throttle: 510 lf	**Up to 7.3 ft of surcharge** **2.0 ft freeboard** Extent of throttle: 510 ft	**Up to 2.8 ft of surcharge** 6.5 ft freeboard**.** Extent of throttle: 510 lf	**Up to 9.2 ft of surcharge** **0.8 ft freeboard** Extent of throttle: 510 ft
2	Fairgrounds Park and L Street	15-inch	Up to 1.0 ft of surcharge 6.4 ft freeboard Extent of throttle: 1,285 lf	**Up to 7.3 ft of surcharge** **1.3 ft freeboard** Extent of throttle: 3,485 lf	**Up to 2.0 ft of surcharge** 6.4 ft freeboard Extent of throttle: 1,367 lf	**Up to 7.7 ft of surcharge** **0.7 ft freeboard** Extent of throttle: 3,485 lf
3	Sycamore Drive to Poppy Way	12-inch	No Capacity Issues	**Up to 3.2 ft of surcharge** **2.3 ft freeboard** Extent of throttle: 1,187 lf	**Up to 2.7 ft of surcharge** **3.7 ft freeboard** Extent of throttle: 1,187 lf	**Up to 5.3 ft of surcharge and potential overflow** Extent of throttle: 3,067 lf
4	Lone Tree Way	12-inch	No Capacity Issues	**Up to 1.7 feet of surcharge** 12 ft freeboard Extent of throttle: 786 lf	No Capacity Issues	**Up to 4.6 feet of surcharge** 10 ft freeboard Extent of throttle: 786 lf
5	Enea Way	12-inch	No Capacity Issues	**Up to 7.1 ft of surcharge and potential overflow**[a] Extent of throttle: 2,431 lf	No Capacity Issues	**Up to 7.1 ft of surcharge and potential overflow**[a] Extent of throttle: 2,431 lf

Note: **Bolded** results indicate capacity deficiency criteria exceedance.
b. About 4 feet of surcharge due to back-up from Location 2.

Two additional locations, at MH G22-7-062 on Inland Court and MH G22-7-071 on Lake Drive were also predicted to exceed the City's surcharge criteria under Scenario C due to a section of reverse slope; since the exceedance was relatively small (2 feet of surcharge), the hydraulic grade line was at least 7 feet below the ground surface, and the exceedance only occurred under the conservative I/I scenario (Scenario C), these sections were not considered to be capacity issues.

As noted in the City's 2003 Master Plan, there are several short reaches of pipe that have apparent reverse slopes. These short results may cause a localized backwater effect, but would not necessarily result in capacity deficiencies and are not described above (except at Location 4). Although these generally would not result in capacity deficiencies per the City's criteria, these sections may cause localized maintenance issues. A list of potential reverse slope segments is included in **Appendix F.**

3.2.2 Interim Connections from FUA-1

In the near-term, the City has indicated that some flow from the FUA-1 area may need alternate connection points into the existing collection system before planned sewers in the FUA-1 area have been fully implemented (these sewers would ultimately convey flow to the Lone Tree Way Interceptor at Heidorn Ranch Road, as shown in Figure 2-9). To evaluate potential alternative routes, the available capacity of the 8-inch sewers in Dallas Ranch Road, Deer Valley Road, and Hillcrest Avenue were determined, and are summarized in **Table 3-3.** These sewers could potentially convey flows north from near-term developments in FUA-1 to the City's 15-inch to 24-inch trunk sewer in Lone Tree Way. The model indicates that the Lone Tree Way sewer has adequate near-term capacity for this additional flow, even if all three sewers are used.

Table 3-3: 8-inch Sewer Capacity Available for Near-Term Flows

Location	Available Capacity
Dallas Ranch Road	0.15 mgd
Deer Valley Road	0.10 mgd
Hillcrest Ave	0.50 mgd

3.3 Capacity Improvement Projects

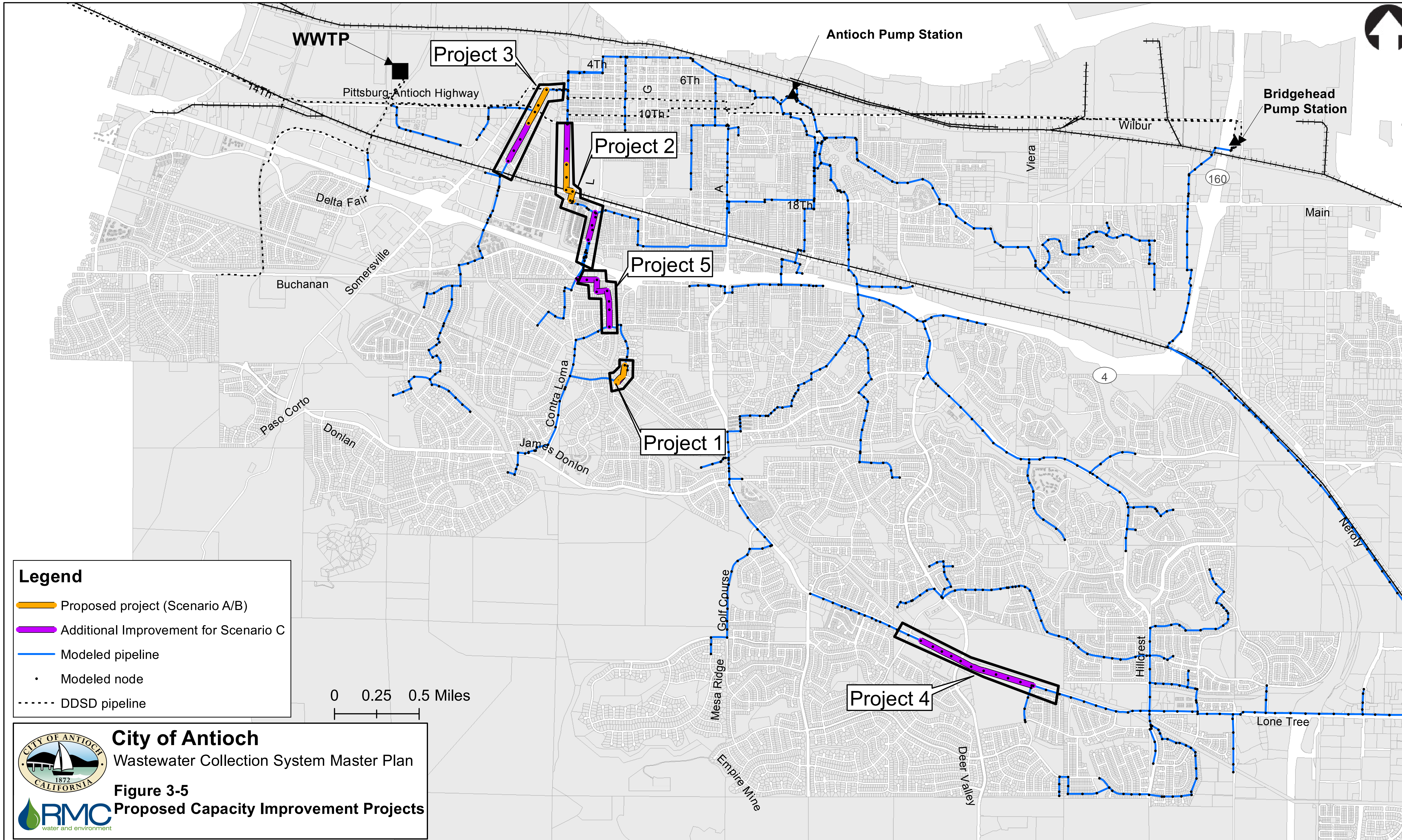
This section describes the sewer improvement projects that would be needed to reduce the risk of overflows in the collection system due to insufficient capacity for design peak wet weather flows. These improvement projects have been developed to address areas in which predicted peak flows would exceed the City's capacity deficiency criteria under the scenarios evaluated for this study. For each identified gravity sewer capacity deficiency, a project was developed to replace the existing pipe with a larger pipe or, alternatively, install a parallel pipe in some cases. None of the predicted capacity deficiencies were located near existing sewers with available capacity; therefore, diversion to another sewer was not feasible. The projects are summarized in **Table 3-4** and shown in **Figure 3-5.**

The assumptions that were used to define the projects are discussed below. Detailed maps and project information sheets that provide project details, key considerations, and planning-level construction and capital cost estimates are included in **Appendix G**.

Table 3-4: Capacity Improvement Projects

Project No.[a] and Scenario	Project Name	U/S MHID	D/S MHID	Description	Estimated Capital Cost (Replace)	Estimated Capital Cost (Parallel)[b]
1 A/B/C	G Street	H22-1-029	H22-1-041	Install 630 feet of new 12" sewer in G St. from Longview Rd. to Gloucester St. and abandon existing parallel easement sewers; install 40 feet of 8" sewer in Longview Rd. in G St. to reverse flow direction.	$299,000	N/A
2 A/B	O Street	G21-7-010	G21-7-046	Replace 1,400 feet of 12" and 15" pipe with 18" pipe (or install 15" parallel pipe) from Sycamore Dr. near Manzanita Way and on O Street through Contra Costa County Fairgrounds (includes UPRR crossing).	$1,105,000	$951,000
2 C	O Street / L Street	G21-7-010 G21-8-019	F21-9-024SF G21-7-003	Replace 2,600 feet of 12", 15" and 18" pipe with 21" pipe (or install 15" parallel pipe) from Sycamore Dr. near Manzanita Way and on O Street through Contra Costa County Fairgrounds to W. 10th St (includes UPRR crossing). Replace 900 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) on L St. from Lemontree Way to Sycamore Dr.	$ 2,068,000	$1,674,000
3 A/B	Aster to 6th St. Easement	F21-9-036	F21-8-012	Replace 1,200 feet of 12" pipe with 15" pipe in an easement extending from north of Poppy Way at Astor Dr. to W. 6th St.	$435,000	N/A
3 C	Poppy Way / Aster to 6th St. Easement	G21-7-033	F21-8-012	Replace 2,500 feet of 12" pipe with 15" pipe in Poppy Way, and continuing in easement from Aster Dr. to W. 6th St.	$ 1,034,000	N/A
4 C	Lone Tree Way	J23-2-014	J23-6-005	Replace 3,800 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) in Lone Tree Way from east of Mokelumne Dr. to Sagebrush Dr.	$794,000	$1,475,000
5 C	Enea Way	G22-3-067	G21-8-032	Replace 2,400 feet of 12" pipe with 15" pipe (or install 12" parallel pipe) in Enea Way from Putnam St. to St. Francis Dr. and continuing in easement to Fitzuren and west to Contra Loma Blvd.	$834,000	$1,115,000
				Total - Scenario A/B	$1,839.000	
				Total – Scenario C	$5,029,000	

a. Correspond to Location Nos. in Table 3-2.
b. Note that parallel pipe option would generally be more expensive if the replacement pipe option involves upsizing by pipe bursting to 15" or smaller pipe, but less expensive if the replacement pipe option involves remove and replace construction of an 18" or larger pipe.



City of Antioch

Wastewater Collection System Master Plan

Figure 3-5

Proposed Capacity Improvement Projects

3.3.1 Project Sizing Criteria

For gravity sewer capacity improvement projects identified as part of this Master Plan, replacement or new pipes were sized to convey the future Design Storm PWWF with no (or only minimal) surcharge. Existing pipe slopes and depths were preserved when upsizing sewers in-place. Model runs with all capacity projects in place were made to determine the impact of increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

3.3.2 Cost Criteria

Costs for capacity improvement projects were estimated based on input from the City and RMC experience with similar projects. These cost estimates are planning or conceptual level estimates, and are considered to have an estimated accuracy range of -30 to +50 percent. This level of accuracy corresponds to an “order of magnitude” or “Class 5” cost estimate as defined by the American Association of Cost Estimators. These estimates are suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed into the design and construction phases. All costs have been adjusted to an Engineering News Record Construction Cost Index (ENR CCI) of approximately 10,892, which represents the April 2014 ENR CCI for the San Francisco Area.

Cost criteria include baseline unit construction costs for gravity sewers using open-cut and trenchless (e.g., pipe bursting) methods. Pipe bursting is assumed for most projects that involve upsizing existing sewers to 15-inch diameter or smaller; construction of new sewers or pipes larger than 15 inches assumes open cut construction, except where trenchless construction would be required for major crossings (e.g., railroad crossings). Costs for gravity trunk sewers vary with pipe diameter and depth (in the case of open-cut construction), and include replacement of lower laterals and installation of cleanouts at the property line. Allowances added to the baseline construction cost include mobilization/demobilization and project-specific costs for bypass pumping for pipe bursting and remove and replace construction, traffic control for work in roadways, and a delay factor (additional construction time) for remove and replace projects. A 30 percent allowance for contingencies for unknown conditions was also included for all projects, as well as an allowance of 25 percent of construction cost for engineering, administration, and legal costs.

3.3.3 Project Priorities

As indicated in Table 3-2, Project 1 addresses a capacity deficiency under existing flow conditions under the least conservative I/I scenario (Scenario A) and is therefore considered the highest priority for construction. Projects 2 and 3 address capacity deficiencies that would occur under existing conditions only for the more conservative I/I scenario (Scenario C) or under future conditions for the least conservative scenario. Projects 4 and 5 are only needed under the more conservative I/I scenario (Scenario C), therefore would be considered lower priority for construction. However, the City should budget for all of these projects, but should monitor flows to confirm if and when they are needed.

3.4 Recommendations

The following paragraphs provide guidelines for implementing the Master Plan.

3.4.1 Flow Verification

While the model was calibrated as best possible based on available data, the lack of significant rainfall during the flow monitoring period resulted in reduced confidence in the model results for peak wet weather flow conditions. While the model results indicate relatively few capacity issues in the City’s collection system, the sensitivity analyses conducted for this study indicate that there could be additional capacity issues if I/I rates are actually higher than currently predicted. Therefore, it is recommended that additional investigation be conducted to further verify the flows in the system. Verification could be conducted by a future temporary flow monitoring program similar to that conducted for this study, as well as by surcharge monitoring or visual observation of flow levels during large storm events.

3.4.2 Investigations for Areas with Potential High Groundwater Infiltration

The flow monitoring and modeling indicated the possible occurrence of significant GWI in flow meter area 9B, which includes the 21-inch trunk sewer that parallels East Antioch Creek. It is recommended that the City televise this line to assess its condition and determine if it is the source of the high GWI. If this is determined to be the case, potential solutions may include rehabilitation of this pipeline, for example using cured-in-place pipe (CIPP) liner. The potential cost of lining 2,400 feet of this sewer (from MHID G22-7-058SF to F22-6-062) could range from $600,000 to $800,000.

3.4.3 Confirmation of Reverse Slopes

The City's GIS data indicates the possible occurrence of reverse slopes in a number of sewer pipelines. While the modeling indicates that the reverse slopes in general do not cause any significant capacity issues in the system, they may result in maintenance issues to do low flow velocities due to backwater effects. However, the City should conduct surveying to verify the apparent reverse slope in the Location 3 area; if confirmed to be accurate, replacement and realignment of this sewer may be necessary to avoid future capacity problems.

3.4.4 Pre-Design Activities

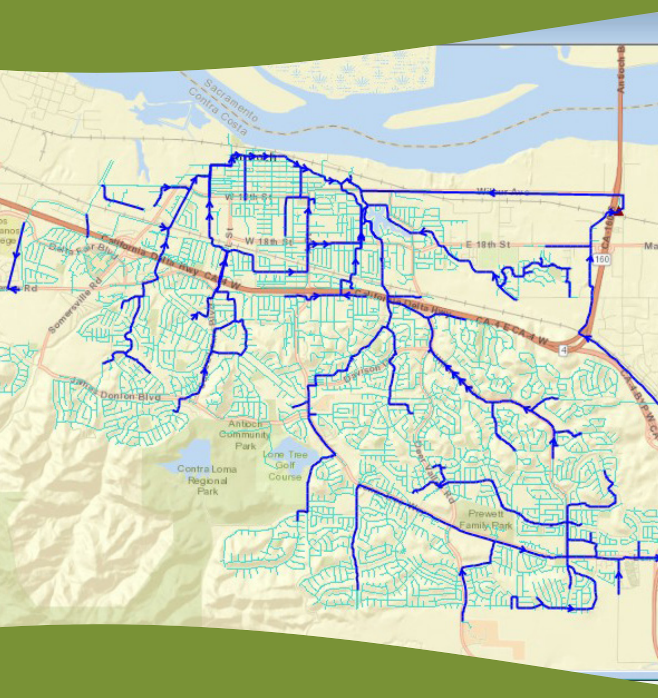
Pre-design work for all projects would include topographic surveys as needed to confirm new pipeline alignments, geotechnical investigations, utility research, constructability reviews, permit applications as needed, and refinement of project cost estimates.

3.4.5 Model and Master Plan Updates

This Master Plan has been prepared to facilitate both use of the information in capital improvement project planning and design, as well as to allow the City to update the Master Plan in the future as the need arises. The model should be kept up-to-date with new sewer improvements, rehabilitation projects, and changes in sewer system flows; and re-calibrated to new flow monitoring data when obtained. The Master Plan should be updated whenever there are major changes in planning assumptions, or at a minimum every five to ten years.

Chapter 4

Long-Term Sewer Renewal/ Replacement Projections



Chapter 4 Long-Term Sewer Renewal/Replacement Projections

This chapter presents an estimate of long-term system renewal and replacement (R/R) needs for the City's gravity sewer system. While the City has conducted closed-circuit television (CCTV) inspection of sewers throughout the system over the past ten years and has identified near-term repair needs, there is currently no comprehensive database of condition data that can be used to estimate the overall long-term R/R needs for the entire systems. Rather, sewer attribute information (e.g., pipe age and material) coupled with reasonable assumptions can be used to develop a first cut at these long-term projections. Therefore, using sewer inventory information and assumptions on sewer useful lives and rehabilitation and replacement methods, a budgetary cost estimate for long-term R/R of the City's wastewater collection system was developed for this report. As additional inspection and condition assessment data is collected in the future and compiled in a consolidated database in a format that can be used for detailed anlaysis, this information will be able to be used to develop a more accurate estimate of the City's future R/R costs.

4.1 System Inventory

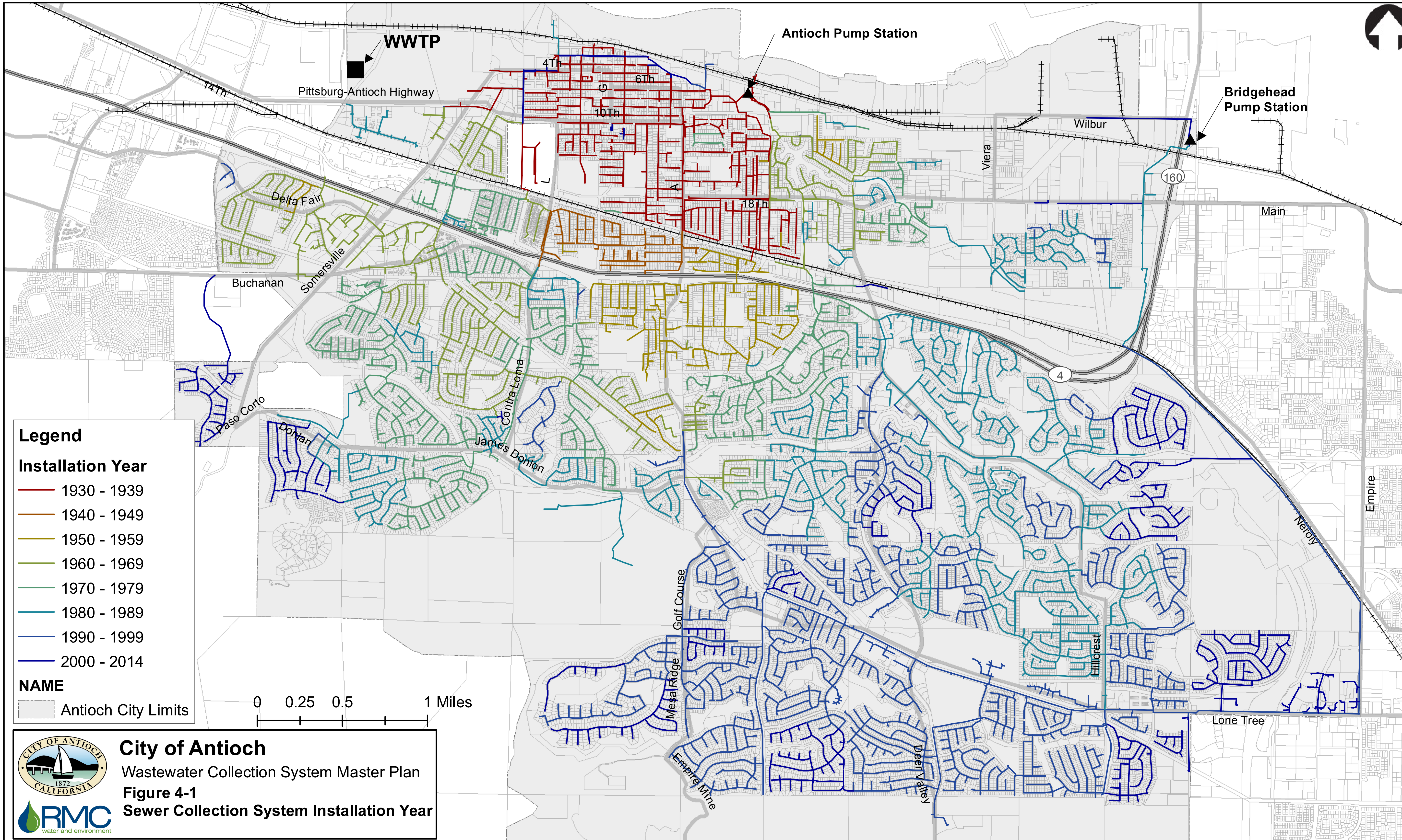
Basic information with which to project long-term R/R needs was derived from the City's sewer inventory data contained in GIS. Using GIS files provided by the City, data for existing sewer facilities were analyzed for accuracy and completeness with respect to pipe diameter, length, material, and installation date. In general, data for pipe materials, diameters, and length were substantially complete. In the limited areas where pipe material was missing from the GIS data, it was assumed to be similar to adjacent pipes. Pipes with missing diameter information were assumed to be 6-inch pipes, based on review of the locations of these pipes. The GIS data also had installation date information for about 60 percent of the sewer inventory. The City was able to provide approximate installation date information (in 10-year increments) for the remaining sewer pipes based on system knowledge and dates of development. Installation year for pipes in the City's system are shown in **Figure 4-1**.

The average age of the collection system is 35 years old, with sewers ranging from new to about 80 years old. The predominant pipe material is vitrified clay pipe (VCP), which comprises approximately 95 percent of the system, with some polyvinyl chloride (PVC), ductile iron pipe (DIP), steel pipe (SP), and asbestos cement pipe (ACP).

Table 4-1 summarizes the length and average age of the various pipe materials in the City's gravity sewer system, and **Table 4-2** summarizes the length distribution of the sewers.

Table 4-1: Length and Average Age of Pipe Material

Pipe Material	Age Range	Average Age (years)	Length (feet)	Percentage of System
VCP	1930 – 2011	36	1,476,073	95.3%
PVC	1980 - 2009	22	56,278	3.6%
DIP	1960 - 2003	45	7,809	0.5%
SP	1990 - 2009	33	5,411	0.3%
ACP	1960 - 1969	50	3,316	0.2%
TOTALS	**1930 - 2011**	**35**	**1,548,887**	**100%**



City of Antioch

Wastewater Collection System Master Plan

Figure 4-1

Sewer Collection System Installation Year

Table 4-2: Distribution of Sewer Length by Pipe Diameter

Diameter (inches)	Length (feet)	Percent of System
4	4,940	0.3%
6	738,948	47.7%
8	567,612	36.6%
10	64,982	4.2%
12	51,779	3.3%
14	1,009	0.1%
15	22,015	1.4%
16	1,768	0.1%
18	36,667	2.4%
20	1,273	0.1%
21	12,974	0.8%
24	8,623	0.6%
33	31,524	2.0%
36	2,887	0.2%
42	700	0.0%
48	1,186	0.1%
Total	1,548,887	100%

4.2 Material Service Life

The basis for projecting long-term R/R needs is the estimated service lives (useful lives) of the sewers. For the purposes of this study, service life is considered to be the age at which deterioration and defect accumulation result in a decision to perform a corrective action on the sewer in the form of a repair, rehabilitation, or replacement project.

Service life is assumed to vary by pipe material. The City's GIS data identified five types of materials in the gravity collection system. Materials are identified in **Table 4-3** along with the assumed average service life of each material. The estimated average service lives are based on generally accepted values derived from manufacturers' estimates and the current consensus of the industry. The assumed average service lives for different materials presented in Table 4-3 should be used as a general guide only.

Table 4-3: Assumed Average Service Life of Sewer Pipe Materials

Pipe Material	Average Service Life (yrs)
VCPRJ[a]	80
VCPRG[b]	100
PVC	100
DIP	75
SP	75
ACP	75

a. VCP sewers constructed before 1960, assumed to have rigid joints.
b. VCP sewers constructed from 1960 on, assumed to have rubber-gasketed joints.

The actual service life experienced for particular assets will vary. Some assets will require repair, rehabilitation, or replacement before the average service life is reached while others will not fail until long after. The probability that an asset will reach a particular service life is expressed using a probability density function. The probability density function indicates the percentage of the total population that would be expected to "fail" at different points in time. (In the context of this report, "failure" simply means that some type of repair, rehabilitation, or replacement would be required to maintain the pipe in adequate condition in order for it to provide continued reliable service.) Probability density functions are shaped similarly to "bell" curves. For purposes of this analysis and in the absence of an analyzable set of failure data, a probability density function based on assumed average service life was used. The assumed probability density function, shown in **Figure 4-2**, indicates the percentage of asset class failure at seven points over the life of the asset class. **Table 4-4** shows the age at which different levels of failure are experienced by pipe material class, based on the seven-point probability density function in Figure 4-2 and the average services lives shown in Table 4-3.

Figure 4-2: Assumed Probability Density Function at 7 Points of Failure

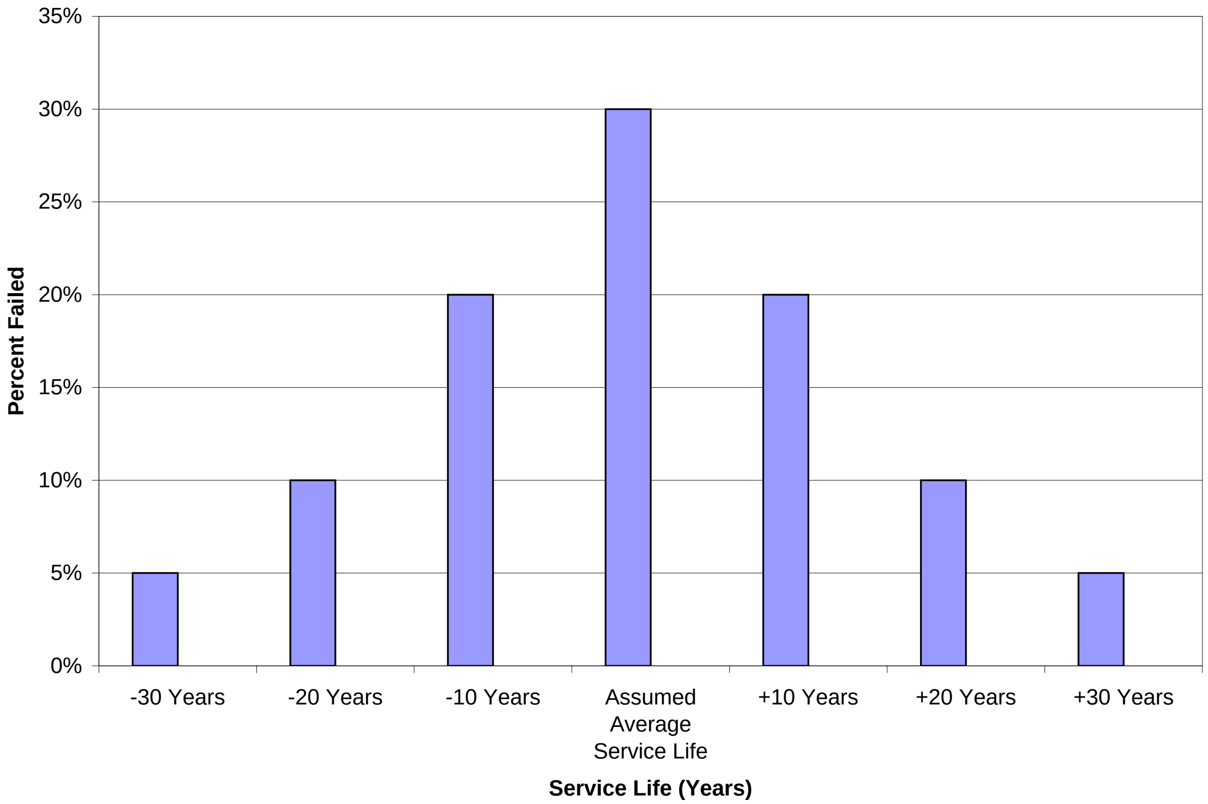


Table 4-4: Estimated and Calculated Material Class Age At 7 Points of Failure

Material	5% Failure	15% Failure	35% Failure	65% Failure	85% Failure	95% Failure	100% Failure
VCPRJ[a]	50	60	70	80	90	100	110
VCPRG[b]	70	80	90	100	110	120	130
PVC	70	80	90	100	110	120	130
DIP	45	55	65	75	85	95	105
SP	45	55	65	75	85	95	105
ACP	45	55	65	75	85	95	105

a. VCP constructed before 1960 (rigid joints)
b. VCP constructed from 1960 on (rubber-gasketed joints)

4.3 Long-term Renewal/Replacement Projections

The long-term R/R projection analysis uses system attribute data (pipe diameter, material, and age) along with a set of assumptions to project future amounts of required sewer renewal and replacement. Projection assumptions include:

1. Material asset classes failure versus age can be defined by probability density functions discussed in Section 4.2.
2. At the end of the useful life, the pipe will be either be lined or replaced by pipe bursting or open-cut replacement. While spot repairs may in some cases be a viable option to extend the useful life of a pipe, they are not assumed for this analysis.
3. Lower lateral replacement and installation of property line cleanouts would occur whenever a pipe is lined or replaced (assumed to be located every 50 feet for 12-inch and smaller sewers).
4. The percentages of assets that are lined or replaced are assumed to vary by diameter. These percentages are defined in **Table 4-5**.
5. The unit cost per foot of renewal will vary by diameter. These costs are also shown in **Table 4-5**.
6. A 6-inch or smaller pipe requiring replacement will be replaced with an 8-inch diameter sewer.

Table 4-5: Allocation and Unit Construction Costs of R/R Methods

Sewer Diameter	Lining Rehabilitation		Replacement[a]	
(in.)	Percent	$/LF	Percent	$/LF
<8	-	-	100	310
8	-	-	100	310
10	-	-	100	325
12	-	-	100	345
14	-	-	100	240
15	-	-	100	250
16	50	190	50	340
18	60	210	40	360
20	80	235	20	385
21	80	245	20	390
24	80	285	20	410
27	80	320	20	460
30	80	355	20	510
33	80	390	20	545
36	80	425	20	565
39	80	460	20	625
42	80	495	20	680
48	80	565	20	865

Note: Costs include mobilization, demobilization, excavation, backfill, shoring, pavement, manhole and lower lateral replacement and installation of property line cleanouts on 12-inch and smaller pipes, traffic control, dewatering, bypass pumping, and all other costs associated with pipe construction.

a. It is assumed that 50 percent of pipe replacement for 6- through 15-inch pipes would be by pipe bursting and 50 percent by open-cut replacement, and all pipe less than 8 inches in diameter would be replaced with 8-inch pipe.

Using these assumptions, estimates of the long-term rehabilitation and replacement needs for the City's wastewater collection system are presented in **Figure 4-3** and **Figure 4-4**. **Figure 4-3** shows the projected annual and cumulative length of pipe projected to be lined or replaced based on the current sewer asset dataset. The figure indicates that there is a backlog of approximately 21,000 feet of sewer renewal for pipes that may have already reached the end of their services lives (presumably the City has already conducted some repairs or rehabilitation of these pipes to extend their service lives), corresponding to a construction backlog of about $6.5 million.

Figure 4-4 shows the projected annual and cumulative construction costs (does not include engineering and other administrative and legal costs) of pipe renewal corresponding to the annual footages in **Figure 4-3**. The purpose of the long-term R/R estimate is to provide the City with guidance on the level of revenue accrual necessary to fund future system rehabilitation and replacement needs. System renewal needs and costs will steadily escalate as VCP pipe installed 40 years ago on average begins to require renewal. The average annual expenditure over the next 20 years needed to meet the long-term R/R forecast presented in **Figure 4-4** is approximately $1.5 million. If the 21,000 feet of sewer renewal backlog is included and renewal costs are spread evenly over the next 20 years, the average annual expenditure would increase to $1.8 million.

4.4 Future Projection Refinements

The projections presented in this report were calculated based on a set of assumptions derived from the best available information. Data collected through a more formal CCTV inspection and condition assessment program could be used to refine and improve the accuracy of the projections and calibrate the projections to more closely align with the actual inspection and renewal results experienced by the City. Condition assessment results should be used to determine more accurate assumptions regarding the useful life and failure probability distribution of various materials for this specific system and the types of renewal methods needed to extend the useful lives of the sewer pipelines.

It is recommended that, as part of its continuing condition assessment program, the City consider conducting further analyses of pipe failure rates, repair/renewal decisions, and costs, as described above. Implementing a more robust condition assessment database will greatly enhance the City's ability to complete these tasks.

Figure 4-3: Total Projected Length of Annual Pipe Renewal

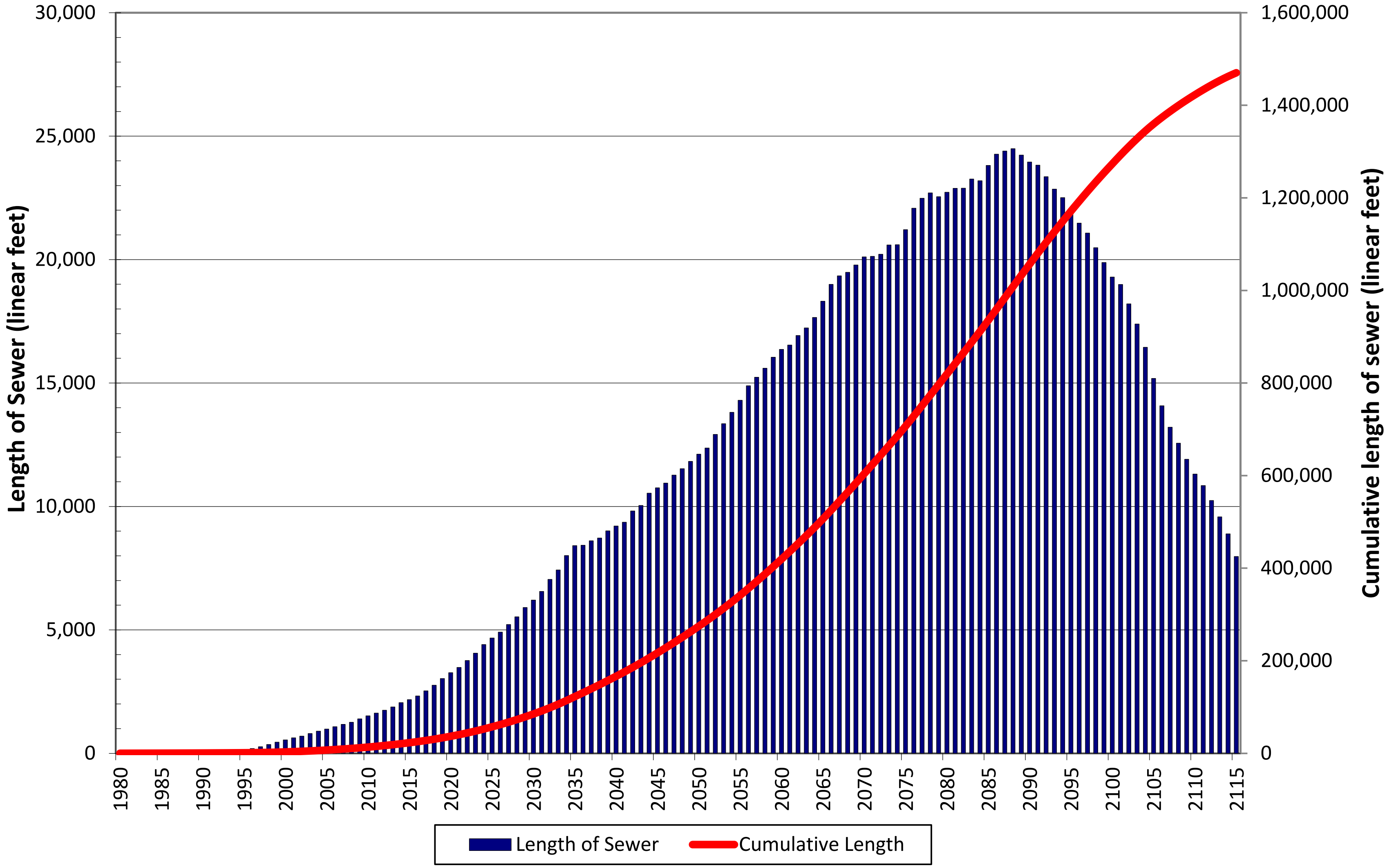
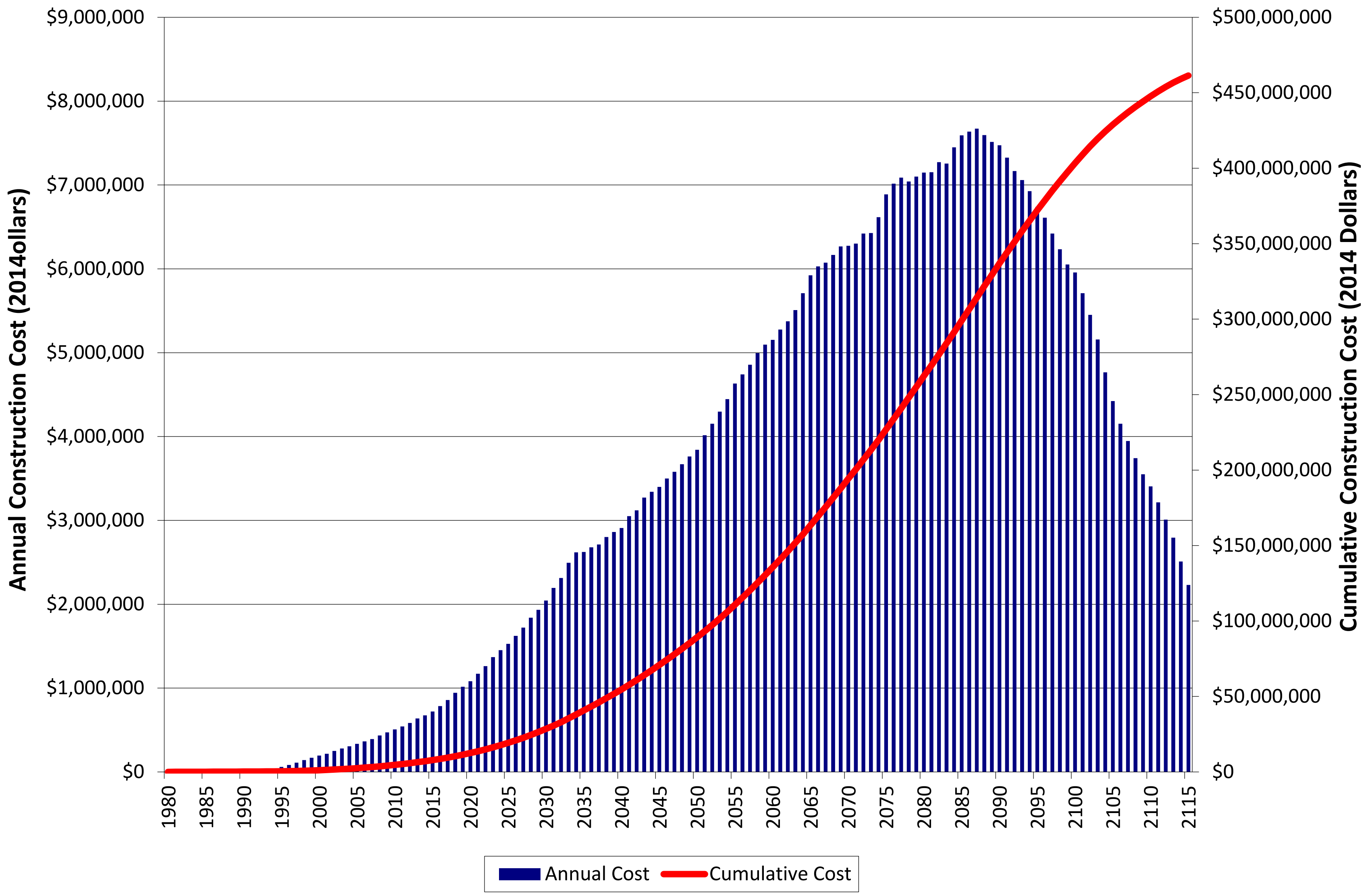
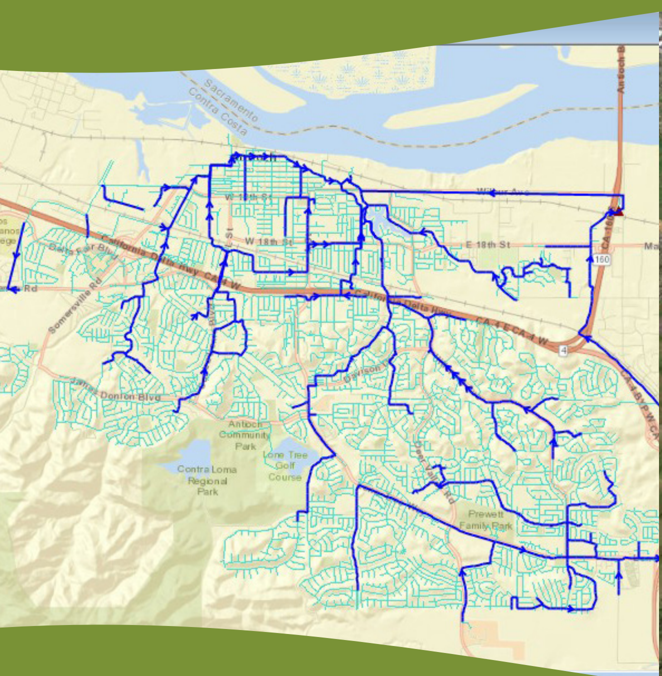


Figure 4-4: Total Projected Annual and Cumulative Construction Costs



Appendix A

Subcatchment Information



Subcatchment ID	Flow Meter ID	DDSD Discharge Location	Existing Loads						Future Development				Future Total Loads					
			Contributing Area	Residential Flow (mgd)	Equivalent Residential Units[a]	Commercial/ Industrial Flows (mgd)	GWI (mgd)	Total Existing ADWF (mgd)	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	GWI (mgd)	Total Future ADWF
10	2	Antioch PS	8.8	0.011	51	0.000	0.000	0.011	0.0	0.000	0	0.000	9	0.012	57	0.000	0.000	0.012
10a	2	Antioch PS	19.4	0.013	59	0.000	0.000	0.013	0.3	0.000	1	0.000	20	0.014	66	0.000	0.000	0.014
10b	2	Antioch PS	7.2	0.003	13	0.000	0.000	0.003	0.0	0.000	0	0.000	7	0.003	15	0.000	0.000	0.003
10c	2	Antioch PS	24.3	0.024	109	0.000	0.000	0.024	0.0	0.000	0	0.000	24	0.026	120	0.000	0.000	0.026
10d	2	Antioch PS	12.8	0.015	67	0.000	0.000	0.015	0.0	0.000	0	0.000	13	0.016	73	0.000	0.000	0.016
5	2	Antioch PS	51.6	0.034	153	0.014	0.000	0.048	0.0	0.000	0	0.000	52	0.037	168	0.016	0.000	0.053
5a	2	Antioch PS	1.5	0.001	6	0.000	0.000	0.001	1.6	0.000	0	0.002	3	0.001	6	0.002	0.000	0.003
5b	2	Antioch PS	19.5	0.008	38	0.002	0.000	0.010	0.0	0.000	0	0.000	19	0.009	42	0.002	0.000	0.011
5c	2	Antioch PS	12.6	0.036	165	0.009	0.000	0.046	0.0	0.000	0	0.000	13	0.040	182	0.010	0.000	0.050
5d	2	Antioch PS	38.9	0.054	248	0.007	0.000	0.062	0.0	0.000	0	0.000	39	0.060	272	0.008	0.000	0.068
5e	2	Antioch PS	0.8	0.009	43	0.000	0.000	0.009	0.0	0.000	0	0.000	1	0.010	47	0.000	0.000	0.010
63a	2	Antioch PS	47.0	0.053	240	0.000	0.000	0.053	1.1	0.002	7	0.000	48	0.060	271	0.000	0.000	0.060
63b	2	Antioch PS	8.1	0.008	37	0.000	0.000	0.008	0.0	0.000	0	0.000	8	0.009	40	0.000	0.000	0.009
63c	2	Antioch PS	29.7	0.049	221	0.000	0.000	0.049	0.0	0.000	0	0.000	30	0.054	243	0.000	0.000	0.054
63d	2	Antioch PS	10.5	0.010	44	0.000	0.000	0.010	0.0	0.000	0	0.000	11	0.011	49	0.000	0.000	0.011
63e	2	Antioch PS	3.5	0.004	17	0.000	0.000	0.004	0.0	0.000	0	0.000	3	0.004	19	0.000	0.000	0.004
64a	2	Antioch PS	39.2	0.045	204	0.000	0.000	0.045	1.0	0.002	10	0.000	40	0.052	235	0.000	0.000	0.052
64b	2	Antioch PS	40.5	0.049	222	0.000	0.000	0.049	25.6	0.000	0	0.056	66	0.054	244	0.056	0.000	0.110
8	2	Antioch PS	100.2	0.105	477	0.000	0.000	0.105	24.7	0.010	45	0.036	125	0.125	569	0.036	0.000	0.161
100	3	Antioch PS	61.9	0.000	0	0.000	0.000	0.000	38.9	0.010	46	0.000	101	0.010	46	0.000	0.000	0.010
105	3	Antioch PS	40.7	0.014	64	0.000	0.000	0.014	12.8	0.015	66	0.000	53	0.030	136	0.000	0.000	0.030
11a	3	Antioch PS	85.3	0.065	295	0.001	0.000	0.066	0.0	0.000	0	0.000	85	0.071	324	0.002	0.000	0.073
11b	3	Antioch PS	171.4	0.142	643	0.004	0.000	0.146	0.0	0.000	0	0.000	171	0.156	708	0.004	0.000	0.160
62a	3	Antioch PS	18.7	0.019	85	0.000	0.000	0.019	0.0	0.000	0	0.000	19	0.021	94	0.000	0.000	0.021
62b	3	Antioch PS	17.4	0.009	40	0.000	0.000	0.009	0.0	0.000	0	0.000	17	0.010	44	0.000	0.000	0.010
62c	3	Antioch PS	18.6	0.019	86	0.000	0.000	0.019	0.0	0.000	0	0.000	19	0.021	94	0.000	0.000	0.021
65a	3	Antioch PS	35.7	0.042	191	0.000	0.000	0.042	7.1	0.005	21	0.008	43	0.051	231	0.008	0.000	0.059
65b	3	Antioch PS	42.4	0.020	93	0.008	0.000	0.028	3.3	0.003	12	0.002	46	0.025	114	0.010	0.000	0.035
83	3	Antioch PS	315.3	0.000	0	0.000	0.000	0.000	3.3	0.014	66	0.000	319	0.014	66	0.000	0.000	0.014
9a	3	Antioch PS	40.7	0.036	162	0.000	0.000	0.036	0.0	0.000	0	0.000	41	0.039	178	0.000	0.000	0.039
9b	3	Antioch PS	52.9	0.007	30	0.000	0.000	0.007	0.0	0.000	0	0.000	53	0.007	33	0.000	0.000	0.007
9c	3	Antioch PS	151.6	0.122	556	0.000	0.000	0.122	0.8	0.001	5	0.000	152	0.136	616	0.000	0.000	0.136
66	4	Antioch PS	142.8	0.117	533	0.004	0.000	0.122	5.1	0.007	30	0.000	148	0.136	617	0.005	0.000	0.140
62d	5	Antioch PS	15.7	0.011	48	0.001	0.000	0.012	1.4	0.002	7	0.000	17	0.013	60	0.002	0.000	0.015
62e	5	Antioch PS	15.4	0.013	61	0.002	0.000	0.015	0.0	0.000	0	0.000	15	0.015	67	0.002	0.000	0.017
6a	5	Antioch PS	37.1	0.124	565	0.000	0.000	0.124	0.0	0.000	0	0.000	37	0.137	622	0.000	0.000	0.137
6b	5	Antioch PS	8.3	0.021	95	0.000	0.000	0.021	0.0	0.000	0	0.000	8	0.023	104	0.000	0.000	0.023
6c	5	Antioch PS	11.9	0.014	62	0.000	0.000	0.014	0.0	0.000	0	0.000	12	0.015	68	0.000	0.000	0.015
6d	5	Antioch PS	16.7	0.017	75	0.000	0.000	0.017	0.2	0.000	1	0.000	17	0.018	84	0.000	0.000	0.018
6e	5	Antioch PS	19.7	0.052	237	0.007	0.000	0.059	0.8	0.000	0	0.001	20	0.057	261	0.009	0.000	0.066
6f	5	Antioch PS	11.6	0.002	11	0.001	0.000	0.003	0.0	0.000	0	0.000	12	0.003	12	0.001	0.000	0.003
78b	5	Antioch PS	75.6	0.000	0	0.001	0.000	0.001	0.0	0.000	0	0.000	76	0.000	0	0.001	0.000	0.001
7a	5	Antioch PS	31.8	0.027	124	0.000	0.000	0.027	0.0	0.000	0	0.000	32	0.030	137	0.000	0.000	0.030
7b	5	Antioch PS	40.0	0.042	191	0.002	0.000	0.044	0.0	0.000	0	0.000	40	0.046	210	0.002	0.000	0.048
79a	6	Antioch PS	25.9	0.023	105	0.005	0.008	0.036	0.0	0.000	0	0.000	26	0.026	116	0.005	0.008	0.039
79b	6	Antioch PS	55.8	0.020	89	0.017	0.018	0.055	0.0	0.000	0	0.000	56	0.022	98	0.019	0.018	0.058
79c	6	Antioch PS	14.2	0.018	80	0.012	0.005	0.034	0.1	0.000	1	0.000	14	0.020	89	0.013	0.005	0.037
79d	6	Antioch PS	10.1	0.013	59	0.002	0.003	0.018	0.0	0.000	0	0.000	10	0.014	65	0.002	0.003	0.020
80a	6	Antioch PS	38.7	0.024	111	0.002	0.013	0.039	0.0	0.000	0	0.000	39	0.027	122	0.003	0.013	0.042
80e	6	Antioch PS	6.7	0.008	38	0.000	0.002	0.011	0.0	0.000	0	0.000	7	0.009	42	0.000	0.002	0.012
80f	6	Antioch PS	2.9	0.007	34	0.000	0.001	0.008	0.0	0.000	0	0.000	3	0.008	37	0.000	0.001	0.009
61a	7	Antioch PS	29.6	0.031	142	0.002	0.000	0.033	0.0	0.000	0	0.000	30	0.034	156	0.002	0.000	0.037
61b	7	Antioch PS	7.1	0.009	40	0.000	0.000	0.009	0.0	0.000	0	0.000	7	0.010	44	0.000	0.000	0.010
61c	7	Antioch PS	19.2	0.026	119	0.000	0.000	0.026	0.0	0.000	0	0.000	19	0.029	131	0.000	0.000	0.029

Subcatchment ID	Flow Meter ID	DDSD Discharge Location	Existing Loads						Future Development				Future Total Loads					
			Contributing Area	Residential Flow (mgd)	Equivalent Residental Units[a]	Commercial/ Industrial Flows (mgd)	GWI (mgd)	Total Existing ADWF (mgd)	Contributing Area	Residential Flow	Equivalent Residental Units[a]	Commercial/ Industrial Flows	Contributing Area	Residential Flow	Equivalent Residental Units[a]	Commercial/ Industrial Flows	GWI (mgd)	Total Future ADWF
61d	7	Antioch PS	4.2	0.005	24	0.003	0.000	0.009	0.0	0.000	0	0.000	4	0.006	27	0.004	0.000	0.009
61e	7	Antioch PS	9.9	0.022	100	0.000	0.000	0.022	0.0	0.000	0	0.000	10	0.024	110	0.000	0.000	0.025
76a	7	Antioch PS	38.7	0.034	156	0.003	0.000	0.037	0.5	0.001	3	0.000	39	0.039	175	0.003	0.000	0.042
76c	7	Antioch PS	38.7	0.030	137	0.011	0.000	0.041	1.8	0.003	12	0.000	40	0.036	162	0.012	0.000	0.047
76d	7	Antioch PS	37.5	0.026	119	0.003	0.000	0.029	0.0	0.000	0	0.000	38	0.029	131	0.003	0.000	0.032
76e	7	Antioch PS	2.8	0.003	12	0.001	0.000	0.004	0.0	0.000	0	0.000	3	0.003	13	0.001	0.000	0.004
76f	7	Antioch PS	2.1	0.003	12	0.000	0.000	0.003	0.1	0.000	1	0.000	2	0.003	14	0.000	0.000	0.003
77a	7	Antioch PS	7.5	0.007	33	0.009	0.000	0.016	0.0	0.000	0	0.000	7	0.008	37	0.009	0.000	0.018
77b	7	Antioch PS	20.7	0.018	83	0.000	0.000	0.018	0.2	0.000	1	0.000	21	0.020	92	0.000	0.000	0.020
77c	7	Antioch PS	7.6	0.008	37	0.001	0.000	0.009	0.0	0.000	0	0.000	8	0.009	40	0.001	0.000	0.009
77d	7	Antioch PS	1.4	0.000	1	0.000	0.000	0.001	0.0	0.000	0	0.000	1	0.000	1	0.000	0.000	0.001
77e	7	Antioch PS	12.0	0.005	21	0.006	0.000	0.011	0.0	0.000	0	0.000	12	0.005	23	0.007	0.000	0.012
75	8	Antioch PS	46.6	0.015	69	0.001	0.000	0.016	2.0	0.007	31	0.000	49	0.023	107	0.001	0.000	0.025
76b	8	Antioch PS	13.3	0.010	46	0.001	0.000	0.011	0.0	0.000	0	0.000	13	0.011	50	0.001	0.000	0.012
76g	8	Antioch PS	32.7	0.032	144	0.006	0.000	0.038	0.1	0.000	1	0.000	33	0.035	159	0.007	0.000	0.042
76h	8	Antioch PS	6.2	0.007	30	0.001	0.000	0.007	1.1	0.001	6	0.000	7	0.009	40	0.001	0.000	0.010
76i	8	Antioch PS	11.9	0.013	59	0.000	0.000	0.013	0.0	0.000	0	0.000	12	0.014	65	0.000	0.000	0.015
78a	8	Antioch PS	59.2	0.052	238	0.009	0.000	0.061	0.2	0.000	1	0.000	59	0.058	262	0.009	0.000	0.067
80b	8	Antioch PS	3.1	0.000	2	0.002	0.000	0.002	0.0	0.000	0	0.000	3	0.000	2	0.002	0.000	0.002
80c	8	Antioch PS	30.9	0.000	0	0.006	0.000	0.006	0.0	0.000	0	0.000	31	0.000	0	0.006	0.000	0.006
80d	8	Antioch PS	4.6	0.000	0	0.003	0.000	0.003	0.0	0.000	0	0.000	5	0.000	0	0.003	0.000	0.003
82a	8	Antioch PS	64.2	0.010	47	0.028	0.000	0.038	0.0	0.000	0	0.000	64	0.011	51	0.030	0.000	0.042
82b	8	Antioch PS	24.6	0.000	0	0.015	0.000	0.015	2.6	0.000	0	0.006	27	0.000	0	0.022	0.000	0.022
45a	9A	Antioch PS	16.7	0.000	0	0.006	0.000	0.006	1.1	0.000	0	0.002	18	0.000	0	0.008	0.000	0.008
45b	9A	Antioch PS	0.0	0.000	0	0.000	0.000	0.000	32.0	0.000	0	0.032	32	0.000	0	0.032	0.000	0.032
49	9A	Antioch PS	11.2	0.009	39	0.000	0.000	0.009	0.2	0.000	1	0.000	11	0.010	44	0.000	0.000	0.010
59	9A	Antioch PS	8.0	0.000	0	0.002	0.000	0.002	0.0	0.000	0	0.000	8	0.000	0	0.003	0.000	0.003
68a	9A	Antioch PS	28.7	0.019	88	0.004	0.000	0.024	2.0	0.000	2	0.003	31	0.022	99	0.007	0.000	0.029
68b	9A	Antioch PS	56.8	0.041	185	0.006	0.000	0.046	0.2	0.000	1	0.000	57	0.045	205	0.006	0.000	0.051
68c	9A	Antioch PS	26.2	0.009	42	0.000	0.000	0.010	2.5	0.001	4	0.001	29	0.011	50	0.002	0.000	0.013
73	9A	Antioch PS	1.3	0.000	1	0.000	0.000	0.000	0.0	0.000	0	0.000	1	0.000	1	0.000	0.000	0.000
56a	9A/9B	Antioch PS	24.4	0.028	129	0.000	0.000	0.029	0.0	0.000	0	0.000	24	0.031	142	0.000	0.000	0.031
56b	9A/9B	Antioch PS	7.9	0.004	16	0.003	0.000	0.007	0.0	0.000	0	0.000	8	0.004	18	0.003	0.000	0.007
70a	9A/9B	Antioch PS	35.1	0.034	155	0.001	0.000	0.035	0.4	0.001	5	0.000	35	0.039	175	0.001	0.000	0.040
70b	9A/9B	Antioch PS	26.7	0.022	102	0.002	0.000	0.024	0.2	0.000	0	0.000	27	0.025	112	0.002	0.000	0.027
70c	9A/9B	Antioch PS	1.0	0.001	6	0.000	0.000	0.001	0.0	0.000	0	0.000	1	0.002	7	0.000	0.000	0.002
72a	9A/9B	Antioch PS	9.1	0.009	43	0.004	0.000	0.013	0.3	0.000	0	0.001	9	0.010	47	0.005	0.000	0.015
72b	9A/9B	Antioch PS	11.5	0.001	7	0.007	0.000	0.009	1.8	0.000	0	0.003	13	0.002	7	0.011	0.000	0.013
72d	9A/9B	Antioch PS	41.0	0.027	125	0.002	0.000	0.030	0.0	0.000	0	0.000	41	0.030	137	0.002	0.000	0.033
72c	9B	Antioch PS	10.2	0.005	22	0.000	0.072	0.076	0.0	0.000	0	0.000	10	0.005	24	0.000	0.072	0.077
72e	9B	Antioch PS	14.5	0.025	116	0.000	0.101	0.127	1.0	0.002	10	0.000	16	0.030	138	0.000	0.101	0.132
72f	9B	Antioch PS	3.9	0.002	9	0.000	0.027	0.029	0.5	0.001	4	0.000	4	0.003	13	0.000	0.027	0.030
47a	10	Antioch PS	78.1	0.000	0	0.000	0.000	0.000	66.8	0.170	773	0.085	145	0.170	773	0.085	0.000	0.255
47b	10	Antioch PS	16.0	0.006	27	0.000	0.000	0.006	0.0	0.000	0	0.000	16	0.006	29	0.000	0.000	0.006
47c	10	Antioch PS	2.4	0.002	11	0.000	0.000	0.002	0.0	0.000	0	0.000	2	0.003	12	0.000	0.000	0.003
47d	10	Antioch PS	17.9	0.020	93	0.000	0.000	0.020	0.0	0.000	0	0.000	18	0.022	102	0.000	0.000	0.022
47e	10	Antioch PS	6.6	0.009	40	0.000	0.000	0.009	0.0	0.000	0	0.000	7	0.010	45	0.000	0.000	0.010
47f	10	Antioch PS	2.0	0.003	13	0.000	0.000	0.003	0.0	0.000	0	0.000	2	0.003	14	0.000	0.000	0.003
47g	10	Antioch PS	21.9	0.023	103	0.000	0.000	0.023	6.8	0.004	17	0.000	29	0.029	130	0.000	0.000	0.029
47h	10	Antioch PS	3.3	0.003	15	0.000	0.000	0.003	0.0	0.000	0	0.000	3	0.004	17	0.000	0.000	0.004
47i	10	Antioch PS	14.7	0.003	11	0.001	0.000	0.004	0.0	0.000	0	0.000	15	0.003	13	0.001	0.000	0.004
47j	10	Antioch PS	10.3	0.009	41	0.000	0.000	0.009	0.0	0.000	0	0.000	10	0.010	45	0.000	0.000	0.010
47k	10	Antioch PS	9.2	0.011	50	0.000	0.000	0.011	0.0	0.000	0	0.000	9	0.012	55	0.000	0.000	0.012
47l	10	Antioch PS	10.0	0.004	16	0.000	0.000	0.004	2.0	0.002	11	0.000	12	0.006	29	0.000	0.000	0.006

Subcatchment ID	Flow Meter ID	DDSD Discharge Location	Existing Loads						Future Development				Future Total Loads					
			Contributing Area	Residential Flow (mgd)	Equivalent Residential Units[a]	Commercial/ Industrial Flows (mgd)	GWI (mgd)	Total Existing ADWF (mgd)	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	GWI (mgd)	Total Future ADWF
47m	10	Antioch PS	0.0	0.000	0	0.000	0.000	0.000	12.9	0.016	72	0.000	13	0.016	72	0.000	0.000	0.016
48a	10	Antioch PS	28.8	0.013	58	0.000	0.000	0.013	0.0	0.000	0	0.000	29	0.014	64	0.000	0.000	0.014
48b	10	Antioch PS	35.9	0.027	125	0.002	0.000	0.030	0.0	0.000	0	0.000	36	0.030	137	0.002	0.000	0.033
48c	10	Antioch PS	0.0	0.000	0	0.000	0.000	0.000	1.9	0.310	1411	0.103	2	0.310	1411	0.103	0.000	0.413
50	10	Antioch PS	63.8	0.054	247	0.000	0.000	0.054	0.0	0.000	0	0.000	64	0.060	272	0.000	0.000	0.060
69	10	Antioch PS	30.6	0.029	133	0.000	0.000	0.029	0.0	0.000	0	0.000	31	0.032	147	0.000	0.000	0.032
12a	11	Antioch PS	87.1	0.032	147	0.013	0.000	0.046	3.4	0.004	18	0.001	91	0.040	180	0.015	0.000	0.055
12b	11	Antioch PS	77.6	0.049	224	0.002	0.000	0.052	0.2	0.000	1	0.000	78	0.054	248	0.003	0.000	0.057
13a	11	Antioch PS	52.1	0.030	135	0.002	0.000	0.032	1.4	0.001	6	0.000	54	0.034	154	0.002	0.000	0.036
13b	11	Antioch PS	15.6	0.008	38	0.001	0.000	0.009	2.5	0.001	3	0.000	18	0.010	45	0.001	0.000	0.011
13c	11	Antioch PS	15.9	0.016	74	0.000	0.000	0.016	0.6	0.001	3	0.000	16	0.019	84	0.000	0.000	0.019
13d	11	Antioch PS	30.4	0.029	132	0.000	0.000	0.029	0.6	0.000	2	0.000	31	0.032	147	0.000	0.000	0.032
13e	11	Antioch PS	43.8	0.023	106	0.002	0.000	0.025	1.4	0.001	4	0.000	45	0.027	121	0.002	0.000	0.029
60	11	Antioch PS	29.1	0.030	135	0.001	0.000	0.031	0.7	0.001	4	0.000	30	0.034	153	0.001	0.000	0.035
70d	11	Antioch PS	0.5	0.001	2	0.000	0.000	0.001	0.0	0.000	0	0.000	1	0.001	3	0.000	0.000	0.001
14a	12	Antioch PS	140.6	0.112	509	0.018	0.000	0.130	0.6	0.000	0	0.002	141	0.123	560	0.022	0.000	0.145
14b	12	Antioch PS	11.1	0.014	64	0.000	0.000	0.014	0.0	0.000	0	0.000	11	0.016	71	0.000	0.000	0.016
33a	12	Antioch PS	43.1	0.037	169	0.010	0.000	0.047	0.0	0.000	0	0.000	43	0.041	186	0.011	0.000	0.051
33b	12	Antioch PS	9.4	0.000	1	0.000	0.000	0.000	0.3	0.000	2	0.000	10	0.001	3	0.000	0.000	0.001
34	12	Antioch PS	80.5	0.057	257	0.013	0.000	0.070	3.8	0.006	29	0.003	84	0.069	312	0.017	0.000	0.086
3b	12	Antioch PS	10.1	0.000	0	0.010	0.000	0.010	15.6	0.000	0	0.033	26	0.000	0	0.044	0.000	0.044
44	12	Antioch PS	13.9	0.014	64	0.000	0.000	0.014	0.0	0.000	0	0.000	14	0.015	70	0.000	0.000	0.015
51a	12	Antioch PS	8.9	0.011	50	0.004	0.000	0.015	0.0	0.000	0	0.000	9	0.012	55	0.005	0.000	0.017
51b	12	Antioch PS	13.4	0.013	60	0.000	0.000	0.013	0.0	0.000	0	0.000	13	0.015	67	0.000	0.000	0.015
51c	12	Antioch PS	8.1	0.013	60	0.000	0.000	0.013	0.0	0.000	0	0.000	8	0.014	66	0.000	0.000	0.014
52a	12	Antioch PS	62.5	0.045	206	0.000	0.000	0.045	0.2	0.000	1	0.000	63	0.050	227	0.000	0.000	0.050
52b	12	Antioch PS	24.7	0.024	111	0.000	0.000	0.024	0.0	0.000	0	0.000	25	0.027	122	0.000	0.000	0.027
53a	12	Antioch PS	17.9	0.017	79	0.000	0.000	0.017	0.0	0.000	0	0.000	18	0.019	87	0.000	0.000	0.019
53b	12	Antioch PS	27.9	0.030	138	0.000	0.000	0.030	0.0	0.000	0	0.000	28	0.033	151	0.000	0.000	0.033
53c	12	Antioch PS	9.5	0.008	36	0.000	0.000	0.008	0.0	0.000	0	0.000	10	0.009	39	0.000	0.000	0.009
53d	12	Antioch PS	22.7	0.021	97	0.000	0.000	0.021	0.0	0.000	0	0.000	23	0.024	107	0.000	0.000	0.024
53e	12	Antioch PS	6.6	0.005	22	0.000	0.000	0.005	0.0	0.000	0	0.000	7	0.005	24	0.000	0.000	0.005
53f	12	Antioch PS	14.7	0.013	60	0.000	0.000	0.013	0.0	0.000	0	0.000	15	0.014	66	0.000	0.000	0.014
54	12	Antioch PS	25.9	0.011	48	0.000	0.000	0.011	0.0	0.000	0	0.000	26	0.012	53	0.000	0.000	0.012
55	12	Antioch PS	32.2	0.029	132	0.000	0.000	0.029	0.0	0.000	0	0.000	32	0.032	145	0.000	0.000	0.032
1a	12B	Antioch PS	127.0	0.087	397	0.000	0.000	0.087	0.0	0.000	0	0.000	127	0.096	437	0.000	0.000	0.096
1b	12B	Antioch PS	154.8	0.091	415	0.000	0.000	0.091	0.0	0.000	0	0.000	155	0.100	457	0.000	0.000	0.100
3a	12B	Antioch PS	109.1	0.123	561	0.002	0.000	0.125	0.0	0.000	0	0.000	109	0.136	617	0.002	0.000	0.138
16a	16	Antioch PS	43.4	0.021	95	0.000	0.000	0.021	0.0	0.000	0	0.000	43	0.023	104	0.000	0.000	0.023
16b	16	Antioch PS	69.9	0.044	199	0.000	0.000	0.044	0.0	0.000	0	0.000	70	0.048	219	0.000	0.000	0.048
16c	16	Antioch PS	44.3	0.022	99	0.000	0.000	0.022	0.0	0.000	0	0.000	44	0.024	109	0.000	0.000	0.024
16d	16	Antioch PS	9.2	0.010	44	0.000	0.000	0.010	0.0	0.000	0	0.000	9	0.011	48	0.000	0.000	0.011
16e	16	Antioch PS	39.2	0.045	204	0.000	0.000	0.045	0.0	0.000	0	0.000	39	0.049	225	0.000	0.000	0.049
37a	16	Antioch PS	137.9	0.061	278	0.001	0.000	0.062	0.0	0.000	0	0.000	138	0.067	306	0.001	0.000	0.068
37c	16	Antioch PS	15.6	0.020	92	0.000	0.000	0.020	0.0	0.000	0	0.000	16	0.022	101	0.000	0.000	0.022
37d	16	Antioch PS	26.1	0.012	55	0.000	0.000	0.012	0.0	0.000	0	0.000	26	0.013	61	0.000	0.000	0.013
37e	16	Antioch PS	44.9	0.031	139	0.004	0.000	0.034	0.0	0.000	0	0.000	45	0.034	153	0.004	0.000	0.038
38a	16	Antioch PS	0.2	0.000	0	0.000	0.000	0.000	16.9	0.026	117	0.000	17	0.026	117	0.000	0.000	0.026
38b	16	Antioch PS	6.6	0.007	30	0.000	0.000	0.007	4.4	0.005	23	0.000	11	0.012	56	0.000	0.000	0.012
38c	16	Antioch PS	2.9	0.004	18	0.000	0.000	0.004	7.7	0.013	57	0.000	11	0.017	77	0.000	0.000	0.017
38d	16	Antioch PS	14.8	0.004	17	0.000	0.000	0.004	25.2	0.029	134	0.000	40	0.034	153	0.000	0.000	0.034
39a	16	Antioch PS	31.5	0.025	115	0.004	0.000	0.030	0.0	0.000	0	0.000	31	0.028	127	0.005	0.000	0.033
39b	16	Antioch PS	142.1	0.092	416	0.002	0.000	0.094	0.0	0.000	0	0.000	142	0.101	458	0.003	0.000	0.103
40	16	Antioch PS	30.4	0.027	124	0.000	0.000	0.027	1.6	0.000	1	0.000	32	0.030	138	0.000	0.000	0.030

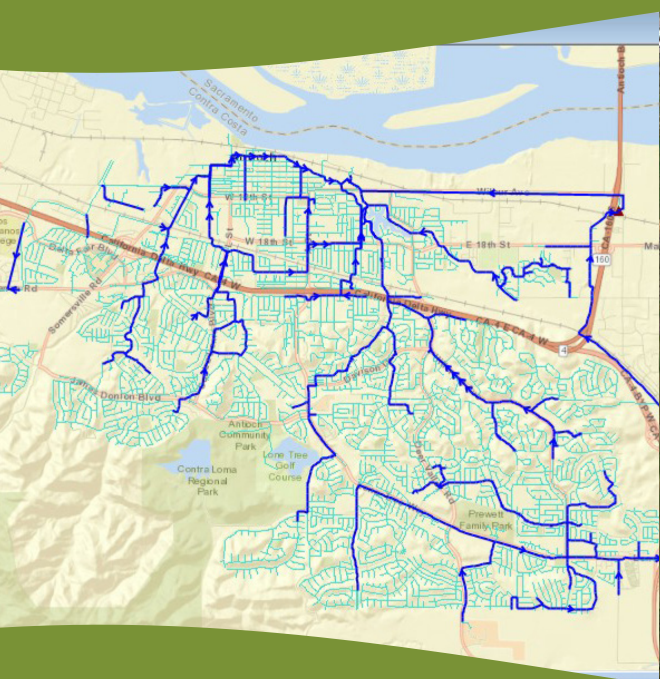
Subcatchment ID	Flow Meter ID	DDSD Discharge Location	Existing Loads						Future Development				Future Total Loads					
			Contributing Area	Residential Flow (mgd)	Equivalent Residental Units[a]	Commercial/ Industrial Flows (mgd)	GWI (mgd)	Total Existing ADWF (mgd)	Contributing Area	Residential Flow	Equivalent Residental Units[a]	Commercial/ Industrial Flows	Contributing Area	Residential Flow	Equivalent Residental Units[a]	Commercial/ Industrial Flows	GWI (mgd)	Total Future ADWF
41a	16	Antioch PS	24.5	0.016	71	0.016	0.000	0.032	4.9	0.000	0	0.004	29	0.017	78	0.021	0.000	0.039
41b	16	Antioch PS	5.2	0.010	47	0.000	0.000	0.010	0.0	0.000	0	0.000	5	0.011	52	0.000	0.000	0.011
42	16	Antioch PS	22.3	0.011	52	0.016	0.000	0.027	30.4	0.003	15	0.047	53	0.016	72	0.064	0.000	0.080
42a	16	Antioch PS	20.1	0.011	49	0.000	0.000	0.011	0.0	0.000	0	0.000	20	0.012	54	0.000	0.000	0.012
42b	16	Antioch PS	19.5	0.007	34	0.002	0.000	0.009	2.1	0.000	0	0.005	22	0.008	37	0.007	0.000	0.015
43	16	Antioch PS	134.4	0.135	615	0.006	0.000	0.141	0.0	0.000	0	0.000	134	0.149	676	0.006	0.000	0.155
84a	16	Antioch PS	52.4	0.048	216	0.000	0.000	0.048	53.1	0.060	271	0.000	106	0.112	509	0.000	0.000	0.112
99	none	Antioch PS	9.4	0.000	0	0.004	0.000	0.004	0.0	0.000	0	0.000	9	0.000	0	0.005	0.000	0.005
102	none	Antioch PS	41.2	0.000	0	0.000	0.000	0.000	0.0	0.000	0	0.000	41	0.000	0	0.000	0.000	0.000
57c	none	Antioch PS	0.0	0.000	0	0.000	0.000	0.000	19.6	0.013	59	0.000	20	0.013	59	0.000	0.000	0.013
67	none	Antioch PS	101.8	0.001	5	0.203	0.000	0.204	0.0	0.000	0	0.000	102	0.001	5	0.224	0.000	0.225
74	none	Antioch PS	13.9	0.000	0	0.000	0.000	0.000	0.0	0.000	0	0.000	14	0.000	0	0.000	0.000	0.000
37b	13	Bridgehead PS	9.2	0.010	47	0.000	0.000	0.010	0.0	0.000	0	0.000	9	0.011	52	0.000	0.000	0.011
46	13	Bridgehead PS	13.6	0.000	0	0.000	0.000	0.000	63.0	0.000	0	0.137	77	0.000	0	0.137	0.000	0.137
58	13	Bridgehead PS	17.9	0.001	2	0.002	0.000	0.002	4.3	0.002	10	0.003	22	0.003	13	0.005	0.000	0.007
86a	13	Bridgehead PS	47.6	0.000	0	0.000	0.000	0.000	94.0	0.024	111	0.029	142	0.024	111	0.029	0.000	0.054
87	13	Bridgehead PS	81.0	0.000	0	0.000	0.000	0.000	53.5	0.014	63	0.017	135	0.014	63	0.017	0.000	0.031
15a	13B	Bridgehead PS	0.0	0.062	284	0.001	0.000	0.064	1.2	0.002	11	0.000	1	0.071	323	0.001	0.000	0.072
15b	13B	Bridgehead PS	0.0	0.006	27	0.000	0.000	0.006	0.0	0.000	0	0.000	0	0.007	30	0.000	0.000	0.007
21a	13B	Bridgehead PS	32.2	0.000	0	0.012	0.000	0.012	1.2	0.000	0	0.003	33	0.000	0	0.016	0.000	0.016
21b	13B	Bridgehead PS	11.6	0.005	23	0.000	0.000	0.005	0.0	0.000	0	0.000	12	0.006	25	0.000	0.000	0.006
21c	13B	Bridgehead PS	9.5	0.007	32	0.000	0.000	0.007	0.0	0.000	0	0.000	9	0.008	35	0.000	0.000	0.008
21d	13B	Bridgehead PS	2.1	0.003	14	0.000	0.000	0.003	0.0	0.000	0	0.000	2	0.003	15	0.000	0.000	0.003
21e	13B	Bridgehead PS	19.2	0.028	126	0.000	0.000	0.028	0.0	0.000	0	0.000	19	0.031	139	0.000	0.000	0.031
22	13B	Bridgehead PS	38.8	0.027	124	0.001	0.000	0.028	0.2	0.000	1	0.000	39	0.030	137	0.001	0.000	0.031
23a	13B	Bridgehead PS	31.5	0.032	148	0.000	0.000	0.032	0.0	0.000	0	0.000	32	0.036	162	0.000	0.000	0.036
23b	13B	Bridgehead PS	12.8	0.006	27	0.000	0.000	0.006	0.0	0.000	0	0.000	13	0.007	30	0.000	0.000	0.007
23c	13B	Bridgehead PS	15.7	0.014	65	0.000	0.000	0.014	0.0	0.000	0	0.000	16	0.016	72	0.000	0.000	0.016
24	13B	Bridgehead PS	15.3	0.020	91	0.000	0.000	0.020	0.0	0.000	0	0.000	15	0.022	100	0.000	0.000	0.022
31g	13B	Bridgehead PS	9.2	0.000	0	0.015	0.000	0.015	3.8	0.000	0	0.006	13	0.000	0	0.022	0.000	0.022
32	13B	Bridgehead PS	30.2	0.033	151	0.001	0.000	0.034	0.0	0.000	0	0.000	30	0.037	166	0.001	0.000	0.038
85a	13B	Bridgehead PS	97.8	0.059	270	0.005	0.000	0.065	23.8	0.030	136	0.000	122	0.095	433	0.006	0.000	0.101
85b	13B	Bridgehead PS	0.3	0.000	0	0.000	0.000	0.000	149.5	0.116	525	0.000	150	0.116	525	0.000	0.000	0.116
86b	13B	Bridgehead PS	41.0	0.000	0	0.016	0.000	0.016	20.7	0.005	24	0.006	62	0.005	24	0.024	0.000	0.030
86c	13B	Bridgehead PS	24.8	0.000	0	0.006	0.000	0.006	0.0	0.000	0	0.000	25	0.000	0	0.006	0.000	0.006
86d	13B	Bridgehead PS	11.3	0.000	0	0.006	0.000	0.006	0.0	0.000	0	0.000	11	0.000	0	0.006	0.000	0.006
88a	13B	Bridgehead PS	7.4	0.011	49	0.000	0.000	0.011	0.0	0.000	0	0.000	7	0.012	54	0.000	0.000	0.012
88b	13B	Bridgehead PS	11.9	0.016	73	0.000	0.000	0.016	0.0	0.000	0	0.000	12	0.018	80	0.000	0.000	0.018
88c	13B	Bridgehead PS	10.1	0.000	0	0.000	0.000	0.000	20.9	0.027	122	0.000	31	0.027	122	0.000	0.000	0.027
18a	14	Bridgehead PS	40.0	0.045	202	0.000	0.000	0.045	0.0	0.000	0	0.000	40	0.049	223	0.000	0.000	0.049
18b	14	Bridgehead PS	29.3	0.000	0	0.002	0.000	0.002	26.0	0.000	0	0.055	55	0.000	0	0.057	0.000	0.057
18c	14	Bridgehead PS	31.6	0.034	155	0.000	0.000	0.034	0.0	0.000	0	0.000	32	0.037	170	0.000	0.000	0.037
19a	14	Bridgehead PS	26.0	0.018	83	0.000	0.000	0.018	0.0	0.000	0	0.000	26	0.020	91	0.000	0.000	0.020
19b	14	Bridgehead PS	49.5	0.061	277	0.000	0.000	0.061	0.0	0.000	0	0.000	49	0.067	304	0.000	0.000	0.067
19c	14	Bridgehead PS	33.9	0.040	183	0.000	0.000	0.041	0.0	0.000	0	0.000	34	0.044	201	0.000	0.000	0.045
19d	14	Bridgehead PS	2.3	0.002	11	0.000	0.000	0.002	0.0	0.000	0	0.000	2	0.003	12	0.000	0.000	0.003
19e	14	Bridgehead PS	13.3	0.019	85	0.000	0.000	0.019	0.0	0.000	0	0.000	13	0.021	94	0.000	0.000	0.021
19f	14	Bridgehead PS	6.1	0.007	33	0.000	0.000	0.007	0.0	0.000	0	0.000	6	0.008	36	0.000	0.000	0.008
19g	14	Bridgehead PS	23.2	0.021	96	0.000	0.000	0.021	0.0	0.000	0	0.000	23	0.023	106	0.000	0.000	0.023
19h	14	Bridgehead PS	26.7	0.042	193	0.000	0.000	0.042	0.0	0.000	0	0.000	27	0.047	212	0.000	0.000	0.047
19j	14	Bridgehead PS	23.7	0.038	171	0.000	0.000	0.038	0.0	0.000	0	0.000	24	0.041	188	0.000	0.000	0.041
20a	14	Bridgehead PS	5.9	0.009	41	0.000	0.000	0.009	0.0	0.000	0	0.000	6	0.010	45	0.000	0.000	0.010
20b	14	Bridgehead PS	69.6	0.084	382	0.001	0.000	0.085	0.0	0.000	0	0.000	70	0.092	420	0.001	0.000	0.094
20c	14	Bridgehead PS	90.6	0.141	640	0.000	0.000	0.141	0.0	0.000	0	0.000	91	0.155	704	0.000	0.000	0.155

Subcatchment ID	Flow Meter ID	DDSD Discharge Location	Existing Loads						Future Development				Future Total Loads					
			Contributing Area	Residential Flow (mgd)	Equivalent Residential Units[a]	Commercial/ Industrial Flows (mgd)	GWI (mgd)	Total Existing ADWF (mgd)	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	Contributing Area	Residential Flow	Equivalent Residential Units[a]	Commercial/ Industrial Flows	GWI (mgd)	Total Future ADWF
31a	14	Bridgehead PS	8.1	0.016	73	0.000	0.000	0.016	0.0	0.000	0	0.000	8	0.018	81	0.000	0.000	0.018
31b	14	Bridgehead PS	0.8	0.002	11	0.000	0.000	0.002	0.0	0.000	0	0.000	1	0.003	12	0.000	0.000	0.003
31c	14	Bridgehead PS	34.8	0.034	157	0.000	0.000	0.034	0.0	0.000	0	0.000	35	0.038	172	0.000	0.000	0.038
31d	14	Bridgehead PS	7.9	0.016	73	0.000	0.000	0.016	0.0	0.000	0	0.000	8	0.018	80	0.000	0.000	0.018
31e	14	Bridgehead PS	1.5	0.003	15	0.000	0.000	0.003	0.0	0.000	0	0.000	2	0.004	17	0.000	0.000	0.004
31f	14	Bridgehead PS	1.6	0.004	16	0.000	0.000	0.004	0.0	0.000	0	0.000	2	0.004	18	0.000	0.000	0.004
31h	14	Bridgehead PS	7.5	0.014	63	0.000	0.000	0.014	0.0	0.000	0	0.000	7	0.015	70	0.000	0.000	0.015
35	14	Bridgehead PS	38.7	0.066	302	0.000	0.000	0.066	0.0	0.000	0	0.000	39	0.073	332	0.000	0.000	0.073
36a	14	Bridgehead PS	35.5	0.019	86	0.000	0.000	0.019	0.0	0.000	0	0.000	35	0.021	94	0.000	0.000	0.021
36b	14	Bridgehead PS	33.0	0.049	224	0.000	0.000	0.049	0.0	0.000	0	0.000	33	0.054	247	0.000	0.000	0.054
36c	14	Bridgehead PS	17.7	0.023	103	0.000	0.000	0.023	0.0	0.000	0	0.000	18	0.025	113	0.000	0.000	0.025
21	15	Bridgehead PS	54.9	0.056	256	0.000	0.018	0.074	0.0	0.000	0	0.000	55	0.062	282	0.000	0.018	0.080
28	15	Bridgehead PS	53.2	0.028	126	0.059	0.017	0.104	2.3	0.000	0	0.005	55	0.030	138	0.070	0.017	0.117
29	15	Bridgehead PS	154.9	0.000	0	0.011	0.050	0.061	0.0	0.000	0	0.000	155	0.000	0	0.012	0.050	0.062
30a	15	Bridgehead PS	118.5	0.119	542	0.000	0.037	0.156	0.0	0.000	0	0.000	119	0.131	596	0.000	0.037	0.168
30b	15	Bridgehead PS	65.2	0.066	299	0.000	0.021	0.087	0.0	0.000	0	0.000	65	0.072	329	0.000	0.021	0.093
30c	15	Bridgehead PS	32.2	0.043	198	0.002	0.002	0.047	0.0	0.000	0	0.000	32	0.048	217	0.002	0.002	0.051
17	15B	Bridgehead PS	47.9	0.054	246	0.000	0.000	0.054	9.0	0.000	0	0.016	57	0.059	270	0.016	0.000	0.075
25	15B	Bridgehead PS	23.1	0.028	129	0.015	0.000	0.043	1.5	0.000	0	0.003	25	0.031	142	0.020	0.000	0.051
26	15B	Bridgehead PS	31.9	0.036	166	0.000	0.000	0.036	0.0	0.000	0	0.000	32	0.040	182	0.000	0.000	0.040
27a	15B	Bridgehead PS	99.1	0.105	476	0.000	0.000	0.105	0.0	0.000	0	0.000	99	0.115	524	0.000	0.000	0.115
27b	15B	Bridgehead PS	93.2	0.091	415	0.009	0.000	0.101	0.0	0.000	0	0.000	93	0.100	457	0.010	0.000	0.111
2a	15B	Bridgehead PS	130.5	0.098	446	0.000	0.000	0.098	0.0	0.000	0	0.000	131	0.108	490	0.000	0.000	0.108
2b	15B	Bridgehead PS	74.3	0.066	302	0.000	0.000	0.066	0.0	0.000	0	0.000	74	0.073	332	0.000	0.000	0.073
2c	15B	Bridgehead PS	39.9	0.059	267	0.000	0.000	0.059	0.0	0.000	0	0.000	40	0.065	293	0.000	0.000	0.065
84b	16	Bridgehead PS	0.0	0.000	0	0.000	0.000	0.000	0.0	0.000	0	0.000	0	0.000	0	0.000	0.000	0.000
93	none	Bridgehead PS	41.4	0.000	1	0.011	0.000	0.011	93.6	0.000	1	0.077	135	0.000	2	0.089	0.000	0.090
94	none	Bridgehead PS	81.5	0.000	0	0.000	0.000	0.000	347.5	0.000	0	0.198	429	0.000	0	0.198	0.000	0.198
103	none	Bridgehead PS	6.0	0.000	0	0.060	0.000	0.060	0.0	0.000	0	0.000	6	0.000	0	0.066	0.000	0.066
104	none	Bridgehead PS	0.0	0.000	0	0.000	0.000	0.000	640.0	0.070	320	0.000	640	0.070	320	0.000	0.000	0.070
57a	none	Bridgehead PS	141.4	0.000	0	0.009	0.000	0.009	34.1	0.000	0	0.034	175	0.000	0	0.044	0.000	0.044
57b	none	Bridgehead PS	71.3	0.000	0	0.000	0.000	0.000	66.5	0.048	219	0.001	138	0.048	219	0.001	0.000	0.049
89	none	Bridgehead PS	191.6	0.000	0	0.013	0.000	0.013	1811.8	0.886	4026	0.056	2003	0.886	4026	0.070	0.000	0.956
90	none	Bridgehead PS	0.0	0.000	0	0.000	0.000	0.000	0.0	0.000	0	0.000	0	0.000	0	0.000	0.000	0.000
91	none	Bridgehead PS	230.1	0.000	0	0.000	0.000	0.000	1118.0	0.242	1100	0.000	1348	0.242	1100	0.000	0.000	0.242
4a	1	P-A Interceptor	66.0	0.000	0	0.053	0.000	0.053	0.0	0.000	0	0.000	66	0.000	0	0.059	0.000	0.059
4b	1	P-A Interceptor	164.7	0.173	787	0.040	0.000	0.213	13.6	0.000	0	0.010	178	0.190	865	0.055	0.000	0.245
101	none	P-A Interceptor	50.8	0.000	0	0.000	0.000	0.000	0.0	0.000	0	0.000	51	0.000	0	0.000	0.000	0.000
81	none	P-A Interceptor	67.5	0.000	0	0.014	0.000	0.014	4.8	0.000	0	0.010	72	0.000	0	0.026	0.000	0.026
98	none	P-A Interceptor	41.3	0.045	202	0.000	0.000	0.045	83.1	0.032	143	0.001	124	0.076	346	0.001	0.000	0.077

Notes:
a. Equivalent Residential Units (ERUs) are calculated based 220 gpd/ERU

Appendix B

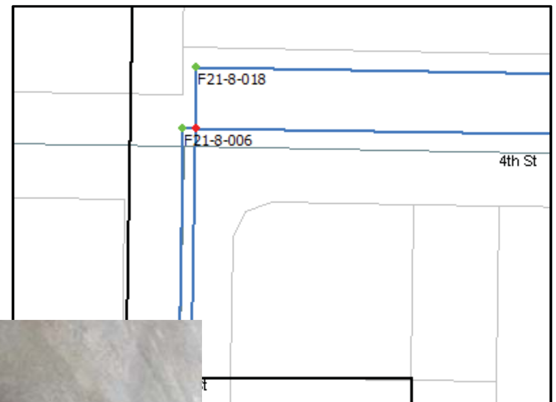
Flow Split Manhole Site Reports

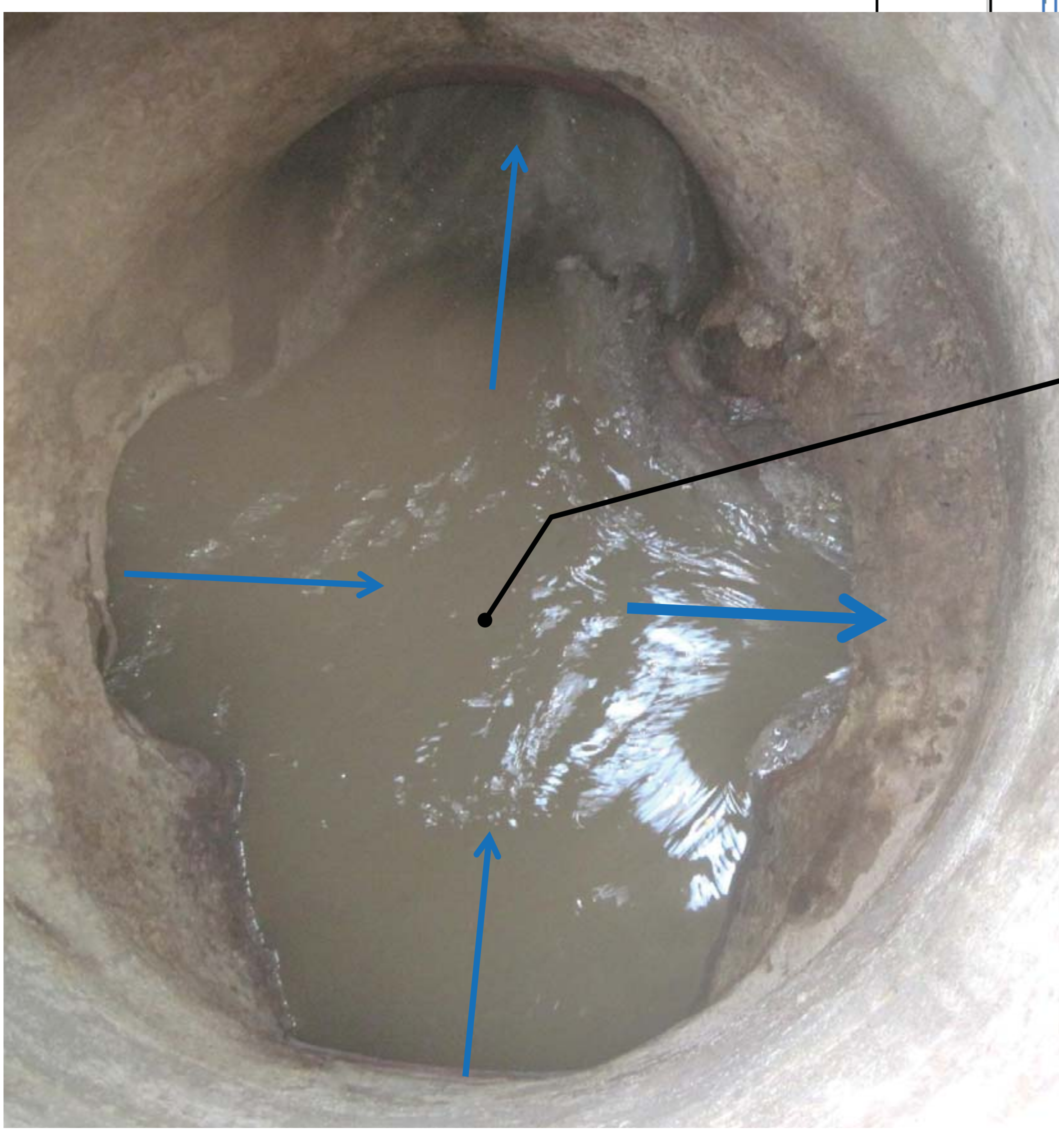


City of Antioch Wastewater Collection System Master Plan

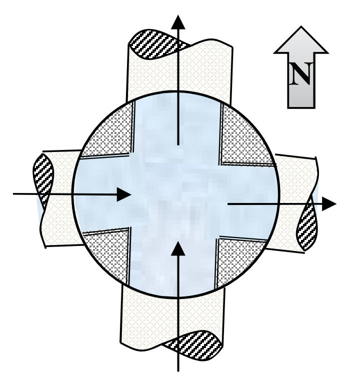
Site 1: F21-8-196SF (O Street and 4th Street)

Coordinates: -121.8234° W, 38.0155° N





10.14’ (R to I)



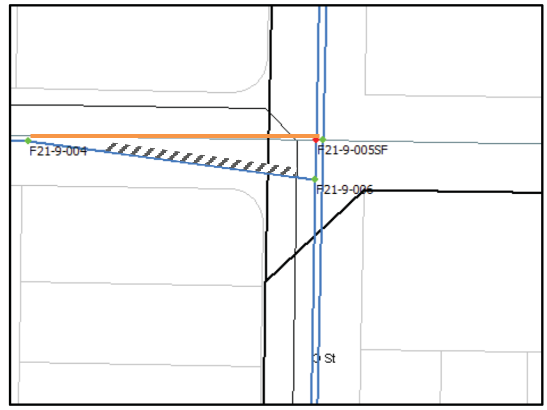
Site 1: F21-8-196SF (O Street and 4th Street)

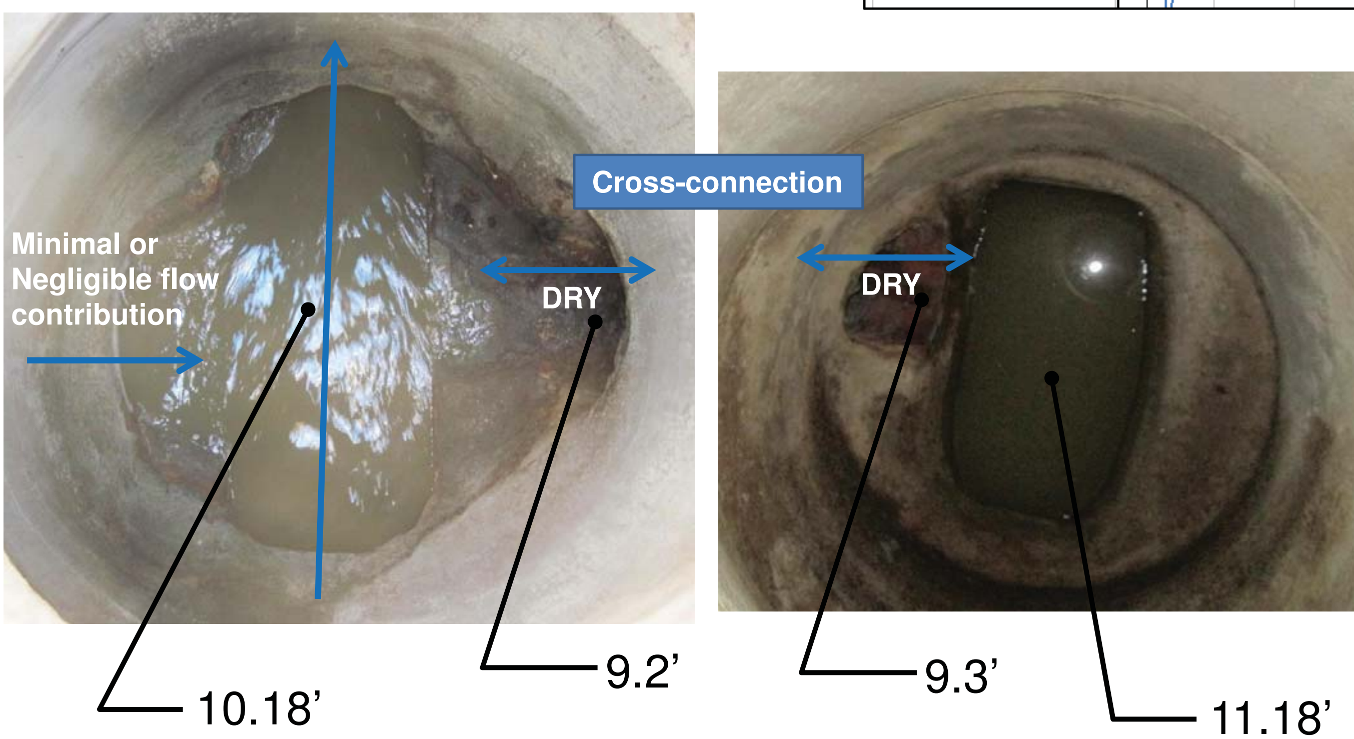
Coordinates: -121.8234° W, 38.0155° N

Notes: Inspector noted slightly more flow to the east outlet, but nearly 50/50. It appears the north outlet may have a slightly lower invert elevation; however, debris build-up (on the lower lip of the north pipe?) may be directing the flow more to the east. Also, there appears to be a greater velocity and momentum from the west inlet (than from the south inlet) – this momentum also may direct the flow more to the east.

Site 2: F21-9-005SF (O Street and 6th Street)

Coordinates: -121.823409° W, 38.0140° N



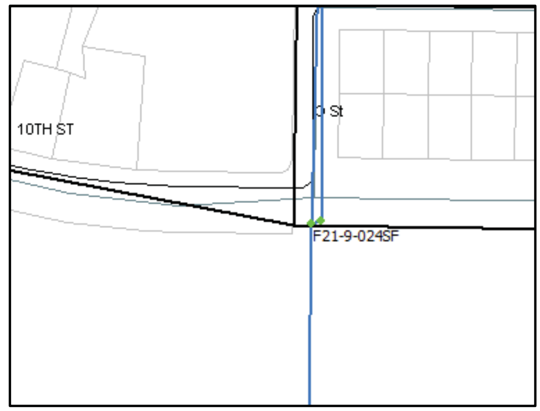


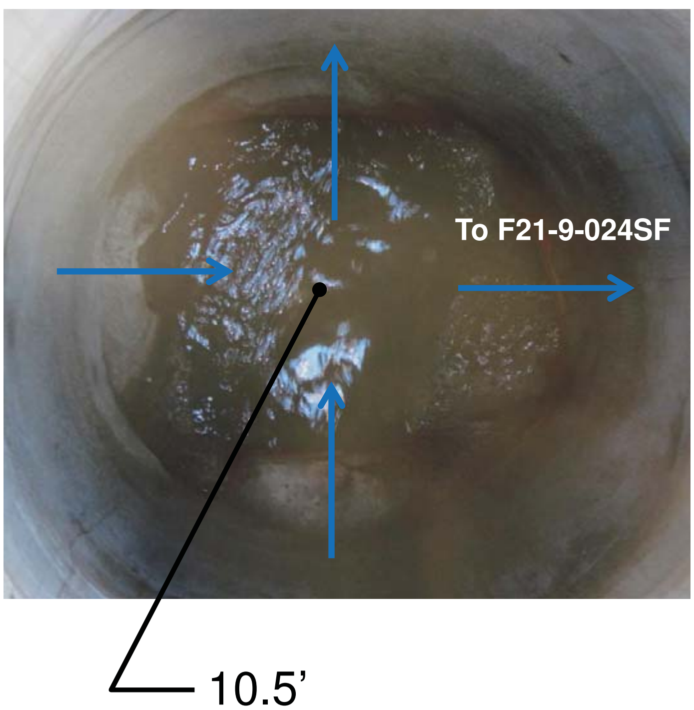
Site 2: F21-9-005SF (O Street and 6th Street)

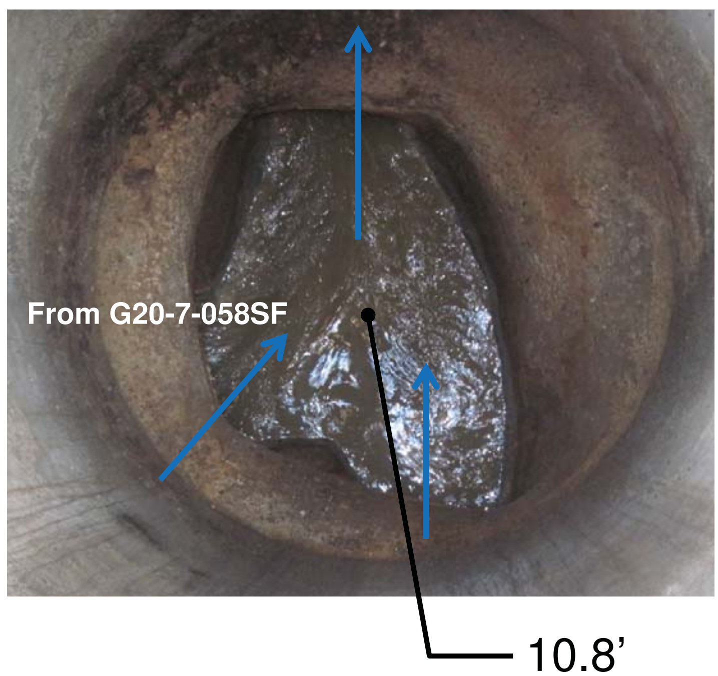
Coordinates: -121.823409 ° W, 38.0140 ° N

Site 3: F21-9-024SF (O Street and 10th Street)

Coordinates: -121.8234° W, 38.0112° N



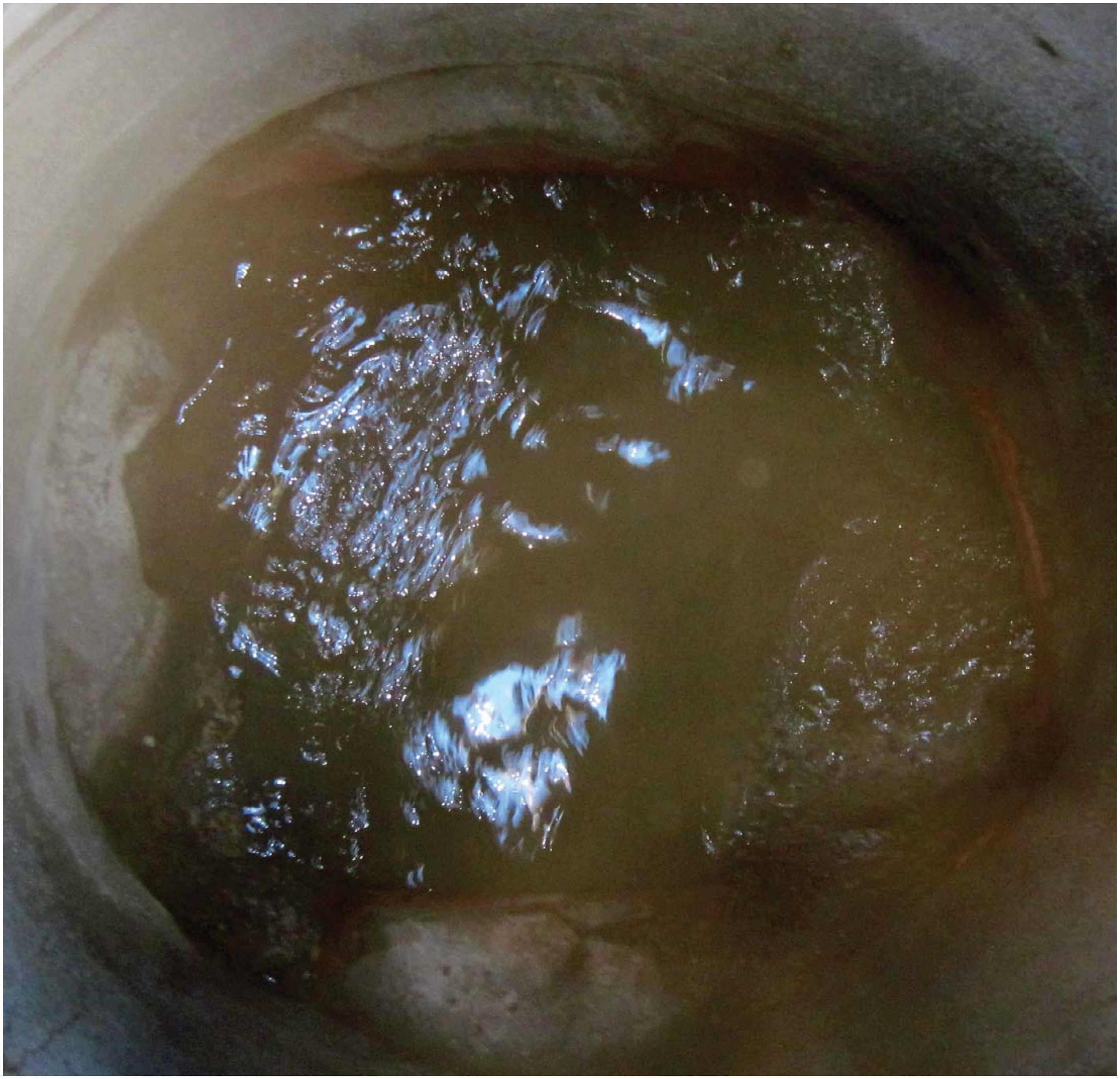




Site 3: F21-9-024SF (O Street and 10th Street)

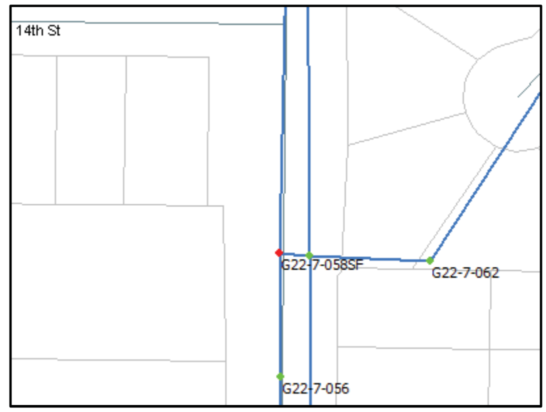
Coordinates: -121.8234° W, 38.0112° N

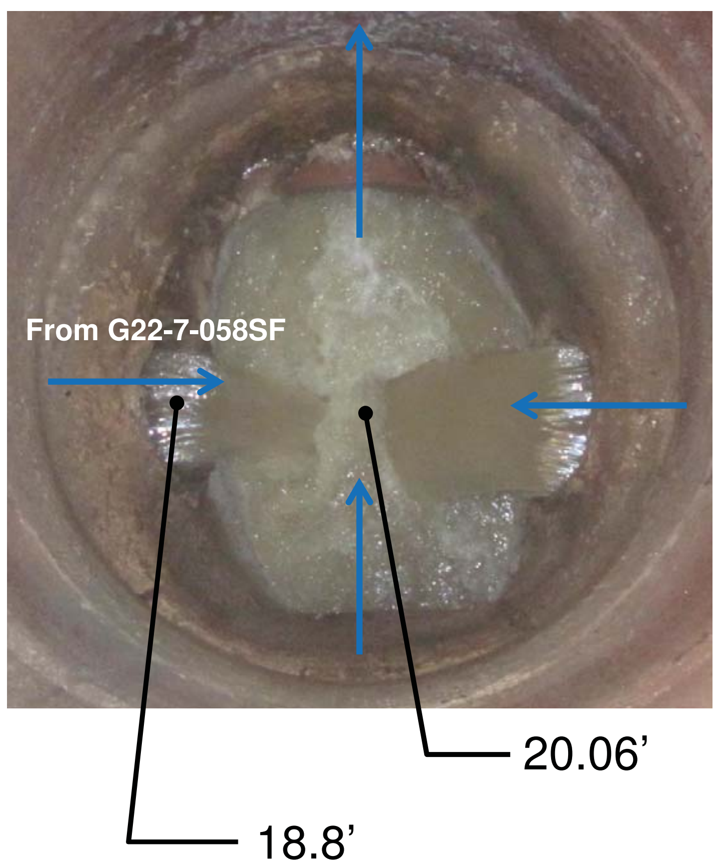
Notes: Guestimate 60% of flow to the north, 40% of the flow to the east. Inspector noted sediment in the manhole channel.



Site 4: G22-7-058SF (Cavallo Road south of 14th Street)

Coordinates: -121.7968° W, 38.0077° N





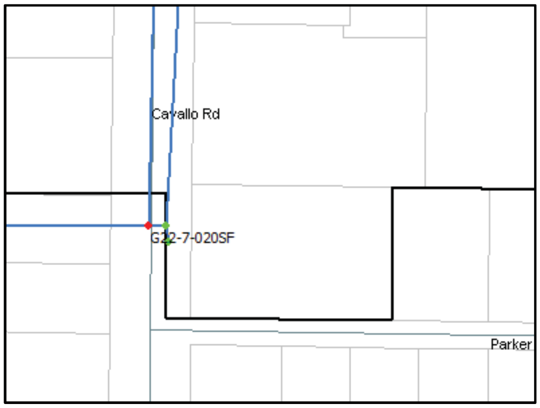
Site 4: G22-7-058SF (Cavallo Road south of 14th Street)

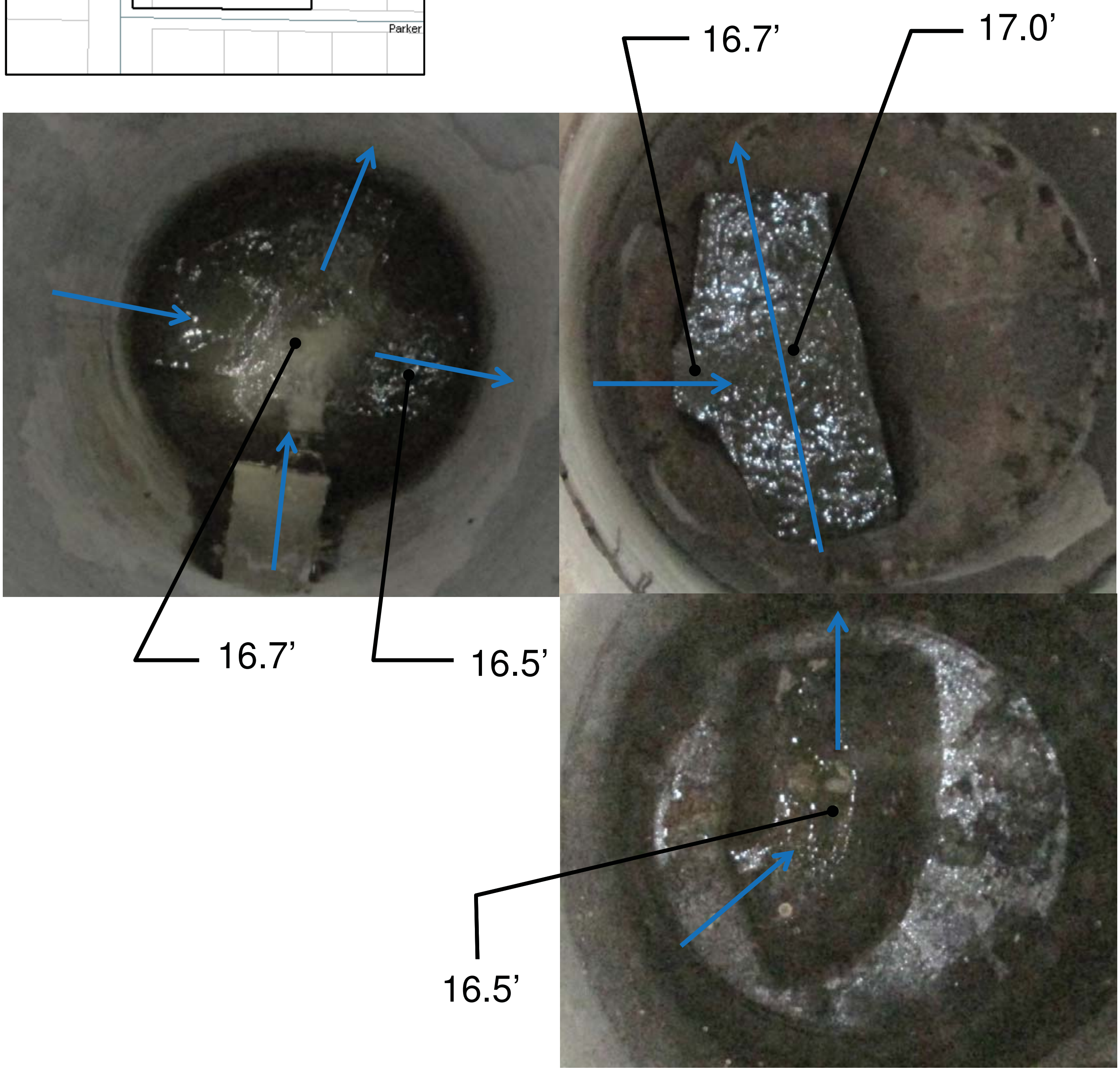
Coordinates: -121.7968° W, 38.0077° N

Notes: East connection pipe appears cut at the spring-line and is not channeled with the direction of flow. Most of the flow does head north but a good portion spills over to the east.

Site 5: G22-7-020SF (Cavallo Road and Parker Lane)

Coordinates: -121.7968° W, 38.0040° N





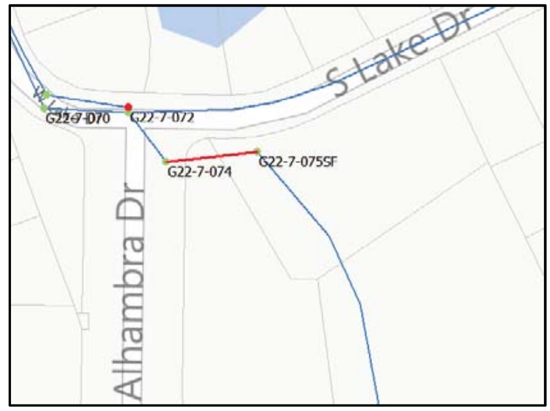
Site 5: G22-7-020SF (Cavallo Road and Parker Lane)

Coordinates: -121.7968° W, 38.0040° N

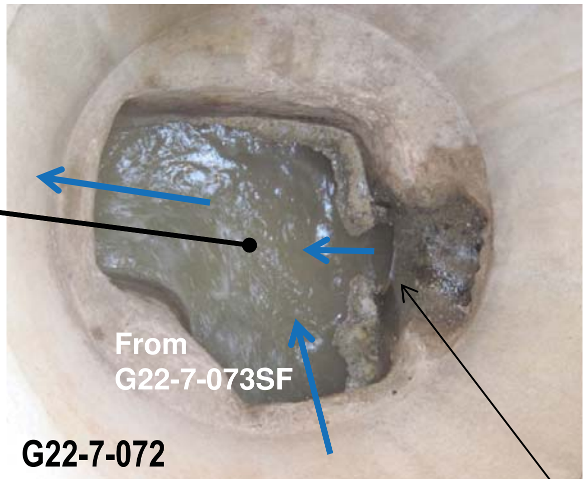
Notes: Guestimate 50/50 split to the north and east.

Sites 6 and 7: G22-7-073SF and G22-7-075SF TO G22-7-074 (Lake Drive and Alhambra Drive)

Coordinates: -121.7940° W, 38.0058° N and
-121.7937° W, 38.0055° N

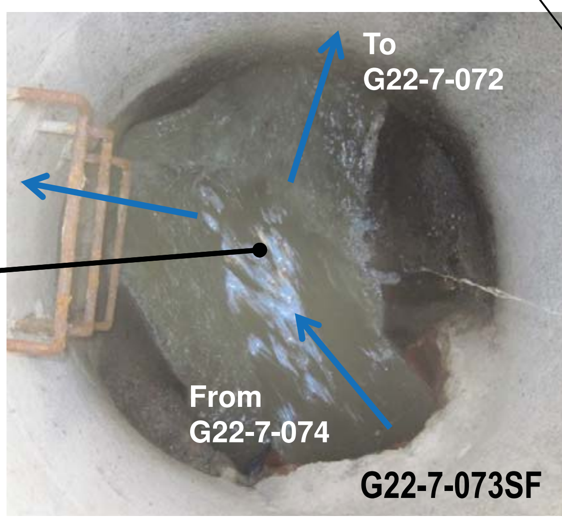


9.38’



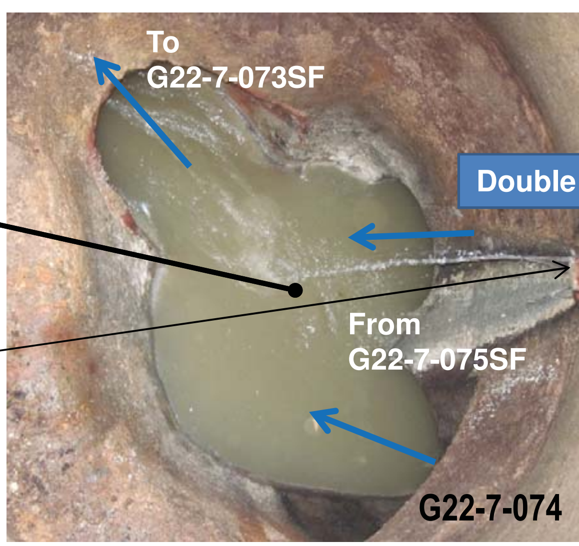
Notes: the 6-inch line from S. Lake Drive comes into G22-7-072, not G22-7-073SF.

9.32’

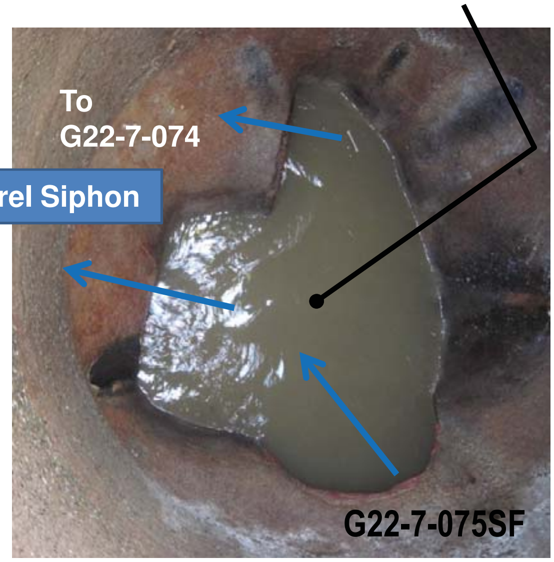


9.44’

8.78’



Double Barrel Siphon



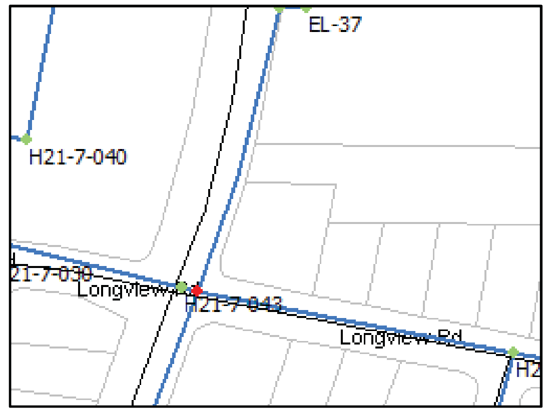
Infiltration

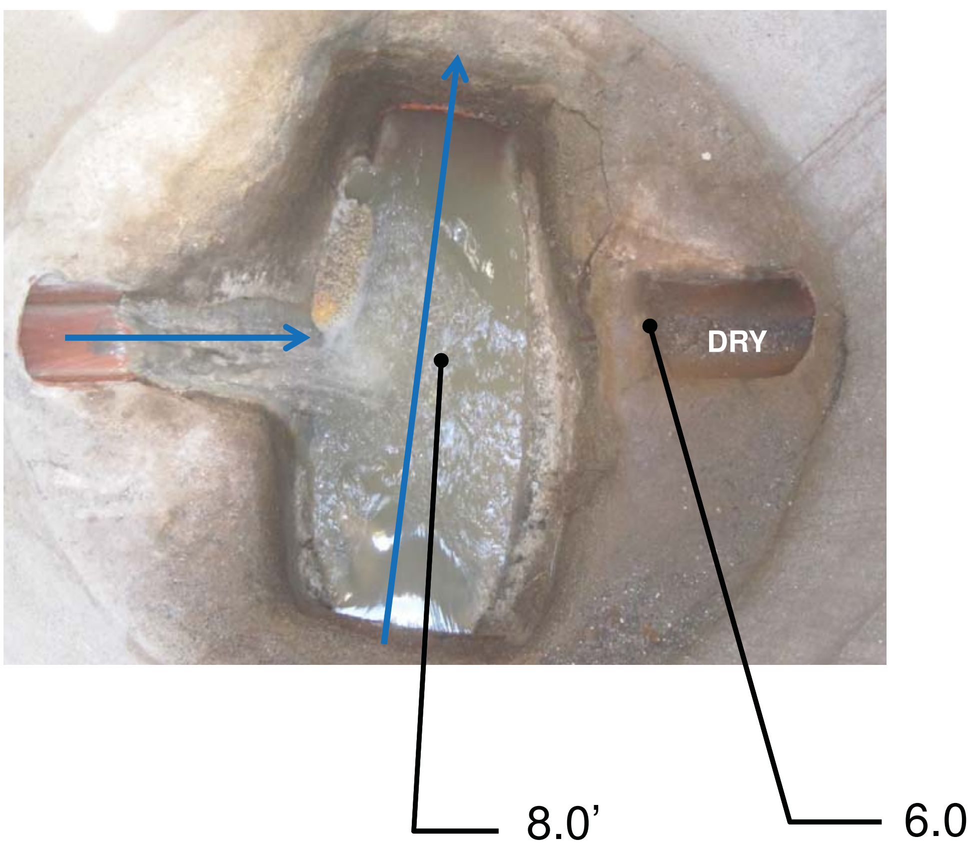
Sites 6 and 7: G22-7-073SF

Notes: Guestimate 50/50 Split.

Site 8: H21-7-056SF (Longview Road and Contra Loma Boulevard)

Coordinates: -121.8228° W, 37.9897° N





Site 8: H21-7-056SF (Longview Road and Contra Loma Boulevard)

Coordinates: -121.8228° W, 37.9897° N

Site 9: F22-6-063 (Wilbur Avenue west of Marie Avenue)

Coordinates: -121.8002° W, 38.0123° N

Rim to Invert: 22.6 feet

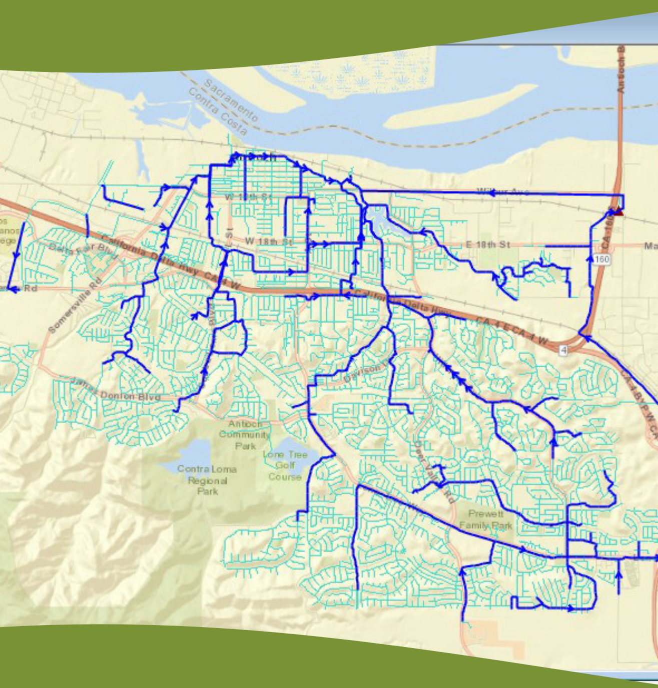
Site 10: F22-6-066 (AT METER 8) (North of Wilbur Avenue, 735 Wilbur Apartments Parking Lot)

Coordinates: -121.8013° W,38.0137° N

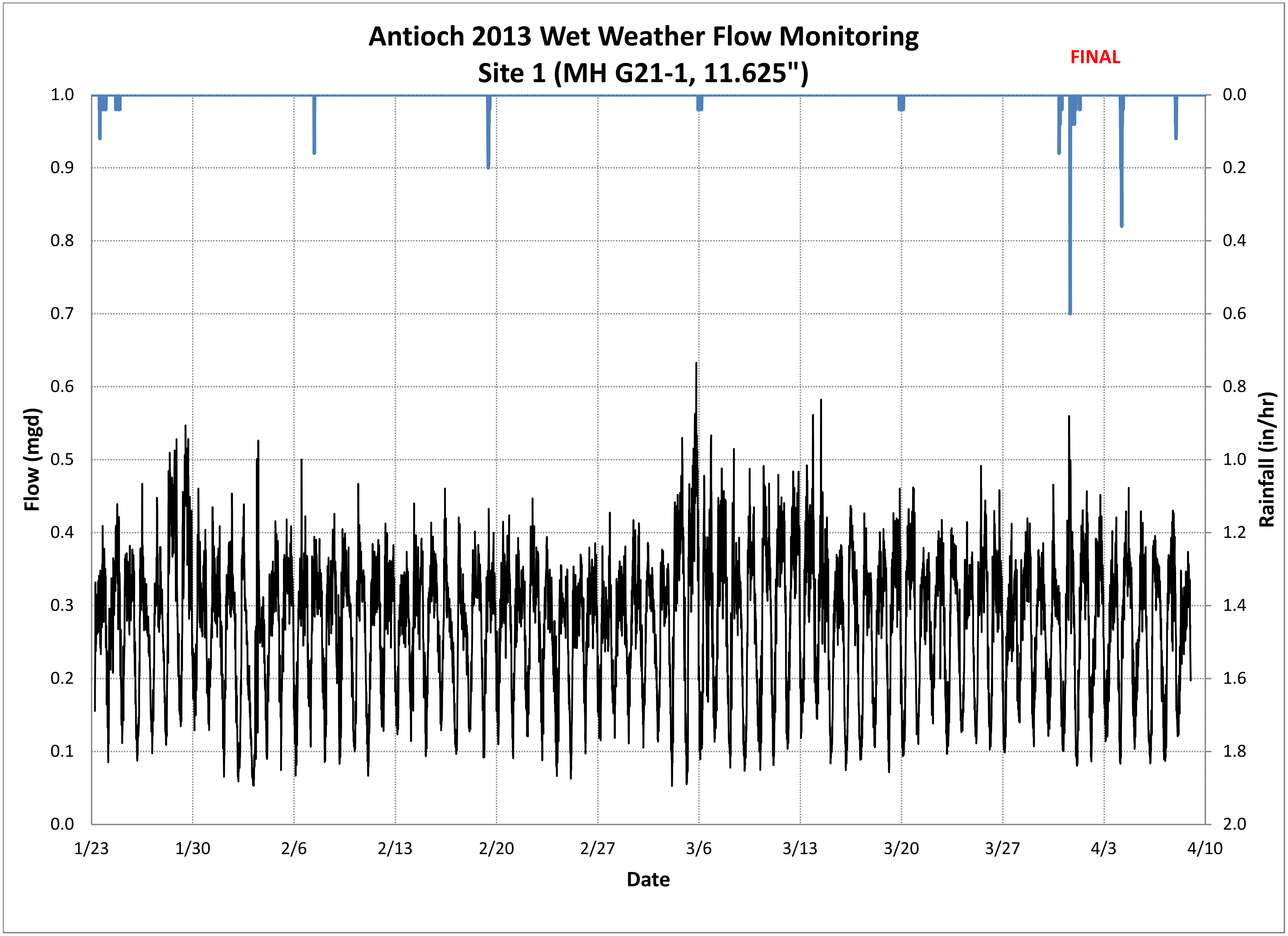
Rim to Invert: 17.8 feet

Appendix C

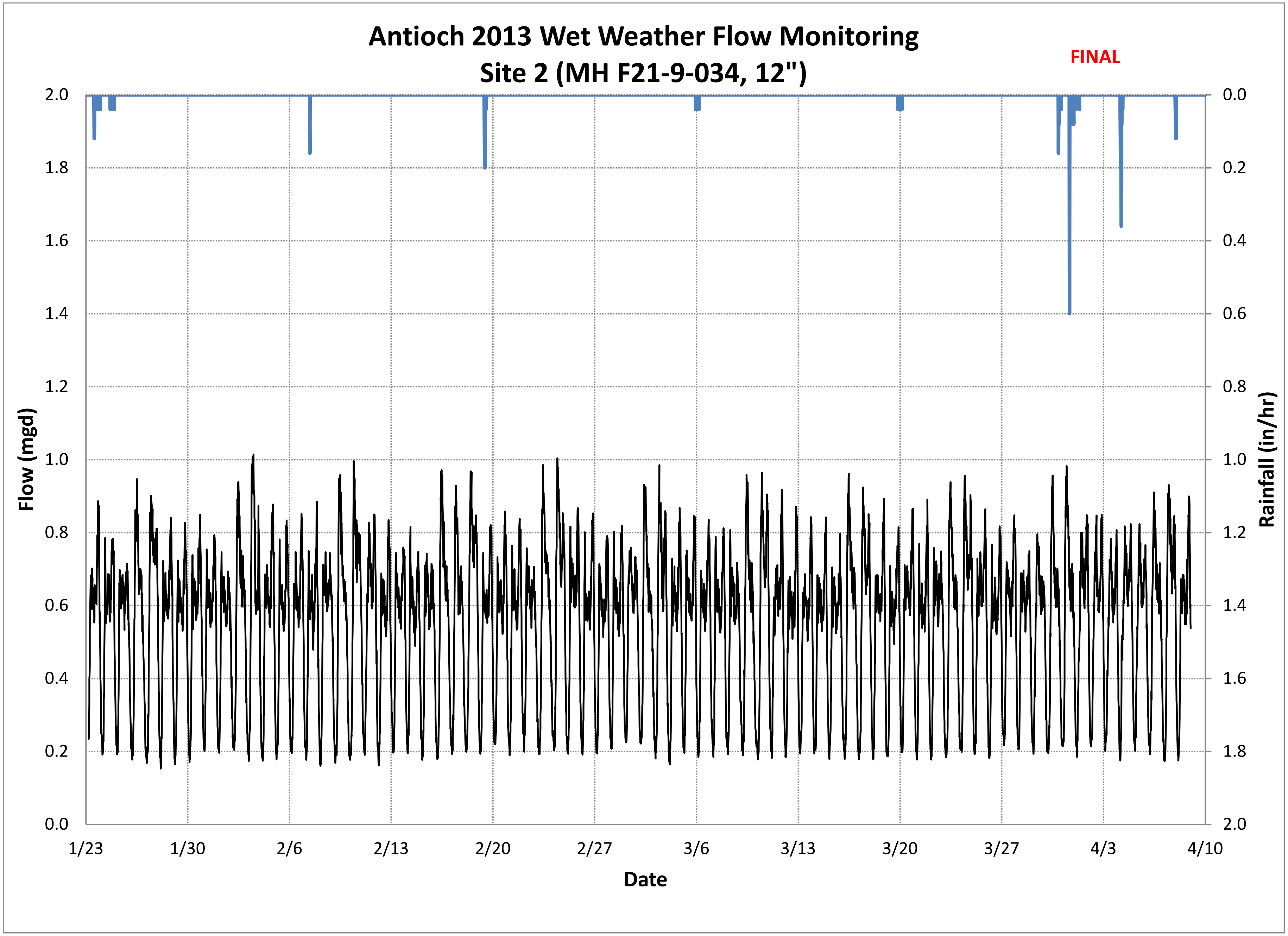
Plots of Flow Monitoring Data



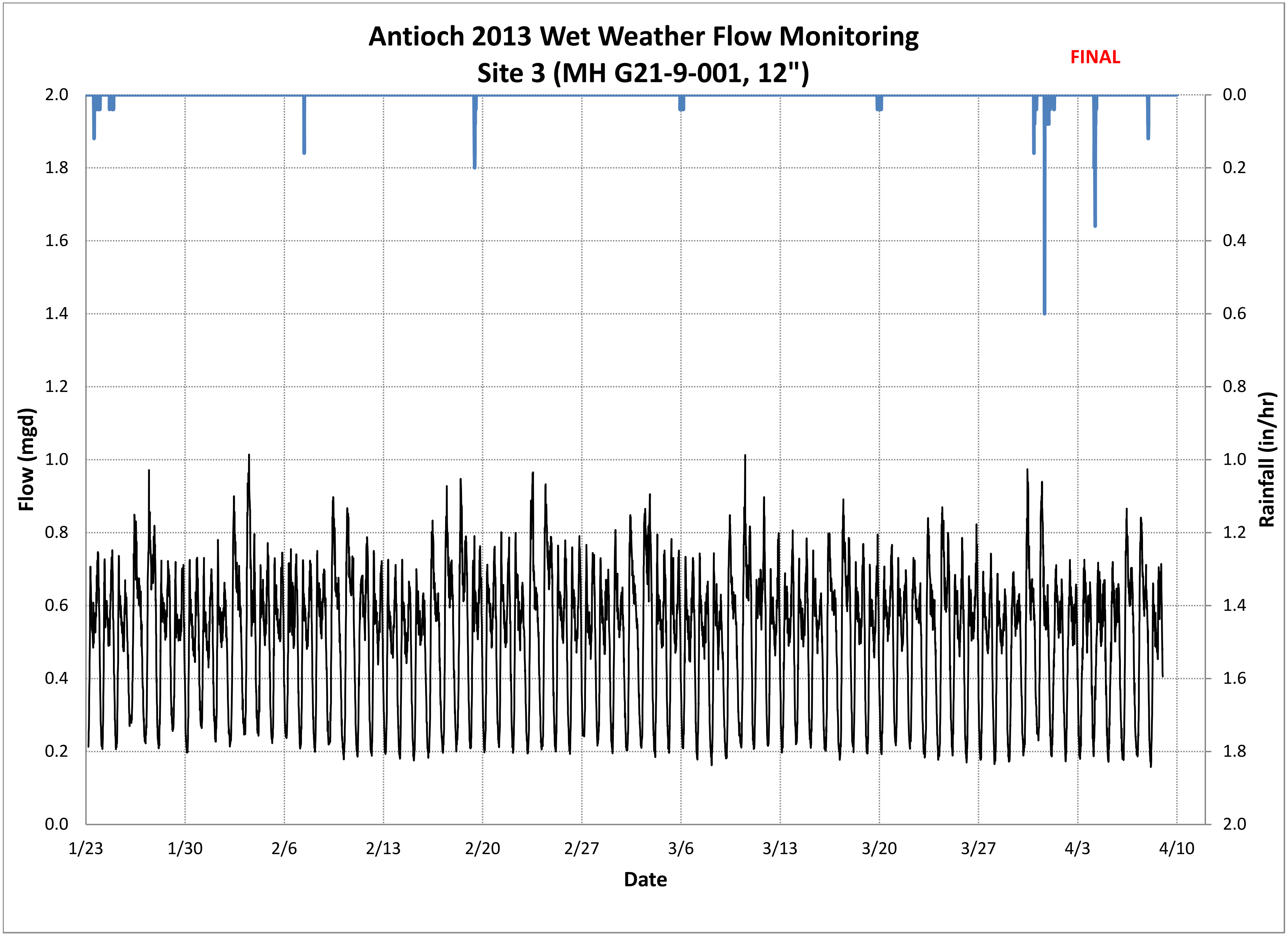
City of Antioch Wastewater Collection System Master Plan



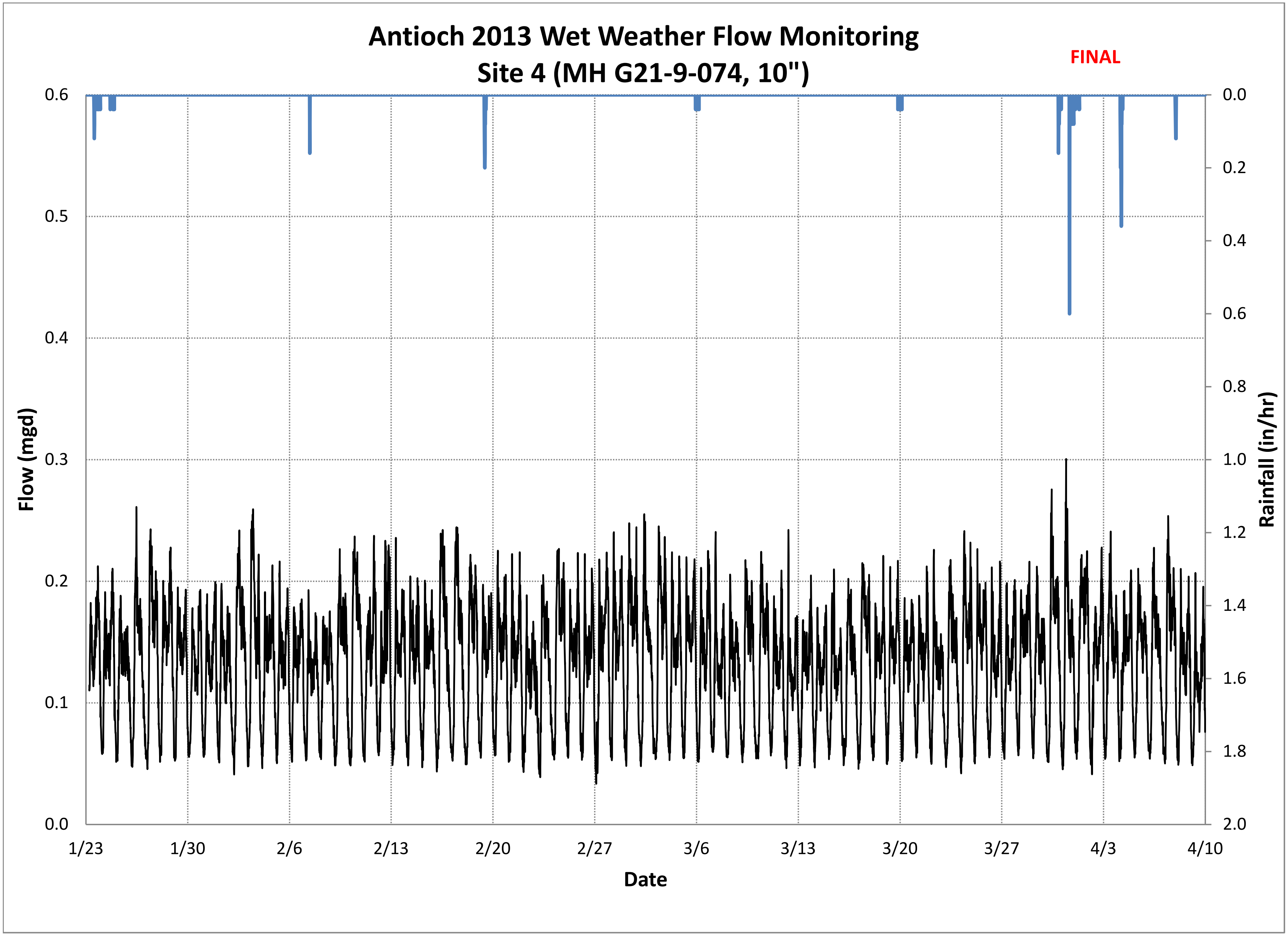
Antioch 2013 Wet Weather Flow Monitoring
Site 1 (MH G21-1, 11.625")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



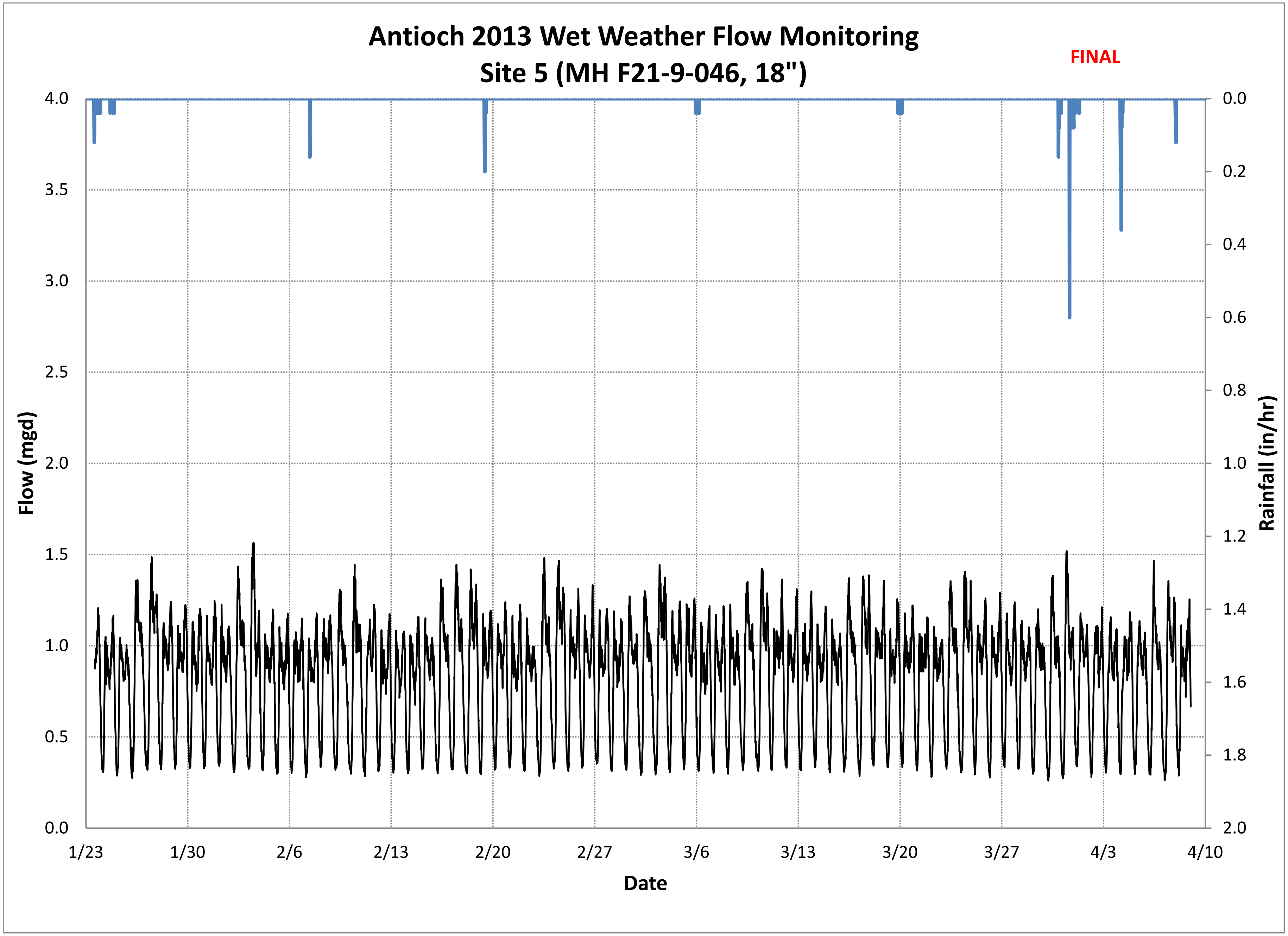
Antioch 2013 Wet Weather Flow Monitoring
Site 2 (MH F21-9-034, 12")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



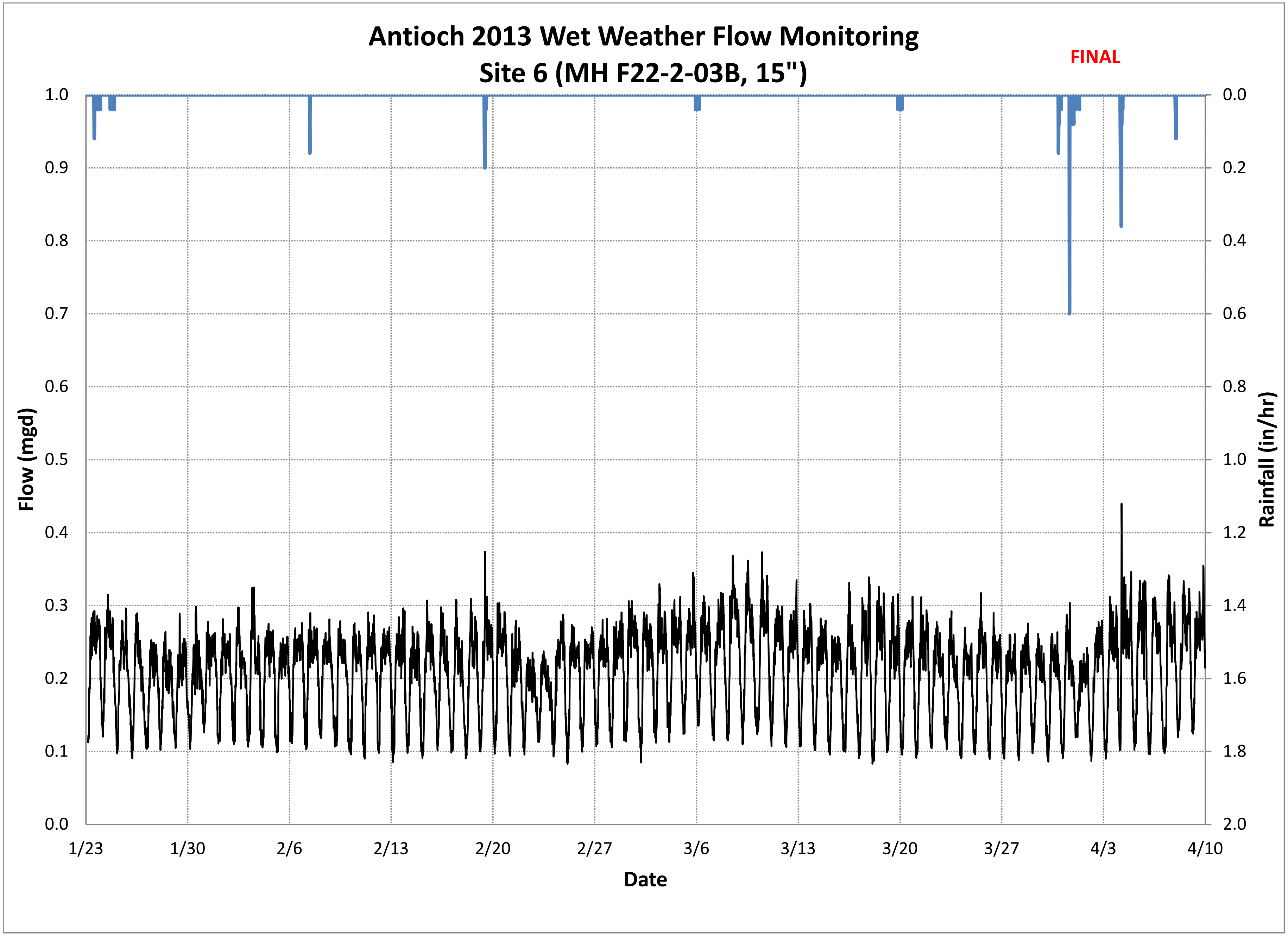
Antioch 2013 Wet Weather Flow Monitoring
Site 3 (MH G21-9-001, 12")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10

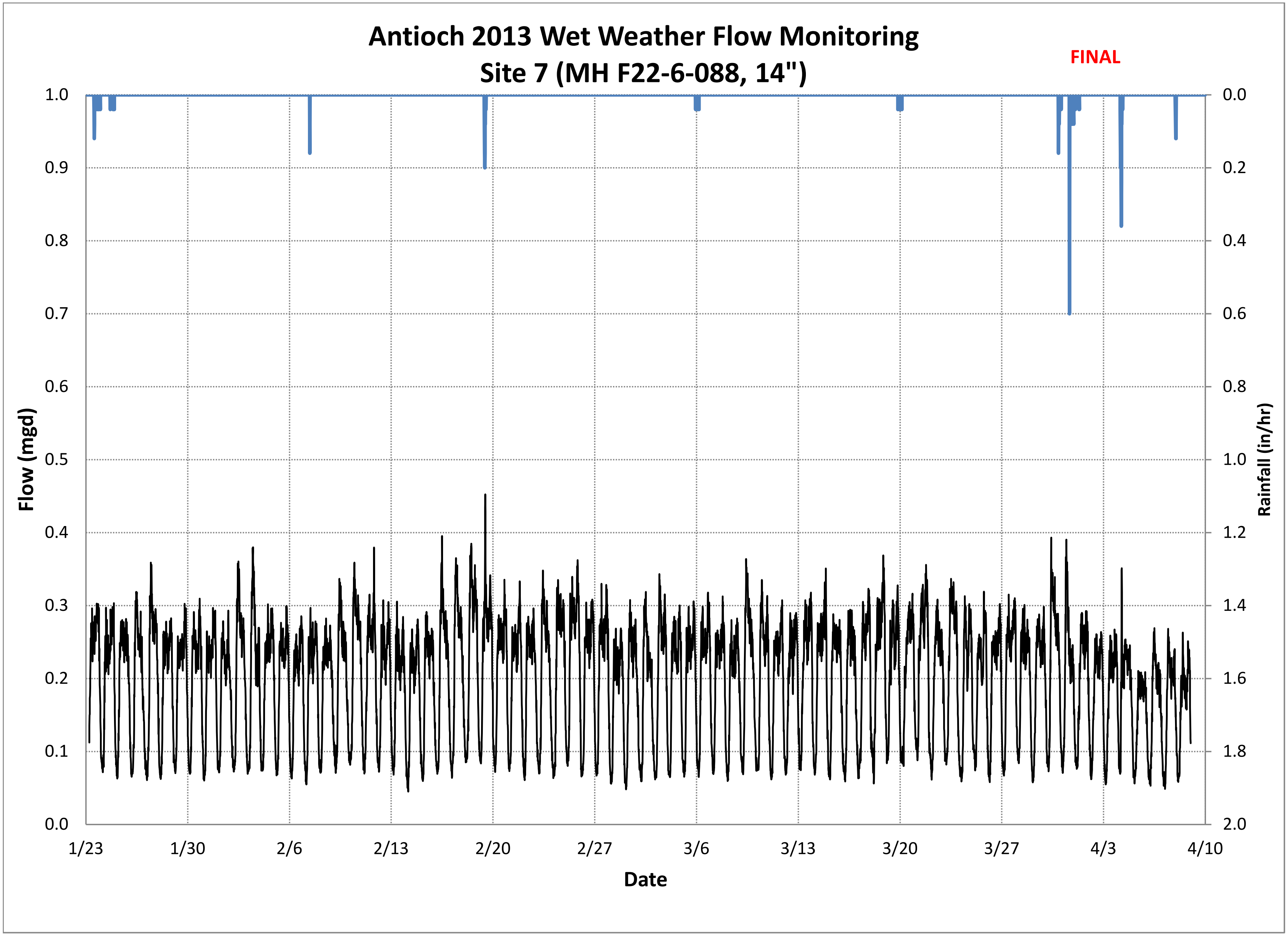


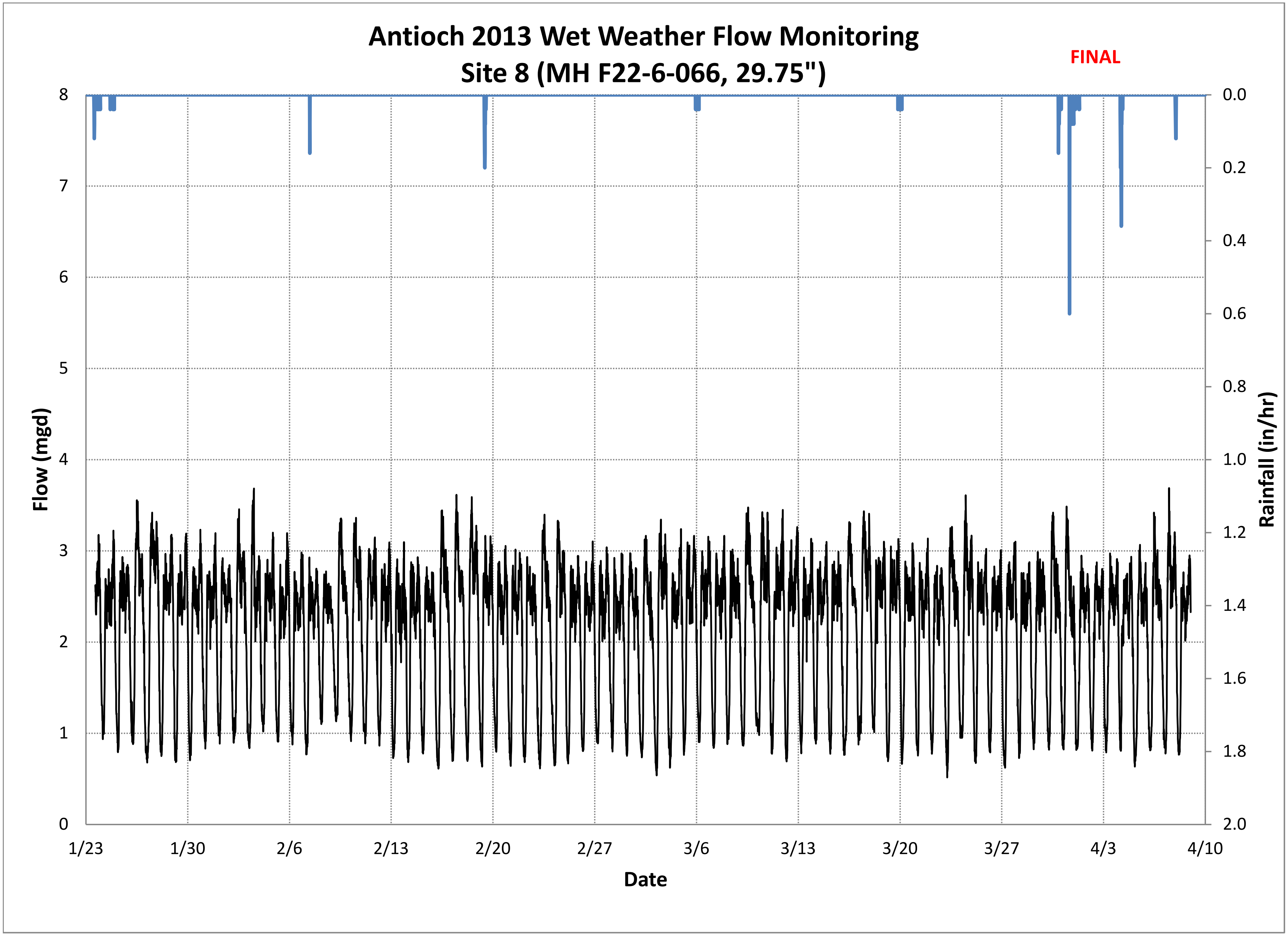
Antioch 2013 Wet Weather Flow Monitoring
Site 4 (MH G21-9-074, 10")
FINAL
Flow (mgd)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date



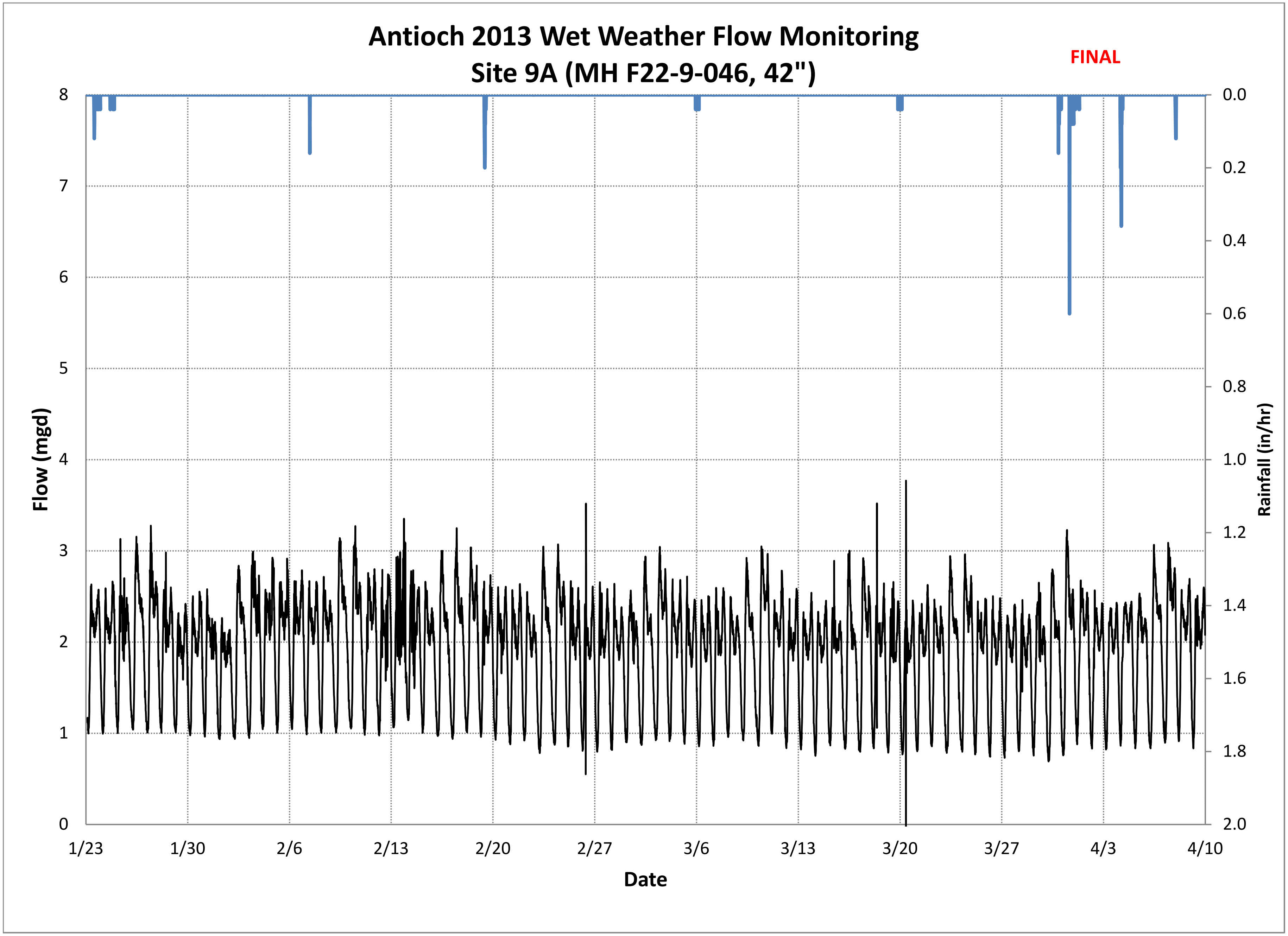
Antioch 2013 Wet Weather Flow Monitoring
Site 5 (MH F21-9-046, 18")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10


Antioch 2013 Wet Weather Flow Monitoring
Site 6 (MH F22-2-03B, 15")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10

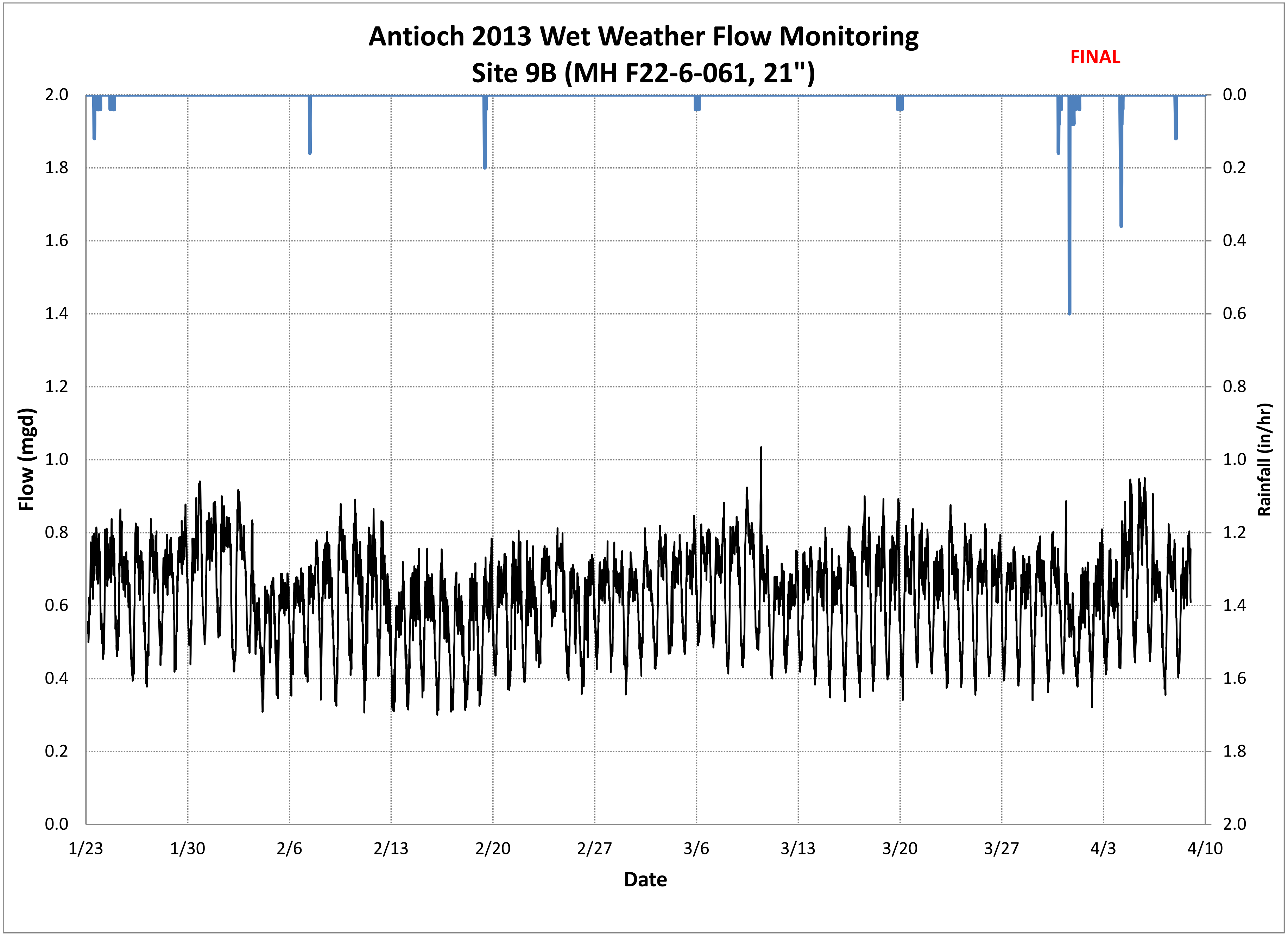

Antioch 2013 Wet Weather Flow Monitoring
Site 7 (MH F22-6-088, 14")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.0
1.8
1.6
1.4
1.2
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10

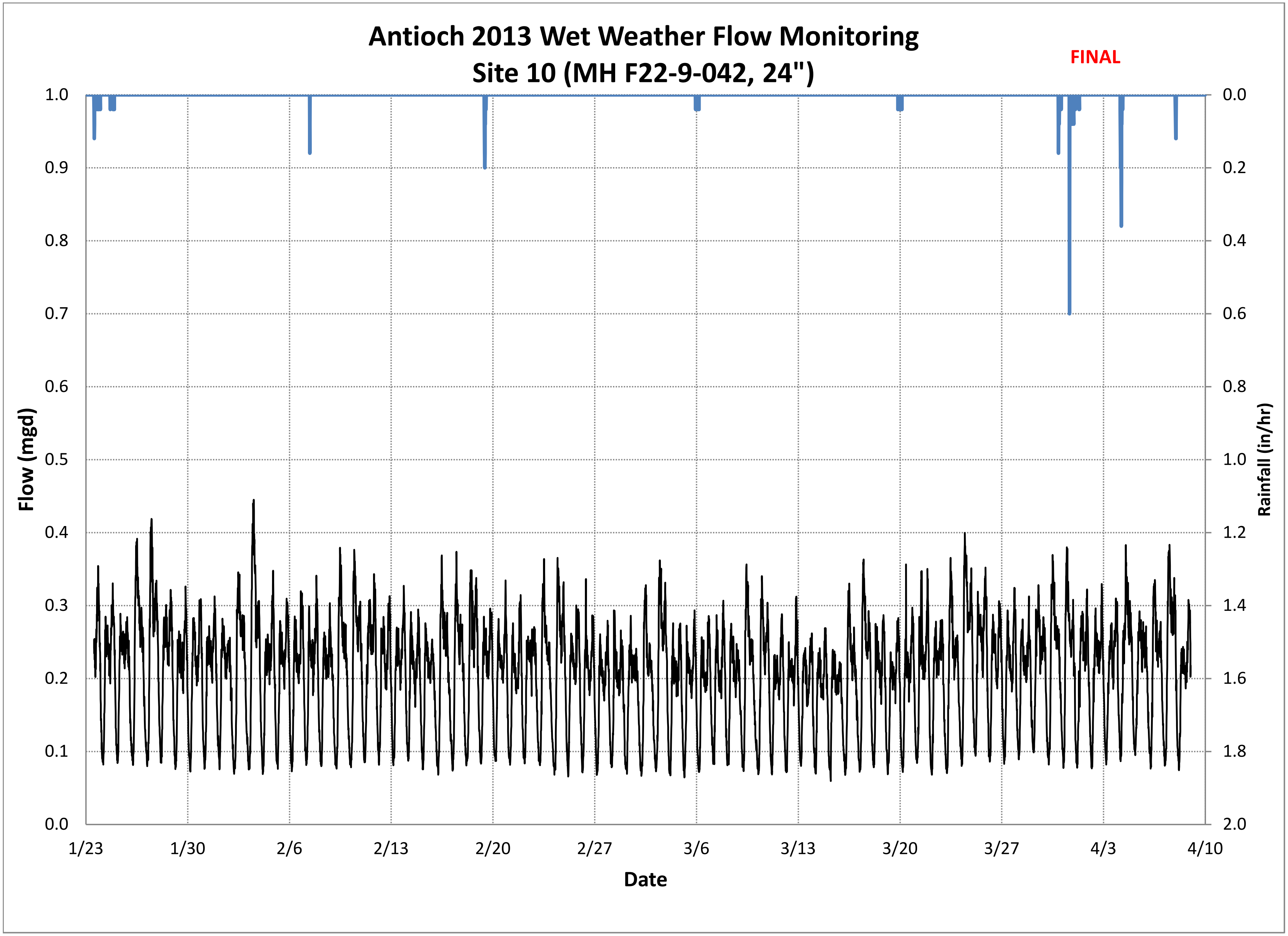


Antioch 2013 Wet Weather Flow Monitoring
Site 8 (MH F22-6-066, 29.75")
FINAL
Flow (mgd)
0
1
2
3
4
5
6
7
8
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date

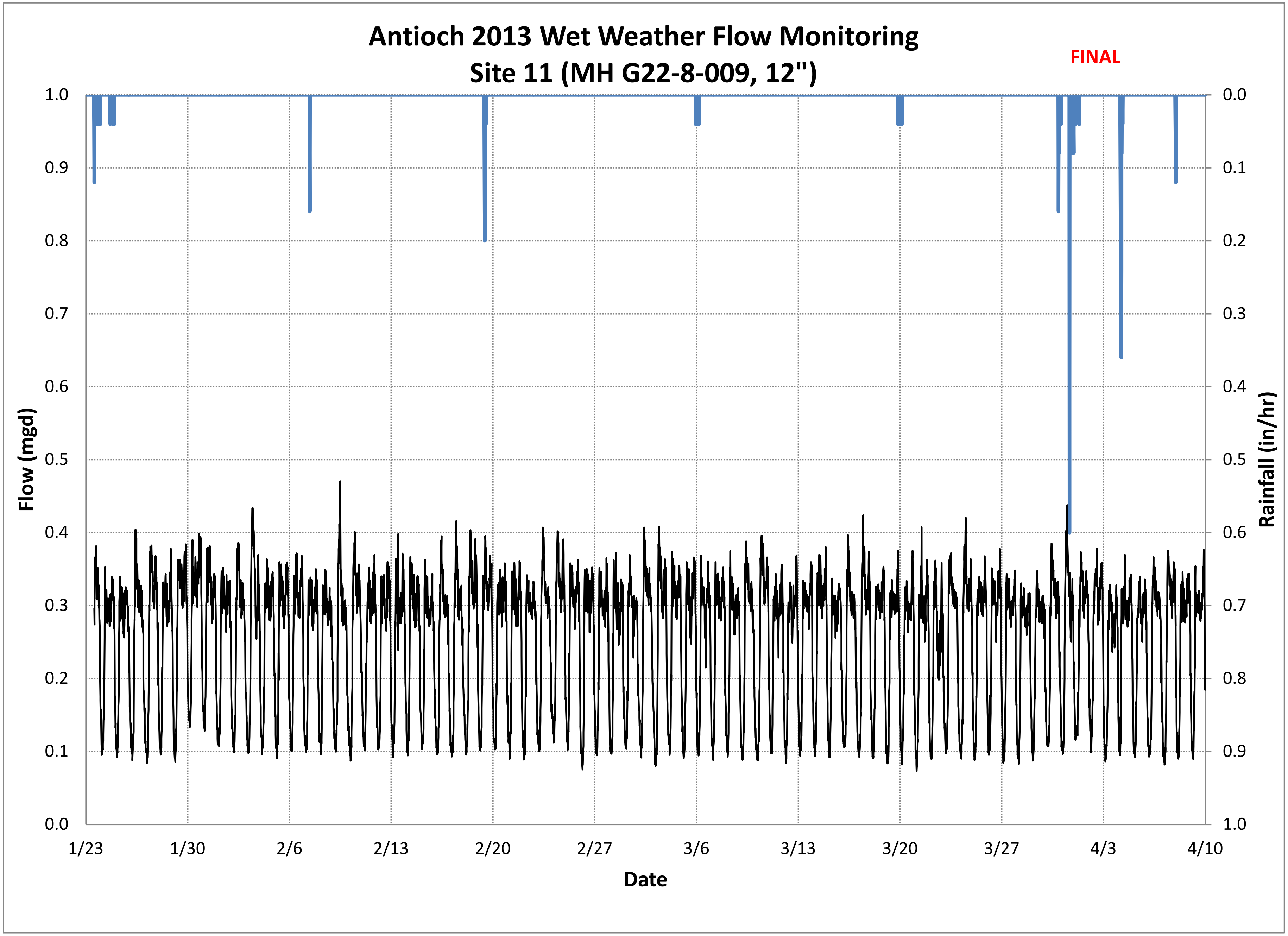


Antioch 2013 Wet Weather Flow Monitoring
Site 9A (MH F22-9-046, 42")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
8
7
6
5
4
3
2
1
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10

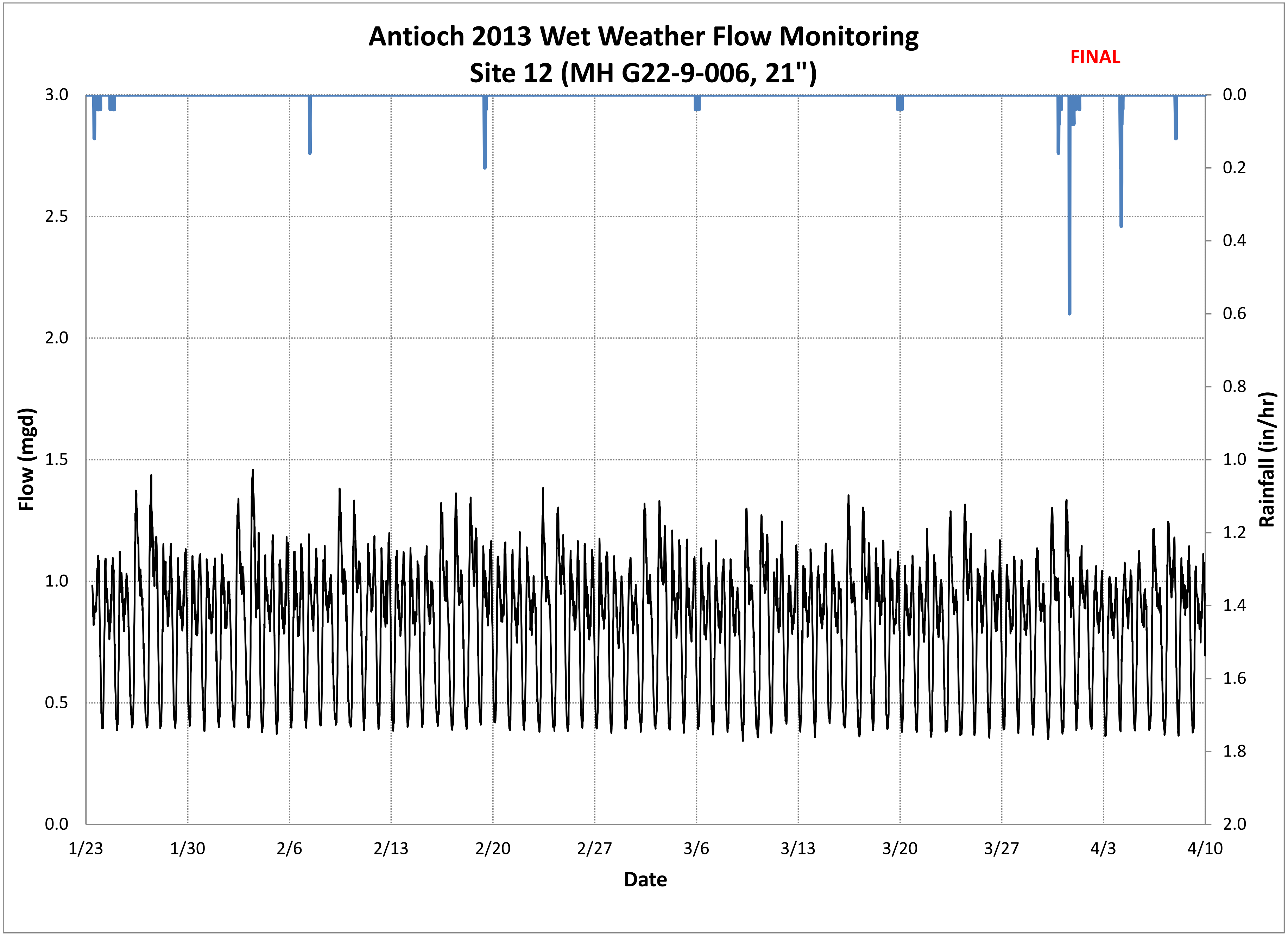

Antioch 2013 Wet Weather Flow Monitoring
Site 9B (MH F22-6-061, 21")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



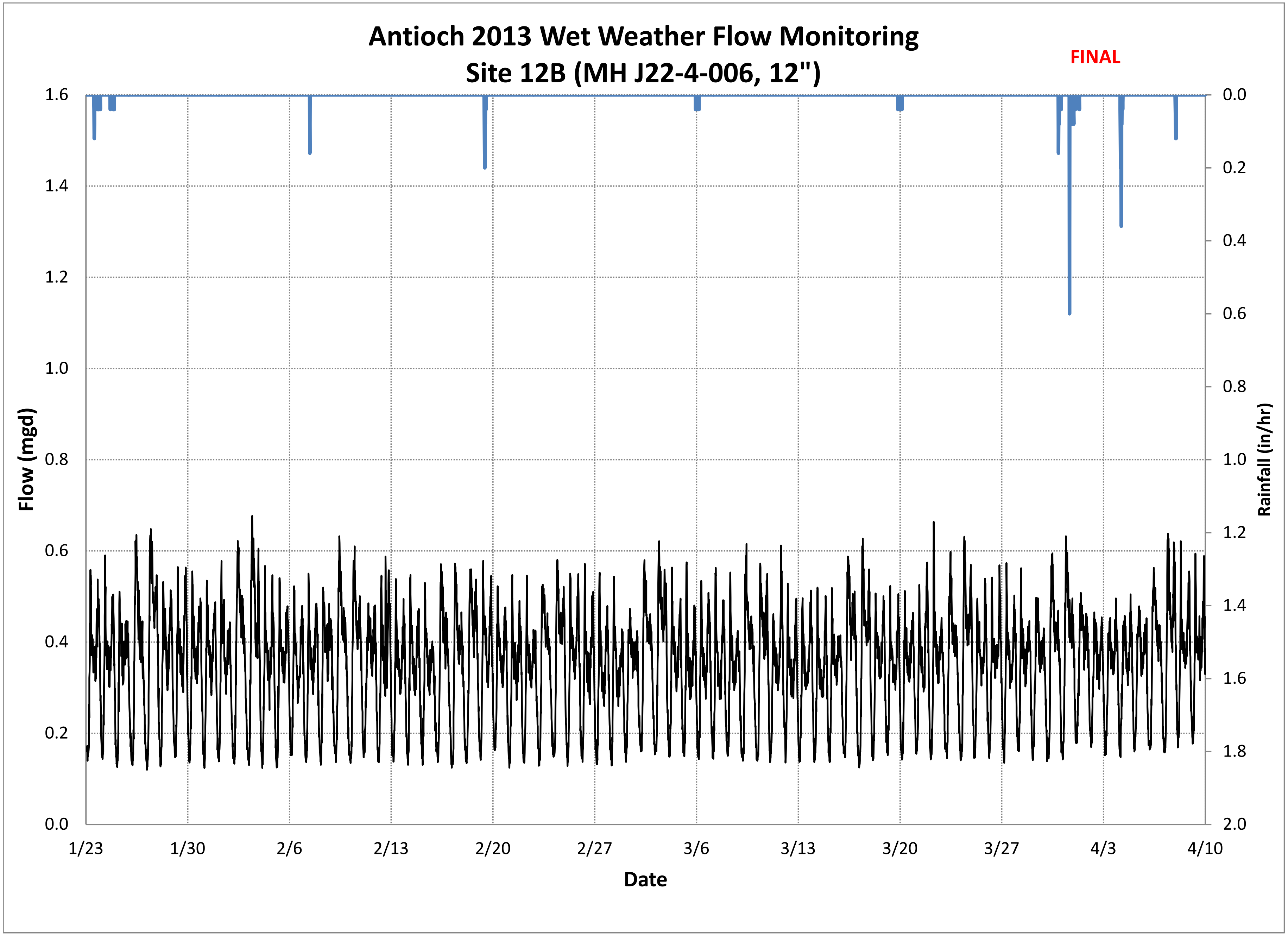
Antioch 2013 Wet Weather Flow Monitoring
Site 10 (MH F22-9-042, 24")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



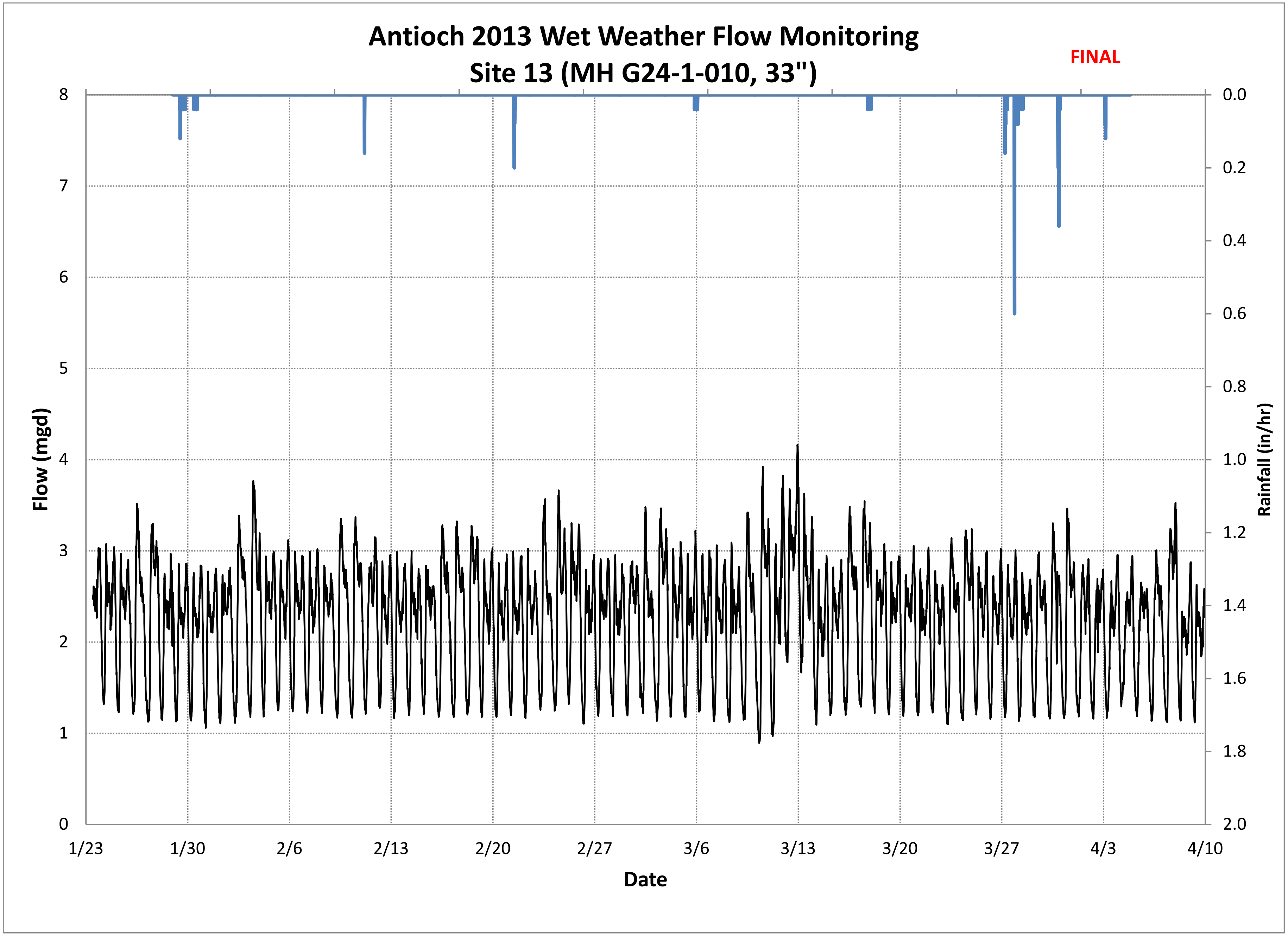
Antioch 2013 Wet Weather Flow Monitoring
Site 11 (MH G22-8-009, 12")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



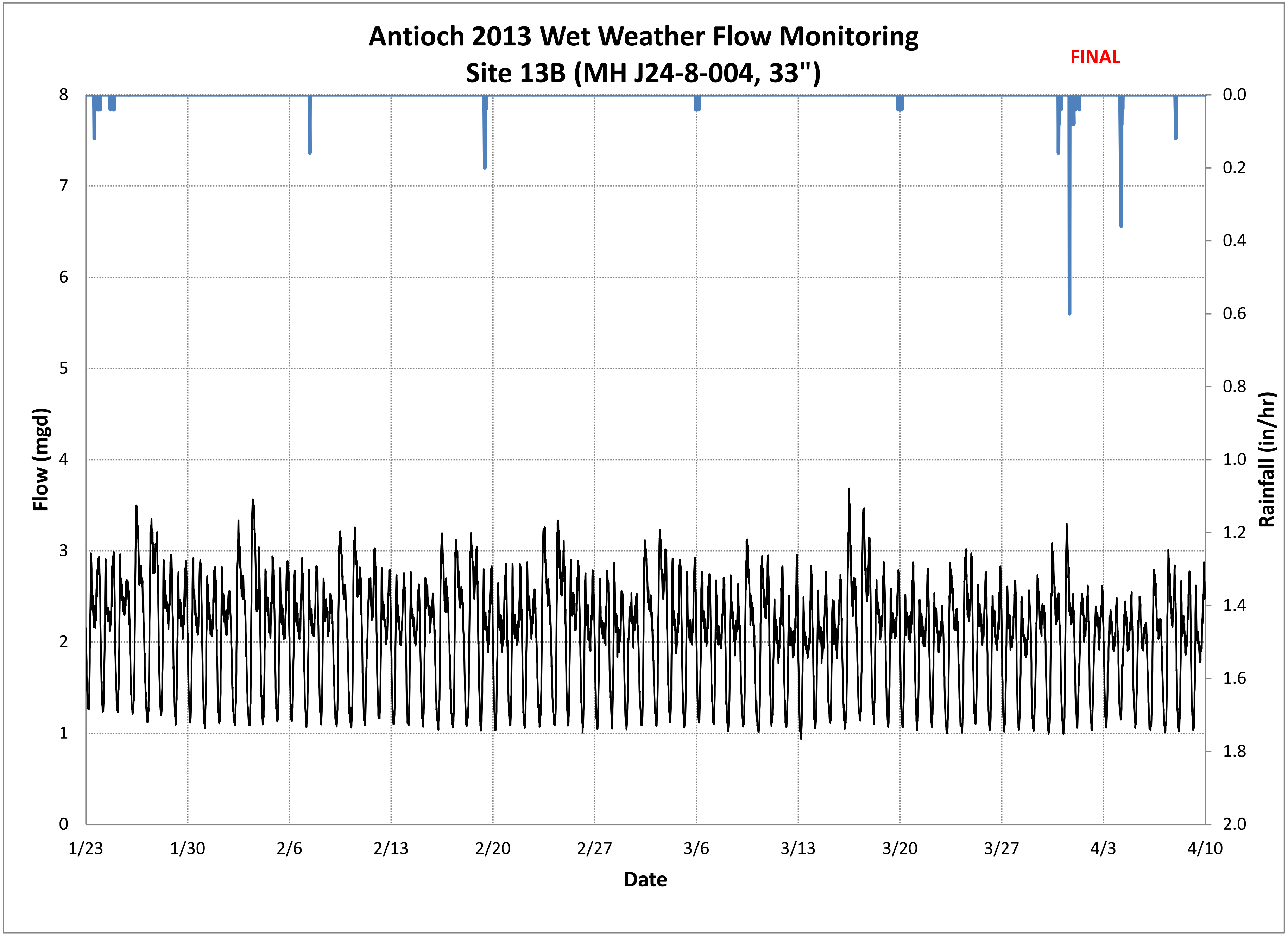
Antioch 2013 Wet Weather Flow Monitoring
Site 12 (MH G22-9-006, 21")
FINAL
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Flow (mgd)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Rainfall (in/hr)
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date

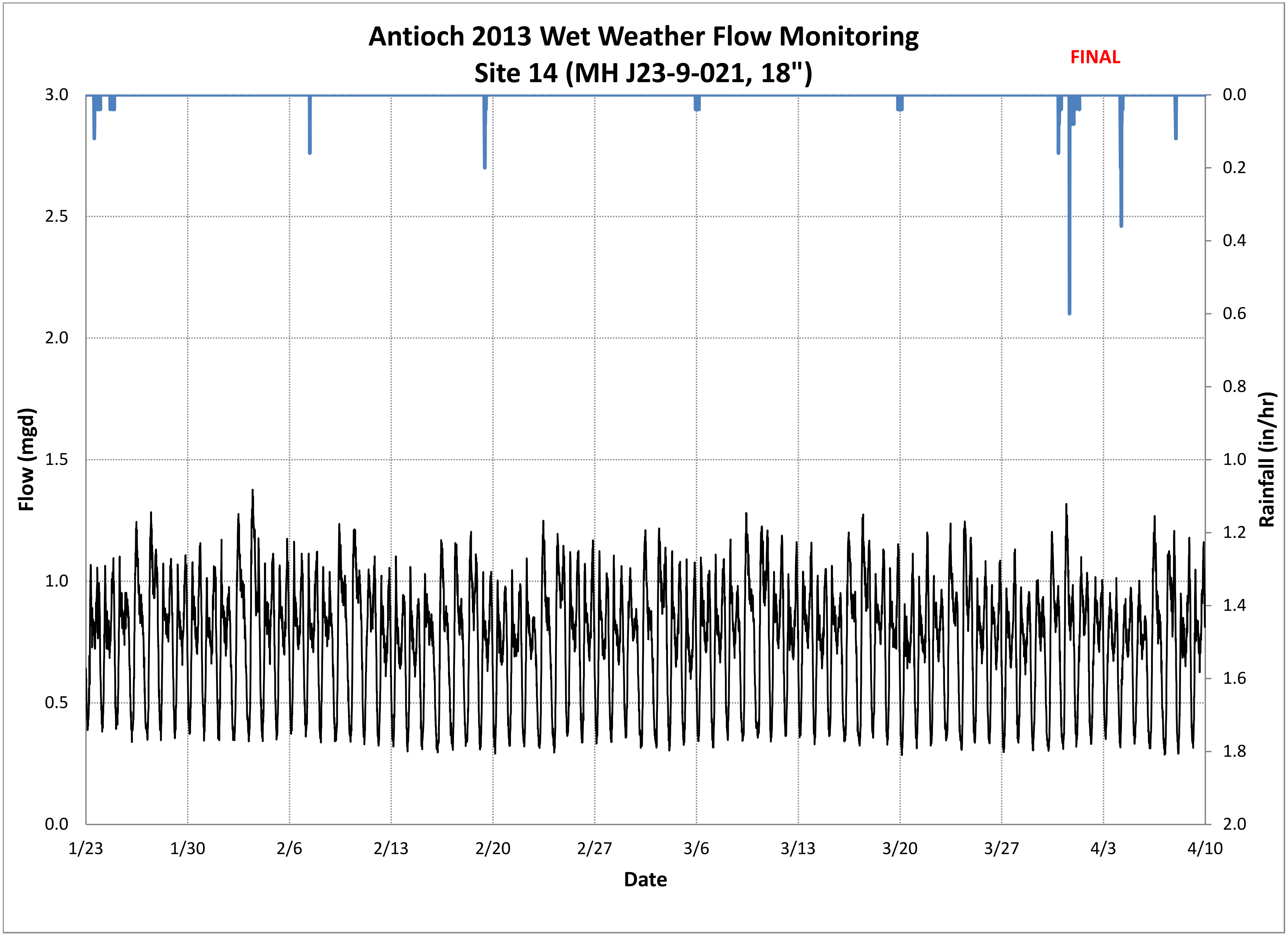


Antioch 2013 Wet Weather Flow Monitoring
Site 12B (MH J22-4-006, 12")
FINAL
Flow (mgd)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date



Antioch 2013 Wet Weather Flow Monitoring
Site 13 (MH G24-1-010, 33")
FINAL
Flow (mgd)
8
7
6
5
4
3
2
1
0
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date


Antioch 2013 Wet Weather Flow Monitoring
Site 13B (MH J24-8-004, 33")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
0
1
2
3
4
5
6
7
8
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10


Antioch 2013 Wet Weather Flow Monitoring
Site 14 (MH J23-9-021, 18")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
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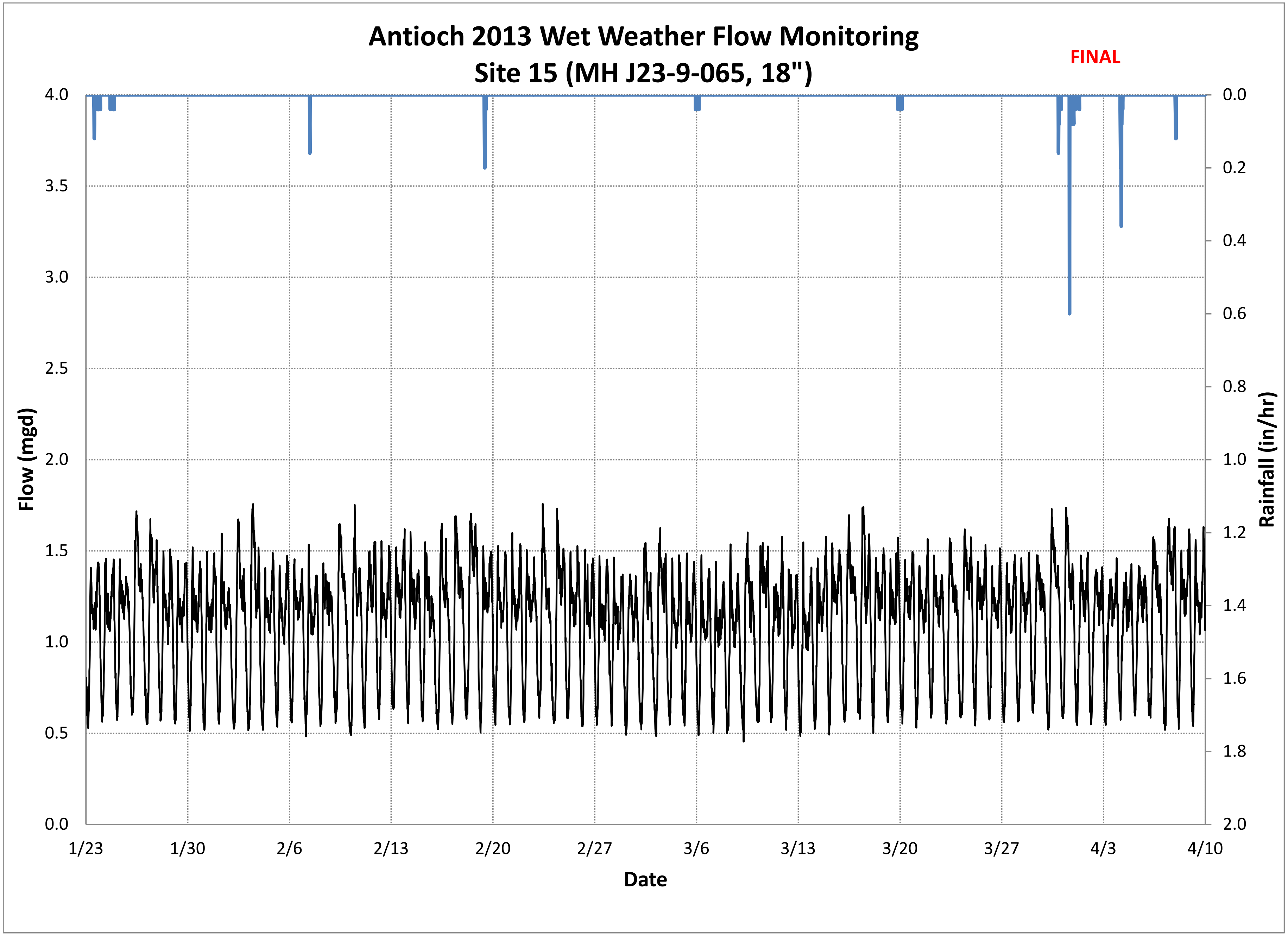
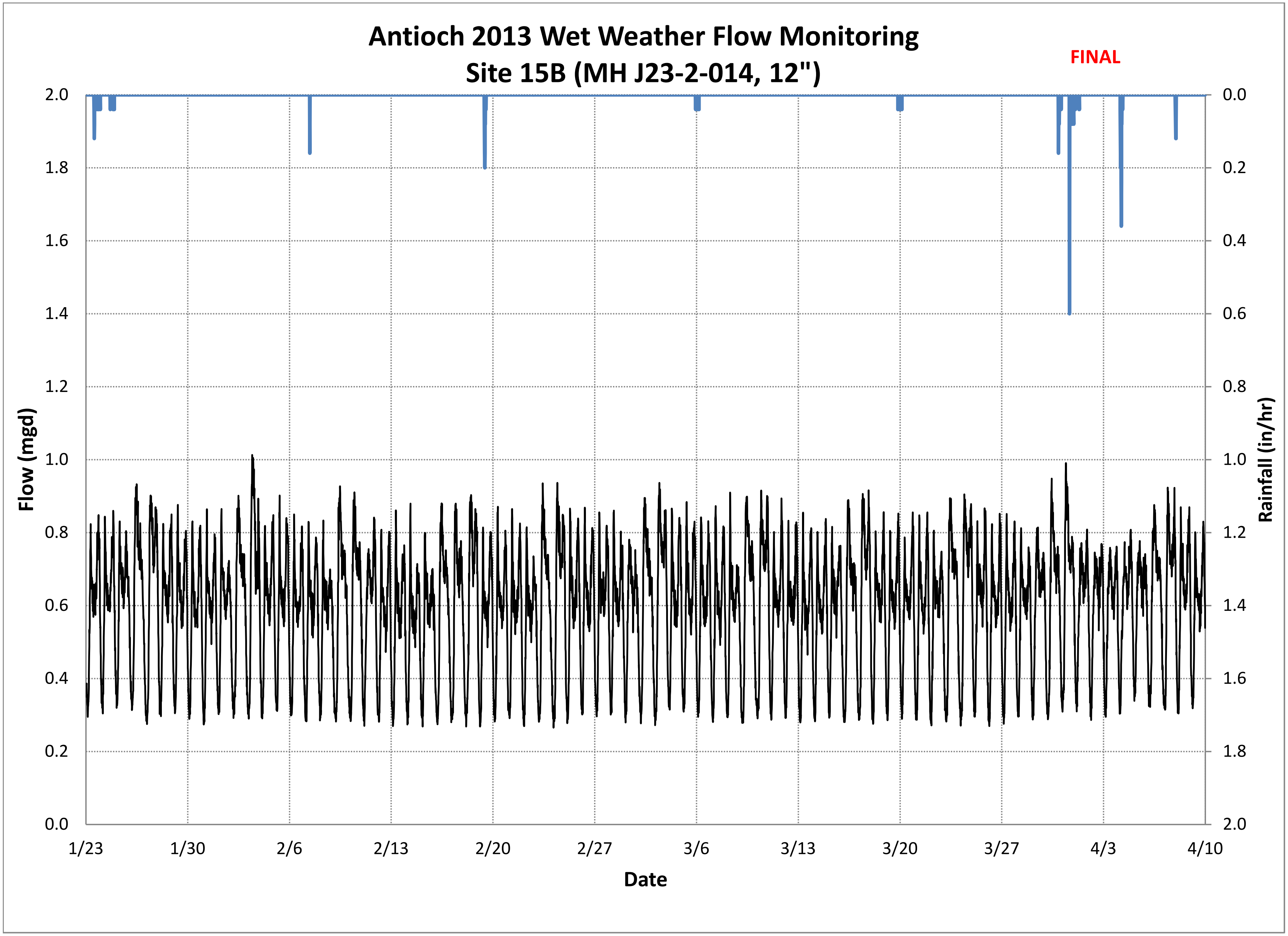
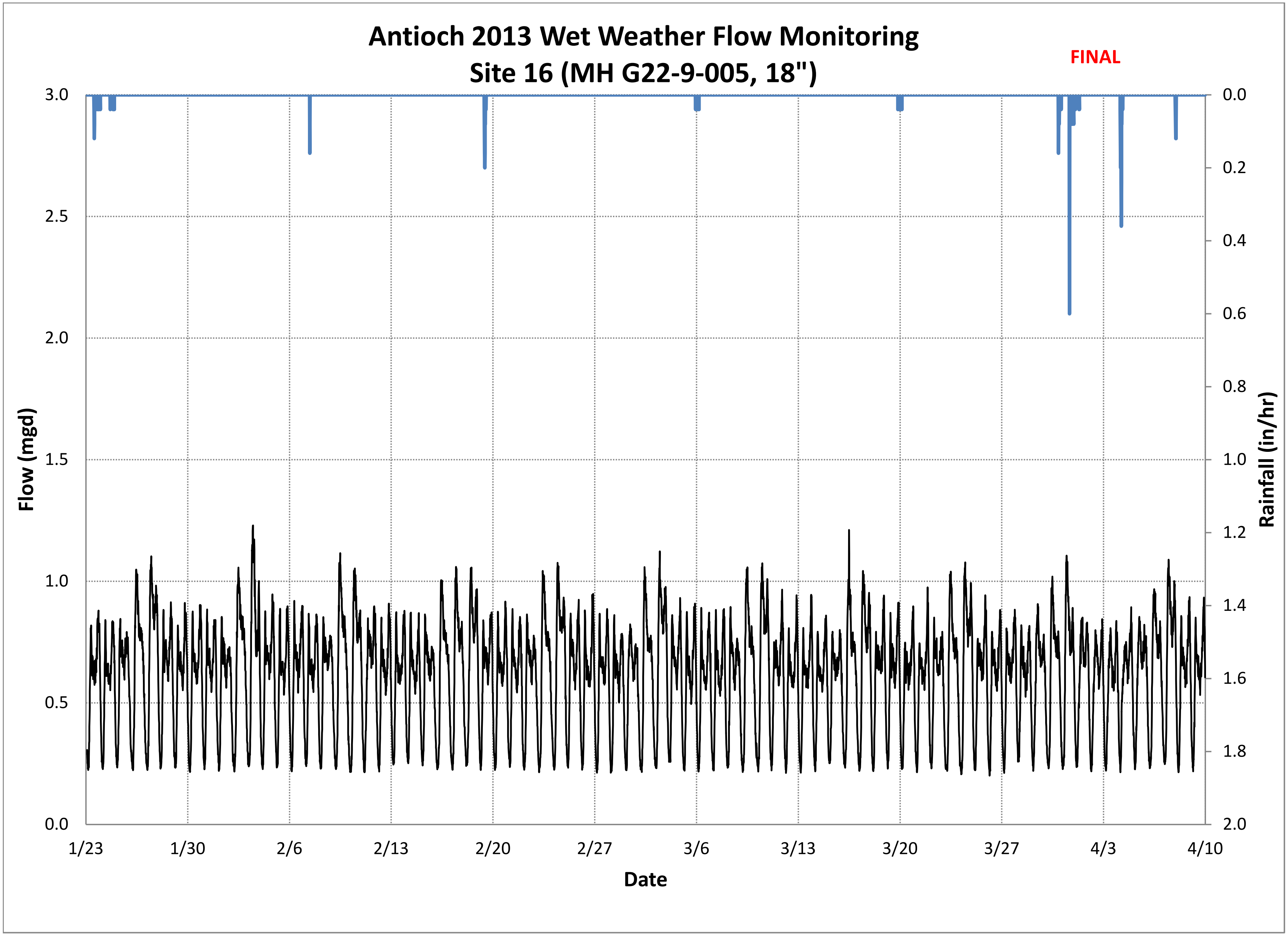
3/20
3/27
4/3
4/10



Antioch 2013 Wet Weather Flow Monitoring
Site 15 (MH J23-9-065, 18")
FINAL
Flow (mgd)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date



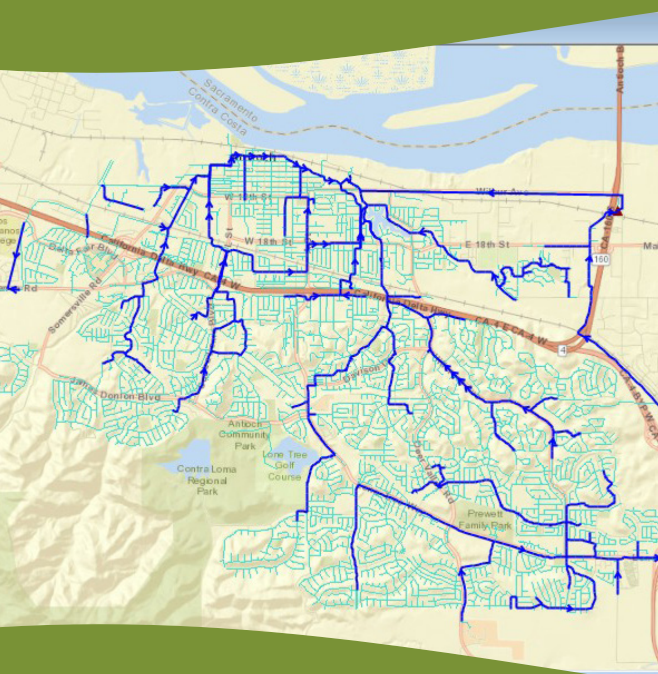
Antioch 2013 Wet Weather Flow Monitoring
Site 15B (MH J23-2-014, 12")
FINAL
Flow (mgd)
Rainfall (in/hr)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10



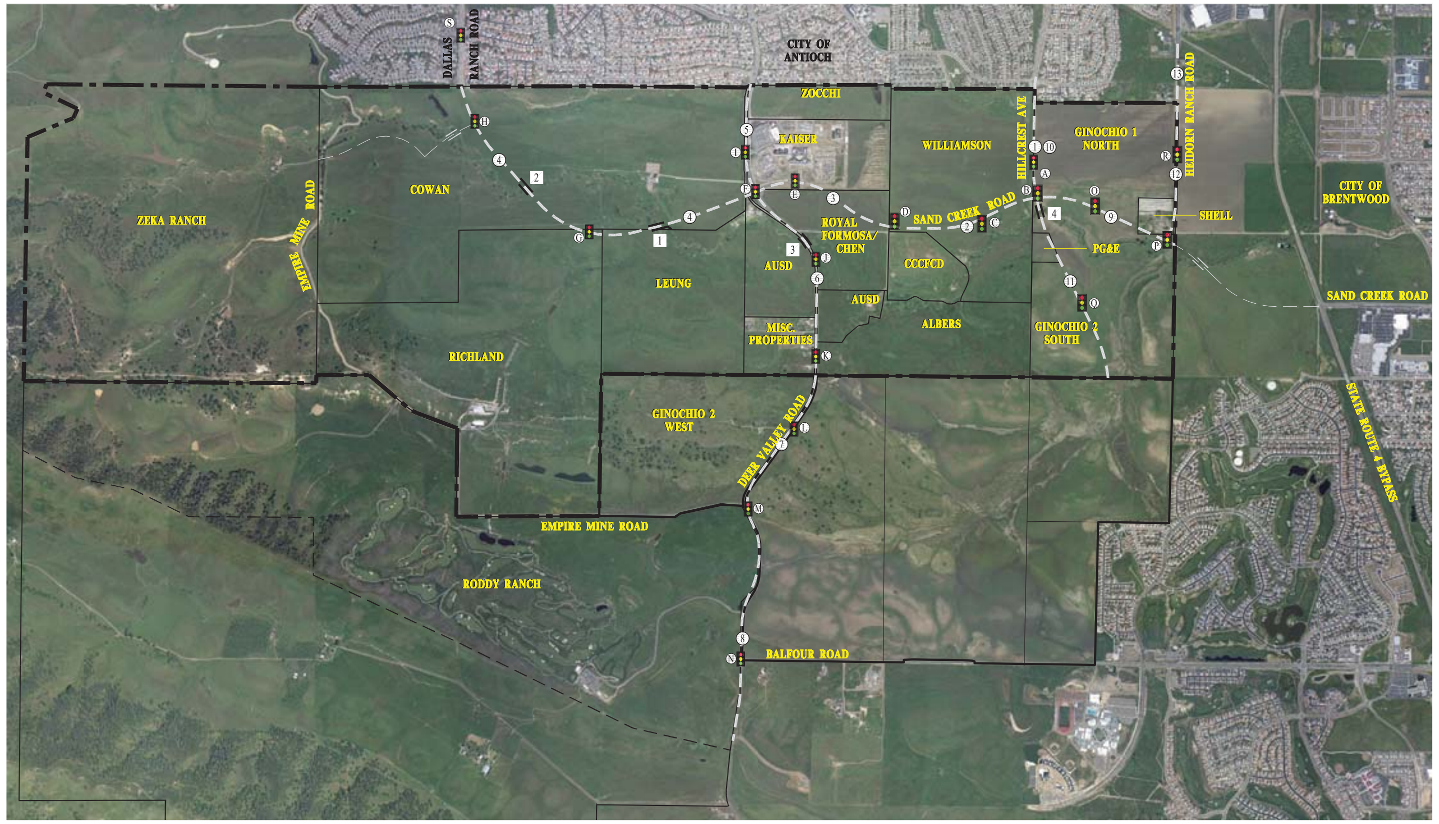
Antioch 2013 Wet Weather Flow Monitoring
Site 16 (MH G22-9-005, 18")
FINAL
Flow (mgd)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Rainfall (in/hr)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
1/23
1/30
2/6
2/13
2/20
2/27
3/6
3/13
3/20
3/27
4/3
4/10
Date

Appendix D

Future Development Information



Appendix D - Future Development Information – FUA 1



STREET IMPROVEMENTS

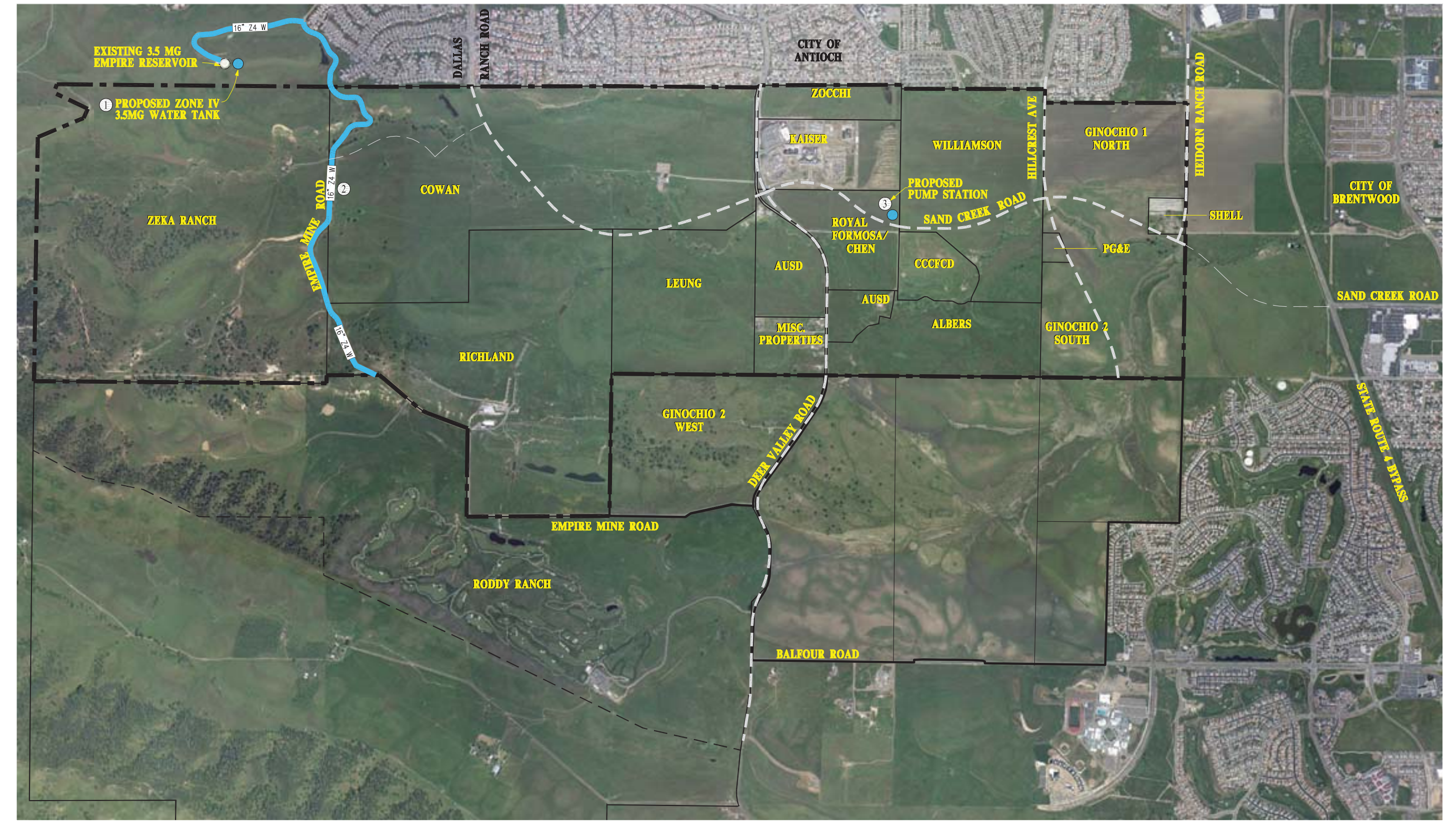
SCALE: 1" =1000'±

LEGEND:

(6) STREET SEGMENT REFERENCED IN PRELIMINARY ENGINEER'S CONSTRUCTION COST ESTIMATE

TRAFFIC SIGNAL REFERENCED IN PRELIMINARY ENGINEER'S CONSTRUCTION COST ESTIMATE

[2] BRIDGE REFERENCED IN PRELIMINARY ENGINEER'S CONSTRUCTION COST ESTIMATE

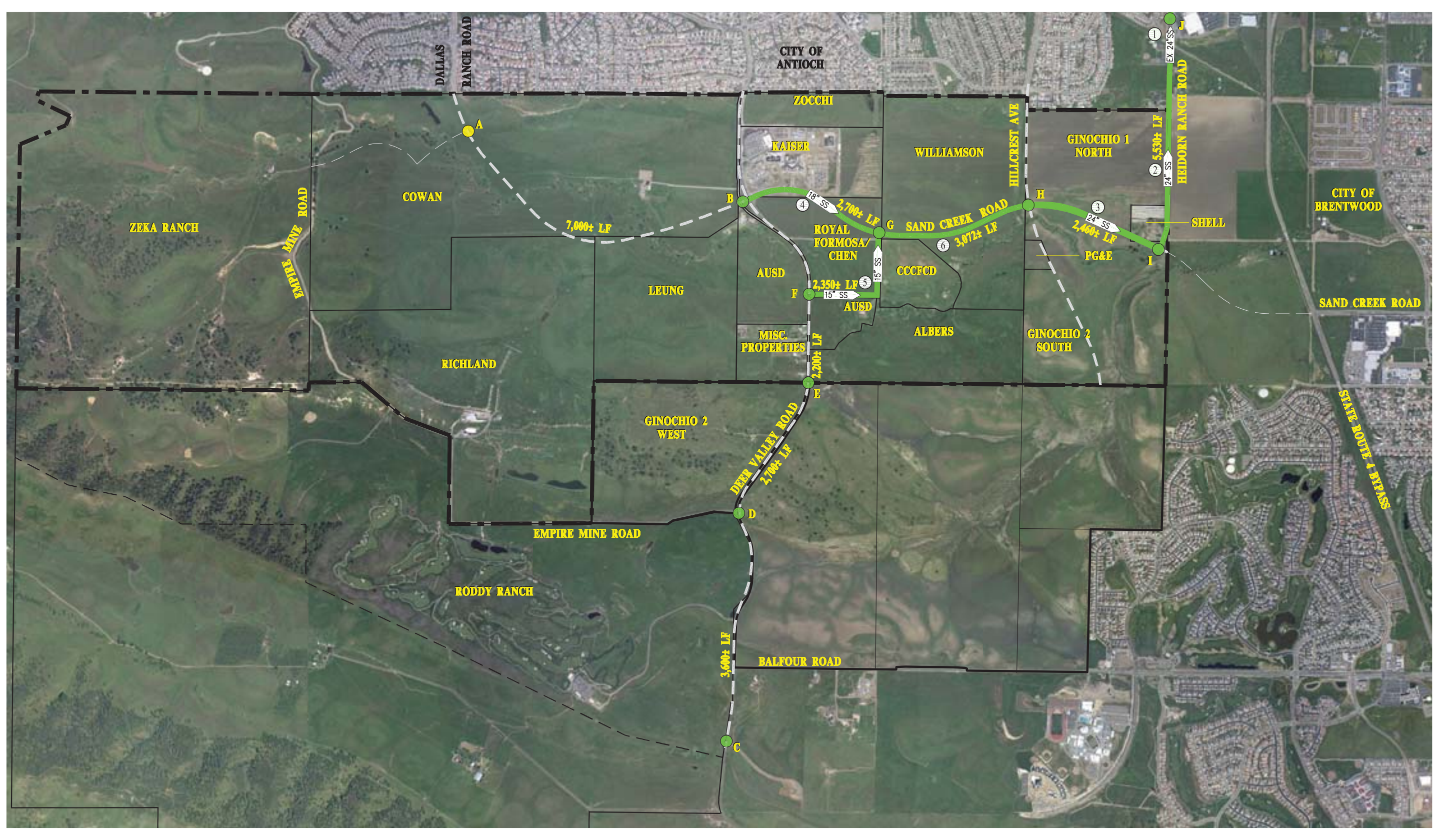


WATER

SCALE: 1" =1000'±

LEGEND:

(1) WATER INFRASTRUCTURE ITEM REFERENCED IN PRELIMINARY ENGINEER'SCONSTRUCTION COST ESTIMATE



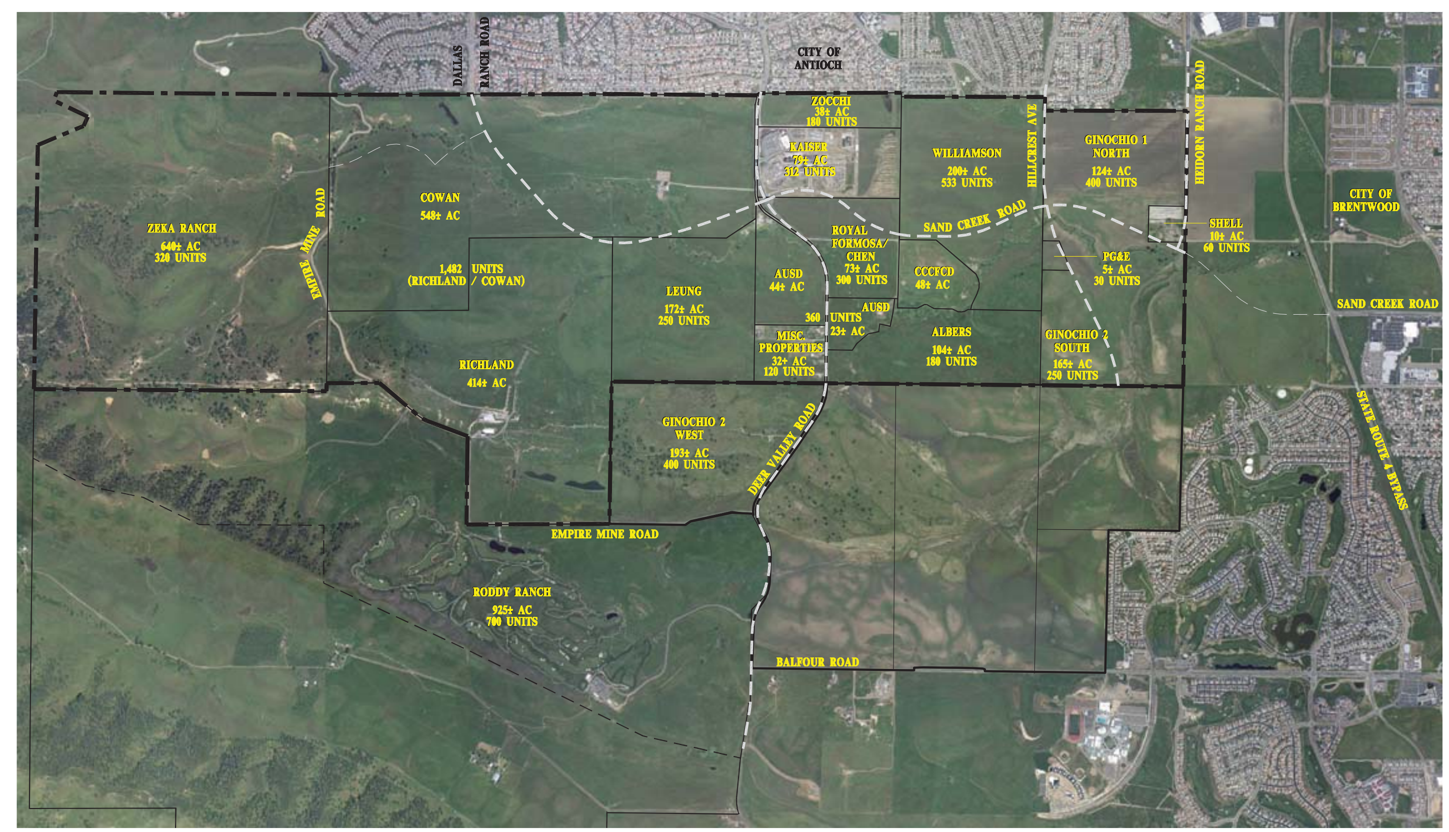
SEWER

SCALE: 1" =1000'±

LEGEND:

(2) SANITARY SEWER SEGMENT REFERENCED IN PRELIMINARY ENGINEER'S CONSTRUCTION COST ESTIMATE

C NODE DEPICTING TERMINUS OF SANITARY SEWER IMPROVEMENTS FOR COST ALLOCATION PURPOSES



PROPERTY SUMMARY

SCALE: 1" =1000'±

COST ALLOCATION EXHIBIT
COMMUNITY FACILITIES DISTRICT
FUTURE URBAN AREA 1

CITY OF ANTIOCH, CALIFORNIA

0' 1000' 3000' 4000'

SCALE : 1" = 1000'±
DATE: JUNE 20, 2007

cbg
Carlson, Barbee & Gibson, Inc.
CIVIL ENGINEERS • SURVEYORS • PLANNERS
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925-866-0322 • fax 925-866-8575
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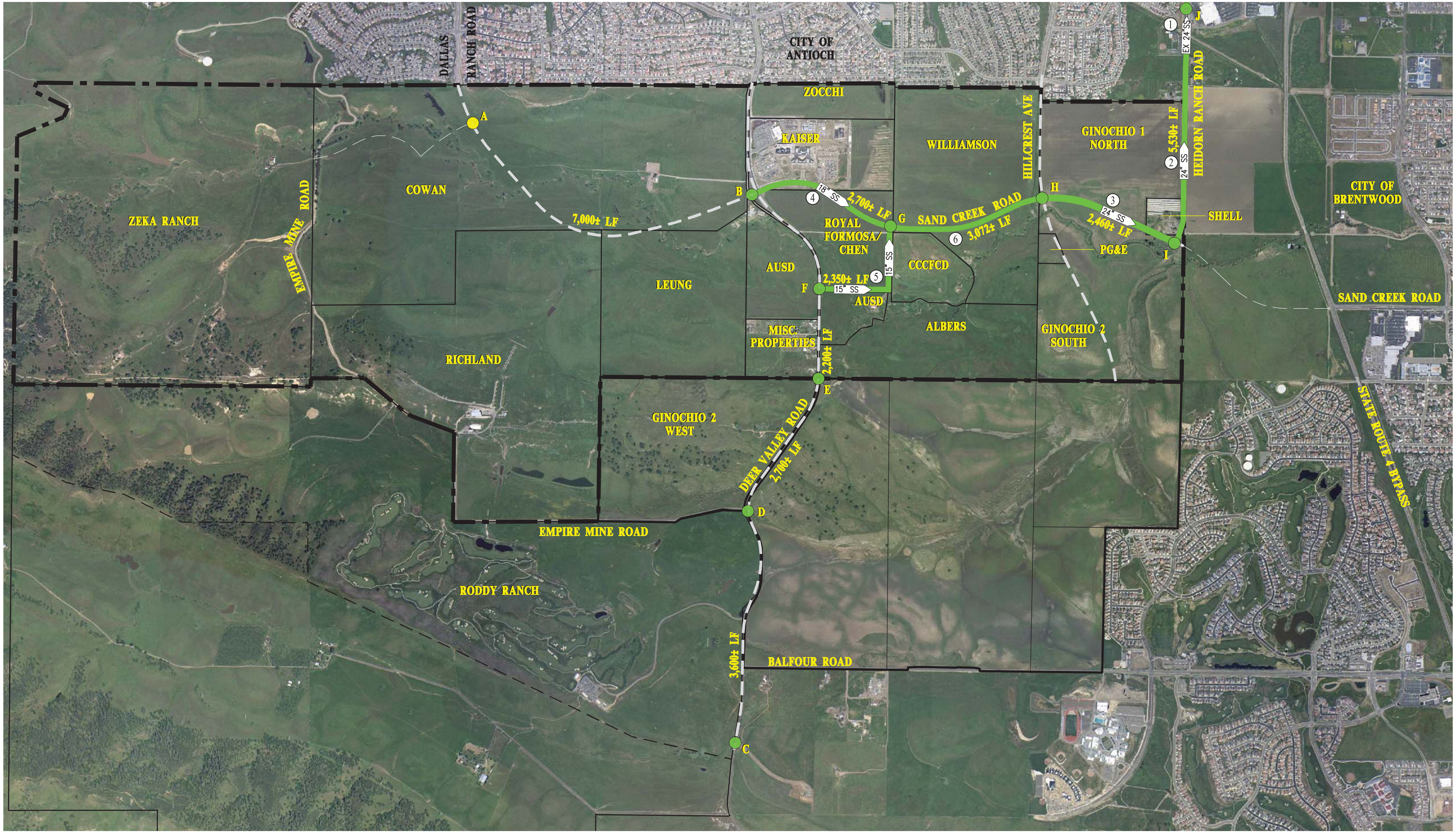


SEWER

SCALE: 1" =1000'±

LEGEND:

SANITARY SEWER SEGMENT REFERENCED IN PRELIMINARY ENGINEER'S CONSTRUCTION COST ESTIMATE

NODE DEPICTING TERMINUS OF SANITARY SEWER IMPROVEMENTS FOR COST ALLOCATION PURPOSES

Appendix D - Future Development Information – FUA 2

provisions for public transit and non-motorized forms of transportation.

ff. subject to its financial feasibility (see Policy "m"), a golf course shall be provided within the Focus Area, designed in such a way as to maximize frontage for residential dwellings. The golf course may also be designed to serve as a buffer between development and open space areas set aside to mitigate the impacts of development.

The golf course shall be designed to retain the existing trail within Sand Creek.

The golf course and Sand Creek corridor shall function as a visual amenity from the primary access road within the Focus Area (Dallas Ranch Road/Sand Creek Road). As part of the golf course clubhouse, banquet and conference facilities shall be provided.

gg. A park program, providing active and passive recreational opportunities is to be provided. In addition to a golf course and preservation of natural open space within Sand Creek and the steeper portions of the Focus Area, the development shall meet the City's established park standards. A sports complex is to be developed.

A sports complex is to be developed. The sports complex is intended to be located within the Flood Control District's detention basin.

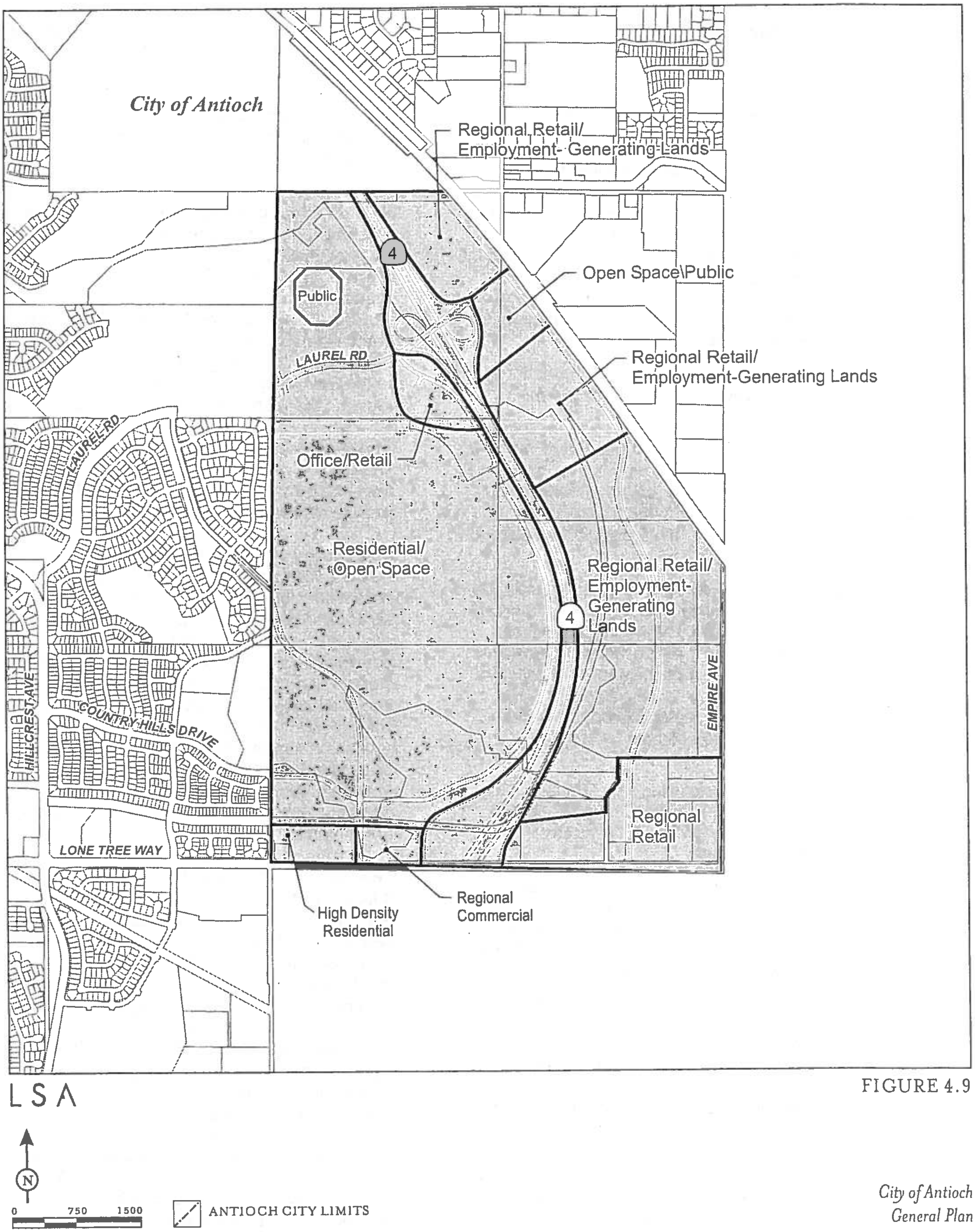
Neighborhood park facilities may be privately maintained for the exclusive use of project residents. The sports complex within the Sand Creek Detention Basin will be maintained by the City.

hh. Development of an appropriate level of pedestrian and bicycle circulation throughout the community is to be provided, including pathways connecting the residential neighborhoods, as well as non-residential and recreational components of the community. Sand Creek Focus Area development should also provide recreational trail systems for jogging and bicycling, including areas for hiking and mountain biking. Trails along Sand Creek and Horse Valley Creek shall be designed so as to avoid impacting sensitive plant and amphibian habitats, as well as water quality.

4.4.6.8 East Lone Tree Specific Plan Area. The East Lone Tree Specific Plan Focus Area encompasses approximately 796 acres in the eastern portion of the City of Antioch. It is bounded by Lone Tree Way on the south, Empire Avenue and the Southern Pacific rail line on the east, the Contra Costa Canal on the north, and existing residential subdivisions on the west (Figure 4.9). The City's previous General Plan identified the East Lone Tree Specific Plan Area as "Future Urban Area 2." The alignment of the SR-4 bypass runs through the center of the Focus Area, with interchanges proposed at Lone Tree Way and at the extension of Laurel Road.

a. Purpose and Primary Issues. City General Plan policy has long held that the lands within the East Lone Tree Focus Area should be developed for employment-generating uses, with the majority of the area developed with suburban-type business parks, incorporating major office complexes and light industrial uses, all developed in accordance with high development standards. The SR-4 By-pass runs through the middle of the Focus area, along the base of rolling hills. The eastern portion of the area is relatively flat, while the western portion of the area consists of rolling hills.

The East Lone Tree Specific Plan was adopted by the City in May 1996. The Specific Plan supports long-standing General Plan goal of a new employment center by devoting the flat eastern portion of the Focus Area to employment-generating uses. At the heart of the employment center is a proposed retail nucleus of restaurants, shops, and service providers. The Specific Plan identifies the purpose of this retail nucleus as providing a "sense of vitality and urbanity to what is otherwise a low, spread-out campus of largely internalized workplaces." The Specific Plan also encourages a commuter rail station along the existing Southern Pacific rail line to link the proposed employment center with the proposed commuter rail system. The



LSA

FIGURE 4.9

City of Antioch
General Plan

East Lone Tree Focus Area

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commuter rail station proposed in the Specific Plan will actually be located to the east of the Specific Plan (see Figure 7.1).

The Specific Plan identifies three sites as being appropriate for regional retail development. A 30-acre site at the Lone Tree Way interchange along the SR-4 Bypass is reserved in the Specific Plan exclusively for regional retail use, while two other sites, encompassing 48 acres are identified for regional retail use, but may be used for employment-generating uses. These two sites are located at the Laurel Road interchange along the Bypass, and at the intersection of Lone Tree Way and Empire Road. The East Lone Tree Specific Plan dedicates the western portion of the area primarily to detached single-family development at a density of 4 to 6 units per acre. A system of open space, trails, and parks is planned throughout the residential portion of the area.

The East Lone Tree Specific Plan, with its frontage along the SR-4 Bypass, provides Antioch with substantial opportunities for expansion of the employment and retail bases. The 98 acres devoted to employment-generating uses in the Specific Plan could provide employment for up to 2,850 workers. An additional 2,275 jobs could be created within the 78 acres reserved by the Specific Plan for "Regional Focus Area Retail/Employment" uses, if that area were to be devoted to employment-generating use. Retail and service employment could be as high as 2,025.

b. Policy Direction. The East Lone Tree Specific Plan implements General Plan policies aimed at establishing Antioch as a balanced community, providing a broad range of employment and shopping opportunities for its residents. The eastern portion of the Focus Area, east of the SR-4 Bypass, is to be devoted to employment-generating and commercial land uses, while the area west of the Bypass will be devoted to residential and open space uses, with supporting neighborhood commercial development and public uses. The eastern portion of the Focus Area was included by ABAG in its "Shaping Our Future" program[1].

Along with the provisions of the Specific Plan, the following land use policies shall apply.

a. The maximum development intensity for the East Lone Tree Specific Plan area shall be as follows:

   - Single-Family Residential: 1,100 dwelling units, developed within the areas shown as "Residential/Open Space in Figure 4.9, subject to the provisions of the Low and/or Medium Low Density Residential land use category described in Section 4.4.1.1 of the Land Use Element.
   - Multi-Family Residential: 250 dwelling units, developed within the areas shown as "Residential/Open Space in Figure 4.9, subject to the provisions of the High Density Residential land use category described in Section 4.4.1.1 of the Land Use Element.
   - Commercial/Office: 1,135,000 square feet, developed within the areas shown as "Office/Retail," "Regional Retail," or "Regional Retail/ Employment Generating Lands in Figure 4.9. Such development may include a mix of uses that comply with the provisions of the Regional Retail land use category described in Section 4.4.1.2 or the Office land use category described in Section 4.4.1.3 of the Land Use Element.

[1] "Shaping Our Future" is sponsored by 45 organizations in the Bay Area in an attempt to achieve consensus on comprehensive approaches to growth and change in Contra Costa County. The program aims to define a "smarter way to grow," including "efficient" design of development along the edges of the metropolitan area. Planning principles being followed in Shaping Our Future include reducing single occupant vehicle trips through mixed use development at "efficient" densities, developing new transit centers and focusing new development around those centers, and preserving open space and agricultural lands.

- Business Park/Industrial: 2,152,300 square feet, developed within the areas shown as "Regional Retail/Employment Generating Lands" in Figure 4.9. Such development may include a mix of uses that comply with the provisions of the Business Park or Light Industrial land use categories described in Section 4.4.1.3 of the Land Use Element.

b. Land uses within the area shown as Open Space/Public in Figure 4.9 may include a mix of uses that comply with the provisions of the Open Space or Public/Institutional land use category described in Section 4.4.1.4 of the Land Use Element.

c. If a regional mall can be attracted to the East Lone Tree Specific Plan area, the land area devoted to regional retail may be expanded as necessary to accommodate this use.

d. Should the Antioch Unified School District not purchase land within the East Lone Tree Focus Area for a new high school as provided in State law, the area may be developed consistent with the East Lone Tree Focus Area Residential/Open Space designation.

e. The physical extent of the office/retail area along in the southwest quadrant of the Laurel Road interchange may be expanded, should the market support additional office/commercial development.

f. With implementation smart growth principles and the introduction of a rail transit stop in the vicinity of the Focus Area, the Commercial/Employment area located adjacent to the transit stop, may be developed as a mixed-use area, incorporating high intensity, residential, commercial, and office uses. Such development could occur at densities as high as an FAR of 1.0 for non-residential uses and mixed-use buildings, up to 20 units per acre for residential areas. Residential development should incorporate residential village themes, providing identifiable neighborhood areas within the Focus Area. The identity of individual neighborhoods should be reinforced with differing architectural styles and location within the community.

g. Development of an appropriate level of pedestrian and bicycle circulation throughout the community is to be provided, including pathways connecting the each residential neighborhood, as well as non-residential and recreational components of the community. Development of the East Lone Tree Specific Plan area should also provide recreational trail systems for jogging and bicycling, including areas for hiking and mountain biking.

h. Public services and facilities, including needed on-site and off-site facilities, shall be provided and financed by the project as needed to meet the public services performance standards set forth in the Growth Management Element for each increment of project development.

i. Project development shall provide full mitigation of impacts on school facilities to the Antioch Unified School District, Brentwood Union School District, and Liberty Union High School District to offset demands for new school facilities created by future development within each district

j. Project entry, streetscape, and landscape design elements are to be designed to create and maintain a strong identification of the East Lone Tree Specific Plan area as an identifiable "community."

4.4.6.9 Roddy Ranch. Roddy Ranch is located in the southerly portion of the General Plan study area, within unincorporated territory. A portion of Roddy Ranch is inside the Voter-Approved Citywide Urban Limit Line (Figure 4.12). This Focus Area encompasses over 2,100 acres of rolling land used for grazing and ranching. Other existing land uses include a golf course, clubhouse, and open space. As a condition of approval for the golf course, development rights on 875 acres of land were dedicated to the County in 1998. These lands will be retained in permanent Open Space.

Appendix D - Future Development Information – Hillcrest Station Area

3.2 DEVELOPMENT PROGRAM

Total Buildout Projections

The Specific Plan creates a land use and regulatory framework that allows up to 2,500 residential units and 2.5 million square feet of commercial uses in the Station Area. The following buildout projections were prepared to assess the need for transportation and utilities infrastructure to serve development, and potential impacts on the physical environment as evaluated in the Environmental Impact Report. Growth projections are based on gross acreage of each land use category, as seen in Table 3-1. The ultimate amount of development could be more or less than projected, depending on market conditions and whether sites are built to the maximum limits. If the amount of development exceeds the projections, additional environmental review would be required.

The buildout projections are based on an assumption that the average development intensity of each land use type will be approximately the midpoint of the permitted density or intensity range. Table 3-2 details the assumptions used to calculate the buildout projections, including the percentage of land uses types within the mixed-use categories; for example, 2,100 square feet of commercial space per acre (80 square feet per unit) is assumed within the Residential TOD area. Residential units are assumed to be 1,200 gross square feet each (including lobbies, circulation, etc.) and hotel rooms are assumed to be 1,000 square feet each. A maximum of 325 hotel rooms is assumed as part of the buildout conditions. The EIR evaluated all 325 hotel rooms in the Town Center Mixed Use area; however, hotel uses could be also developed within the Transit Village area.

The amount of non residential development for each of the three Development Areas will ultimately be determined through the entitlement process, subject to the intensity, development standard, setback, subsequent environmental analysis and other requirements of this Specific Plan.

TABLE 3-1: HILLCREST STATION AREA LAND USE SUMMARY

LAND USE	GROSS ACRES	PERCENT OF TOTAL
Community Retail	13	3%
Office TOD	36.6	10%
Residential TOD	38.2	10%
Town Center Mixed Use	105.5	28%
Parks/Open Space [1]	8.6	2%
Public/Institutional – Transit Parking	17.5	5%
Public/Institutional – BART Yard & Future ROW	9.7	3%
Wetlands, Buffer & Detention Basins	41.6	11%
Industrial/Utilities – PG&E Substation	61.1	16%
Union Pacific Railroad Right-of-Way	19.5	5%
Other: Arterial Roads and Collectors	23.8	6%
TOTAL	**375.1**	**100%**

1. Except for the creek-side loop trail, the locations of the parks have not been defined. When the master plans are completed, land will be dedicated from the appropriate parcels. The amount of park/open space land is based on the estimated number of residential units and household size.

Source: Dyett & Bhatia, 2008.

TABLE 3-2: BUILDOUT ASSUMPTIONS: BUILDING INTENSITY AND DENSITY

LAND USE	TOTAL FAR	AVERAGE RESIDENTIAL DENSITY	AVERAGE SF OFFICE PER ACRE	AVERAGE SF RETAIL PER ACRE
Residential TOD	–	26	0	2,100
Office TOD	0.60	0	24,600	1,400
Town Center Mixed Use	0.75	14	2,800	6,900
Community Retail	0.25	0	0	10,800

Source: Dyett & Bhatia, 2008.

Housing Units and Population Projections

Buildout projections include a maximum of 2,500 residential units, which is the maximum allowed under the Specific Plan policies. The majority of the housing will be in multi-unit structures, some of which will be in mixed-use buildings. Based on the residential densities of the land uses in the Station Area, no single-family homes are assumed. Multi-family households are assumed to have 2.0 persons each. This assumption is based on Antioch 2000 US Census block data showing an average multi-family household size of 2.42 persons per unit; and the average household size around the Concord, Pleasant Hill, and Walnut Creek BART Stations which is 1.57 persons per unit.

TABLE 3-3: BUILDOUT PROJECTIONS: HOUSING UNITS AND POPULATION

	MULTI-FAMILY UNITS [1]	POPULATION [2]
Transit Village	1,000	2,000
Town Center	1,500	3,000
TOTAL	**2,500**	**5,000**

1. The maximum number of units allowed by the City of Antioch in the Hillcrest Station Area is 2,500.
2. Multi-family units are assumed to have 2.0 persons per household.

Source: Dyett & Bhatia, 2008.

Commercial Square Footage and Employment Projections

One of the City's goals is for this area to develop as an employment center in order to help balance the jobs/housing ratio in the City of Antioch, and improve traffic flows on SR 4. Based on the land use designations and buildout projections, the Station Area could support up to 5,600 new jobs. Up to 1.2 million square feet of office space may be built, most of which is designated in the Transit Village area. Up to 1.0 million square feet of retail space is projected at buildout. The majority of the retail space is anticipated to be built in the Town Center area. In addition, up to 325 hotel rooms are allowed in the Hillcrest Station Area. The following employment generation rates were used to estimate employment at buildout:

- Retail: 1 employee per 500 square feet gross floor area
- Office: 1 employee per 350 square feet gross floor area
- Hotel: 0.8 employees per room.

TABLE 3-4: BUILDOUT PROJECTIONS: COMMERCIAL SQUARE FOOTAGE AND JOBS

	OFFICE SF	RETAIL SF	HOTEL ROOMS	JOBS [1]
Transit Village	730,000	120,000	–	2,300
Town Center	300,000	730,000	325	2,500
Freeway Area	170,000	150,000	–	800
TOTAL	**1,200,000**	**1,000,000**	**325**	**5,600**

1. Approximate employment generation rates (values rounded):
   - Retail: 1 employee per 500 sf gross floor area
   - Office: 1 employee per 350 sf gross floor area
   - Hotel: 0.8 employees per room.

Source: Dyett & Bhatia, 2008.

Appendix D - Future Development Information – Annexation Area

CHAPTER II

PRESENT AND FORECAST CONDITIONS OF THE NORTHEAST ANTIOCH ANNEXATION AREA

CURRENT LAND USE, DEMOGRAPHIC, AND EMPLOYMENT CHARACTERISTICS OF NORTHEAST ANTIOCH ANNEXATION AREA

The forecasts of annual revenues and costs to the General Fund of the City of Antioch following the annexation of Area 1, Area 2a, and Area 2b draw on the land use, demographic and employment characteristics summarized in the following tables. Table II-1 presents the current characteristics of Area 1.

TABLE II-1

Current Land Use, Demographic, and Employment Characteristics and Assessed Value for Area 1 in Northeast Antioch Annexation Area

Built Space	Amount of Land # Acres	Building Space # Square Feet	Number of Employees #	2008 Assessed Valuation $
Georgia Pacific	36.5	196,000	97	22,965,078
PG&E Gateway Generating Station	21.44	N/A	21.5	350,000,000
Mirant Contra Costa	147.26	N/A	40	34,135,351
Other Industrial	15.11	17,269	17	2,701,225
Residential	0.35		N/A	47,193
Total Built	220.66	213,269	176	409,848,847
Vacant Land (Taxable)				
Land North of Wilbur Avenue[1]	138.25	0	0	11,430,909
Land South of Wilbur Avenue[1]	29.72	0	0	N/A
Other Industrial Land	0.30	0	0	6,699
Total Vacant	168.27	0	0	11,437,608
Total	388.93	213,269	176	421,286,455

[1] PG&E land included in acreage is assessed by State of California Board of Equalization and is not included in total 2008 assessed valuation.

Sources: Contra Costa County Assessor; 2000 Census; Gruen Gruen + Associates.

Area 1 includes developed land of approximately 221 acres with 213,000 square feet of building space, primary due to the Georgia Pacific plant. The PG&E Generating Station under development with an expected completion date of January 2009 is in Area 1 as is the existing Mirant Contra Costa plant. Approximately 168 acres of land is vacant. The PG&E Generating Station at $350 million comprises much of the assessed valuation. The other major sources of assessed valuation are the Georgia Pacific Plant (almost $23 million) and the Mirant Contra Costa plant (currently approximately $34 million). While Area 1 has a very small amount of land zoned for residential use, no households presently live in the area. The businesses in Area 1 are estimated to provide jobs for 176 workers.

Table II-2 presents the current characteristics of Area 2a.

TABLE II-2

Current Land Use, Demographic, and Employment Characteristics and Assessed Value for Area 2a in Northeast Antioch Annexation Area

Built Space	Amount of Land # Acres	Building Space # Square Feet	Number of Employees or Residents #	2008 Assessed Valuation $
Light Industrial[1]	56.06	95,035	95	7,170,637
Commercial Boat Harbors	34.43	5,145	10	4,051,248
Residential	3.06	0	9	442,656
Total	93.55	100,180	105 employees 9 residents	11,664,541

[1] Includes Kiewit Construction and Monterey Mechanical, which together occupy 82,000 square feet of space and employee 82 workers.

Sources: Contra Costa County Assessor; 2000 Census; Gruen Gruen + Associates.

Area 2a includes a light industrial and boat harbor area of approximately 56 acres and 34 acres of land, respectively. The light industrial area contains approximately 95,000 square feet of building space associated primarily with the operations of Kiewit Construction and Monterey Mechanical. Area 2a employers provide jobs for an estimated 105 workers. Included in Area 2a is approximately three acres of residentially-zoned land.

Table II-3 presents the current characteristics of Area 2b.

TABLE II-3

Current Land Use, Demographic, and Employment Characteristics and Assessed Value for Area 2b in Northeast Antioch Annexation Area

Built Space	Amount of Land # Acres	Building Space # Square Feet	Number of Employees or Residents #	2008 Assessed Valuation $
Single-family and Multi-family Residential1	59.25	90	264	17,762,858
Commercial[2]	6.56	7,949	16	1,604,491
Industrial	8.58	0	0	832,319
Institutional	8.27	0	0	34,920
PG&E Land[3]	19.04	0	0	N/A
Total	101.70	7,949 square feet 90 households	16 employees 264 residents	20,234,588

[1] Number of residents is based on 2000 Census data.
[2] Employment in Area 2b is based on assumption of one employee per 500 square feet of commercial space.
[3] PG&E land is assessed by State of California Board of Equalization and is not included in total 2008 assessed valuation.

Sources: Contra Costa County Assessor; 2000 Census; Gruen Gruen + Associates.

Area 2b consists of approximately 102 acres of land. Approximately 59 acres of land includes primarily residential uses and 264 residents. The properties have an assessed valuation of $17.8 million. Area 2b includes relatively small amounts of commercial, industrial, and institutional land with relatively low assessed valuations and 19 acres of vacant PG&E land parcels used for right-of-way.

LAND USE, DEMOGRAPHIC, AND EMPLOYMENT CHARACTERISTICS OF NORTHEAST ANTIOCH ANNEXATION AREA FORECAST AT THE BUILD-OUT CONDITION IN THE FUTURE

Table II-4 summarizes the estimated land use, demographic and employment characteristics of the Northeast Antioch annexation area when the area is fully built-out in the future. Appendix A presents detailed tables summarizing the forecast of conditions when Areas 1 and 2a are fully built-out in the future. Area 2b is assumed to not change. Based on information from the Community Development Department, the existing zoning is assumed to be "grandfathered in" and essentially preserve the existing development pattern patterns and uses. The forecast of future Antioch General Fund revenues and costs induced by the annexation of Area 1, Area 2a, and Area 2b reflect the assumptions about the future characteristics of the proposed Northeast Antioch annexation area.

TABLE II-4

Forecast Northeast Antioch Annexation Area Conditions at Full Build-out in the Future

	Area 1	Area 2a	Area 2b	Total
Total Land (# acres)	388.934[1]	93.55	101.7	584.184
Vacant Land (# acres)	0.3	0	19.04	19.34
Building Space (# s.f.)	2,171,923	772,597	7,949	2,952,469
Number of Employees[2]	1,855	1,529	16	3,400
Number of Households	0	3	90	93
Number of Residents	0	9	264	273
Number of Resident Equivalents[3]	927	774	272	1,973
Future Assessed Valuation	$1,418,655,614	$158,240,881	$20,234,588	$1,597,131,083

[1] Federal and state owned non-taxable land in proposed annexation Area 1 total 88.95 acres and is not included in the 388.934 figure.
[2] Employment estimates for Area 1 are based on discussions with businesses in area; employment estimates for Area 2a are based on discussions with businesses in area and the assumption of one employee per 1,000 square feet of building space for existing space, and two employees per 1,000 square feet for redeveloped space. Employment estimates for Area 2b are based on the assumption of one employee per 500 square feet of building space because space is commercial in nature.
[3] Assumes municipal revenues and costs generated by every two employees equal that of one resident.

Sources: City of Antioch; Contra Costa County Assessor; 2000 Census; Colliers International; Gruen Gruen + Associates.

The 168 acres of land both north and south of Wilbur Avenue in Area 1 is assumed to be redeveloped into industrial and warehouse uses. Based on discussions with local real estate brokers and the Director of Economic Development for Antioch, the vacant land north of Wilbur Avenue, which includes the former Kemwater 18-acre site, the 107.82 acres owned by Forestar Real Estate Group (the former Temple Inland site), and approximately 12 acres owned by PG&E, is likely to be developed with heavy industrial uses. Assuming a floor-area ratio of 0.25 for heavy industrial uses results in an estimate of building space at build-out of 1.5 million square feet. The resulting employment of 753 workers is based on the assumption of ½ worker per 1,000 square feet of building space. Heavy industrial space is expected to be constructed at a cost of $80 per square foot resulting in total added assessed value of $120.4 million.

PG&E owns approximately 30 acres of vacant land south of Wilbur Avenue in Area 1. Based on discussions with local real estate brokers and the Director of Economic Development for Antioch, the vacant land is anticipated to be developed in the future with multi-tenant light industrial uses. Assuming a floor-area ratio of 0.35 for light industrial uses results in an estimate of potential building area of over 450,000 square feet of space. The resulting employment estimate of 906 workers is based on the assumption of two workers per 1,000 square feet of building space. Light industrial space is expected to be constructed at a total cost of $195 per square foot resulting in total added assessed value of $88.4 million.

Mirant has filed an application seeking approval to build a new power plant, Marsh Landing, within its existing Mirant Contra Costa facility in Area 1. The value of the construction improvements is estimated to total $800 million. According to a Mirant representative, the drycooled units will come on line in summer 2011, and the combined cycle units will come on line in summer 2012. Construction is expected to take 33 months. Once complete, the new Mirant plant will employ 20 full-time workers

Under the assumptions outlined above about the potential future build-out of Area 1, 1,679 new workers will be employed and nearly two million square feet of new industrial space (excluding the new Mirant plant) would be developed. Under this build-out scenario, the future assessed value of Area 1 will increase by $997.4 million to nearly $1.4 billion.

Within Area 2a, approximately 53 acres land is assumed to be redeveloped into industrial/warehouse uses. The redevelopment in Area 2a is assumed to occur for the approximately 38-acre Kiewit Construction property, much of which is presently used for outdoor equipment storage, and the approximately 15-acre Antioch Trailer Storage property. Development of these two properties is assumed to add approximately 670,000 square feet of industrial space and over 1,400 new workers. This scale of redevelopment and employment growth assumes a floor-area ratio of 0.35 and two workers for every 1,000 square feet of building space. The construction of the new space of approximately 670,000 square feet is assumed to be built at a total cost of $195 per square foot of building space. Under this build-out scenario, the assessed value of Area 2a is forecast to increase by $146.6 million to an assessed value of $158.2 million.

Note that according to data from the Colliers International 3rd Quarter 2008 Industrial Market Report, Antioch currently contains approximately 3.3 million square feet of industrial space. Approximately 736,000 square feet or 22 percent of the industrial space inventory is vacant. The interviews suggest that the East 18th Street Specific Plan Area south of Area 1 represents another location for industrial space users in Antioch. The availability of deep water access and docks, significant contiguous land, and the potential for a stream-lined permitting process for heavy industrial users are comparative advantages that can be capitalized upon. In the near term, however, the most assured revenue-generating sources for the Antioch General Fund are the PG&E Generating Plant and the proposed Mirant plant. Accordingly, the analysis also identifies whether the revenue from these two uses in Area 1 would be sufficient to offset the costs of providing services to Areas 2a and 2b.

Appendix D - Future Development Information – Project Pipeline

Excerpts from City of Antioch Project Pipeline (May 2013)

Residential Projects

Project Number(s)	Project	Applicant	Location	APN	Units	Site Size	Status	Planner	RMC Note
RDA-03-07 PD-04-14 UP-04-30 AR-05-23 AR-07-17	Almondridge East Tract 7906	KB Associates 6700 Knoll Center Parkway Pleasanton, CA 92821	Philips Lane	051-200-061 051-200-071	81 SFD	21 acres	In plan check Model Plans & on Site Plans Approved PC approved 6/18/08 CC approved 7/8/08 Final map approved	Gentry	Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code.
AR-06-09 UP-01-25	Black Diamond Ranch 7487, 8585, 8586	Discovery Builders 4061 Port Chicago HWY #1 Concord, CA 94524	Somersville Road and James Donlon		Unit 1 58 SFD Unit 2 117 SFD Unit 3 105 SFD		Built Under Const Under Const		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code
MDP-08-01	Bridle Ranch Master Development Plan	Richfield Investment Corp. 10001 Westheimer Rd., Ste 2888 Houston, TX 77042	5599 Empire Mine Road NW corner of Empire Mine Road and Deer Valley Road	057-060-006	Approx. 370 executive SFD		In progress		Part of FUA-1 Development Area.
MDP-06-02 RDA-07-05	Deer Valley Estates	Allied Investments 1033 Detroit Avenue Concord, CA 94520	Off Deer Valley Road north of Kaiser	057-02-002	136 SFD	37.25	MDP approved		Previously Subdivided - sewer flows captured by billing data or vacant parcel
RDA-03-05	Golden Bow Estates 8538	Dhyanyoga Centers P.O. Box 3194 Antioch, CA 94531	Off Lexington	076-031-036	12 SFD		Approved 1 Unit in Plan Check 1 Unit under const.	Gentry	Previously Subdivided - sewer flows captured by billing data or vacant parcel
AR-04-40	Hidden Glen 6909,7505, 8387, 8388	Arcadia Homes 115 Coleman Avenue San Jose, CA 95110	Off Hillcrest at Hidden Glen		Unit 1 89 SFD Unit 2 81 SFD Unit 3 111 SFD Unit 4 90 SFD		Under Const Under const. Approved Approved	Gentry	Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code.
UP-11-07	Meritage New Models at Hidden Glen (Copper Ridge)	Scott Kramer Meritage Homes 1671 East Monte Vista Ave. #214 Vacaville, CA 95688	Hidden Glen @ Hillcrest Avenue		Purchased 191 lots from Arcadia Dev.		PC approved 6/1/11 CC on 6/28/11 Under Construction		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code.
AR-03-33	Mira Vista Hills 6708, 6921	Albert D Seeno Construction 4021 Port Chicago Highway Concord, CA 94524	Off James Donlon at east of Somersville		Unit 13 95 SFD Unit 16 85 SFD		Under Construction Complete		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code
UP-04-01 AR-07-07	Monterra (Nelson Ranch) 6893, 8850, 8851	Standard Pacific Housing 3825 Hopyard Road #195 Pleasanton, CA 94588	Wild Horse Road off of Hillcrest Ave.	052-061-039	Unit 1 102 SFD Unit 2 128 SFD Unit 3 130 SFD	145 acres	Under Construction Under Construction Approved		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code
UP-08-04 AR-05-05 Z-09-02	Park Ridge	Davidon 1600 S Main Street Ste 150 Walnut Creek, CA 94596	Canada Valley Road	053-060-023	525 SFD	171 Acres	PC approved 1/20/10 CC approved 3/23/10	Gentry	Part of FUA-2 Development Area.
MDP-05-01 RDA-07-01 PD-09-03 UP-09-05	Aviano	Pulte Homes 6210 Stone Ridge Mall 5th Floor Pleasanton, CA 94588	At the end of Heidorn Ranch Road	057-030-001 057-050-013	553 Del Webb adult community	189 acres	Approved		Part of FUA-1 Development Area.
PDP-12-01	Quail Cove	Discovery Builders, Inc. 4061 Port Chicago Hwy, Suite H Concord, CA 94520	Prewett Ranch Dr. & Summerfield Dr.	056-130-012	31 SFD	5.59 acres	In Progress	Gentry	Ok
RDA-07-03 PD-07-03 UP-08-05 AR-08-07	Roddy Ranch	Roddy Ranch PBC, LLC 12885 Alcosta Blvd., Suite A San Ramon, CA 94583	West of Deer Valley Road South of Empire Mine Road	057-060-017	574 SFD +/- 100 multi family Hotel		RDAC approved 9/29/08 Environmental Document in progress	Gentry	Part of FUA-1 Development Area.
AR-05-01	Sand Creek Ranch 8640, 8885, 8948	William Lyons Homes 2603 Camino Ramon #150 San Ramon, CA 94583	Off Canada Valley Road & Lone Tree Way		8640 69 SFD 8885 42 SFD 8948 52 SFD		Built Under Const Under Const		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code
UP-08-06 AR-08-09	Sand Creek Ranch Rivergate 8640, 8886, 8951	Shea Homes 2580 Shea Center Drive	Off Canada Valley Road & Lone Tree Way		8640 28 SFD 8886 30 SFD		Under Const Under Const		Previously Subdivided - sewer flows captured by

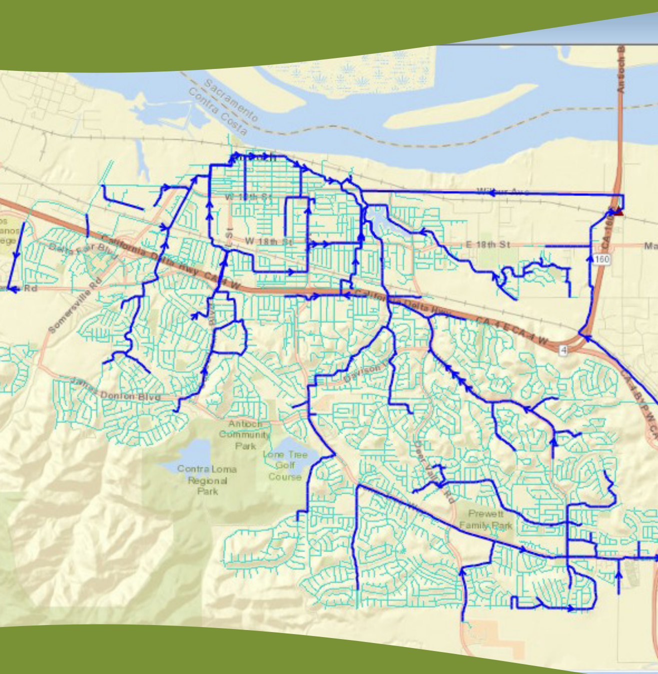
Project Number(s)	Project	Applicant	Location	APN	Units	Site Size	Status	Planner	RMC Note
		Livermore, CA 94551			8951 156 SFD		Proposed unit mix change PC approved 7/2/08 DRB approved 7/9/08 Council approved 8/12/08 Extension granted to 8/12/11		billing data or vacant parcel assessor code.
UP-04-28	Sierra Vista 7722	Suncrest Homes 300 H Street Antioch, CA 94509		075-052-016	50 SFD		Approved		Previously Subdivided - sewer flows captured by billing data or vacant parcel assessor code.
UP-11-08 AR-11-05	Tabora Gardens	Ryan Chao, Executive Director Satellite Housing 1521 University Avenue Berkeley, CA 94703	Southeast corner of James Donlon & Tabora Drive	072-011-062	85 unit affordable senior apartment project		PC Approved 9/21/11 CC Approved	Gentry	Ok
PDP-06-03 RDA-07-02 PD-08-01 UP-08-01 AR-08-03	The Pointe	Discovery Builders 4061 Port Chicago Hwy #H Concord, CA 94520	North of James Donlon at Somersville	089-160-010	60 SFD		RDA approved 1/22/08 Environmental Review In Progress	Gentry	Ok

Commercial Projects

Project Number(s)	Project	Applicant	Location	APN	Bldg Sq Ft Description	Site Size	Status	Planner	Comment
AR-11-07	2100 L Street	Tim Jones c/o Burk Properties P. O. Box 613 Lafayette, CA 94549	2100 L Street	074-343-034	Construct 6.870 sf retail building on vacant land	.774 acre	PC approved on 2/1/12 Under Building Permit Review	Gentry	
UP-05-02	Bluerock Business Center	Reynolds & Brown 1200 Concord Ave #200 Concord, CA 94520	Blue Rock Drive at Lone Tree Way	072-490-001	122,856 sq ft office/retail approved		101, 256 sq ft built	Wehrmeister	21,600 sq ft to be added.
PD-07-01 UP-07-06 AR-07-08	Buchanan Crossings Shopping Center		Buchanan Road at Somersville	074-080-013	102,370 square foot shopping center	13.5 acres	PC approved 7/2/08 CC approved 8/12/08 In plan check	Gentry	
UP-05-35 AR-06-07	Deer Valley Business Park Parcel 1 + Bldgs N, O, P	MS Walker & Associates, Inc 3551 Pegasus Drive Bakersfield, CA 93308	SW Deer Valley at Country Hills	055-071-111	16 single user/multi tenant bldgs 1800-7000 sq ft	6 acres	DRB approved 1/17/07	Gentry	18,000 sq ft already constructed. FAR 0.5 assumed for parcel.
PD-06-04 UP-06-21 S-08-01	Hillcrest Summit	Bedrock Ventures Inc. 4045 Balfour Avenue Oakland, CA 94610	Hillcrest Avenue and E Tregallas	052-100-069 052-100-068	1500 sq feet retail 35,077 sq ft office	5 acres	PC approved 1/16/08 DRB approved 1/23/08 City Council approved 2/26/08 In plan review Approvals Extended to 2/26/13 Requested approval extension until 2/26/15	Gentry	
FD-03-06 UP-03-26 AR-03-38	Kaiser Medical Center	Kaiser Foundation Hospitals 1950 Franklin Street 12th Flr Oakland, CA 94605	6200 Deer Valley Road	057-022-003	500,000 sq ft hospital 450,000 sq ft medical offices		340,400 sq ft hospital built 313,050 sq ft offices built	Gentry	In FUA-1 Development Area
AR-04-26 UP-04-21	Lone Tree Landing	John Tomasello 516 Nelly Court Alamo, CA 94507	Lone Tree Way at Hillcrest	056-470-002 056-470-003 056-470-004	81,690 sq feet retail center	413,790 sq ft	25,000 sq ft built		

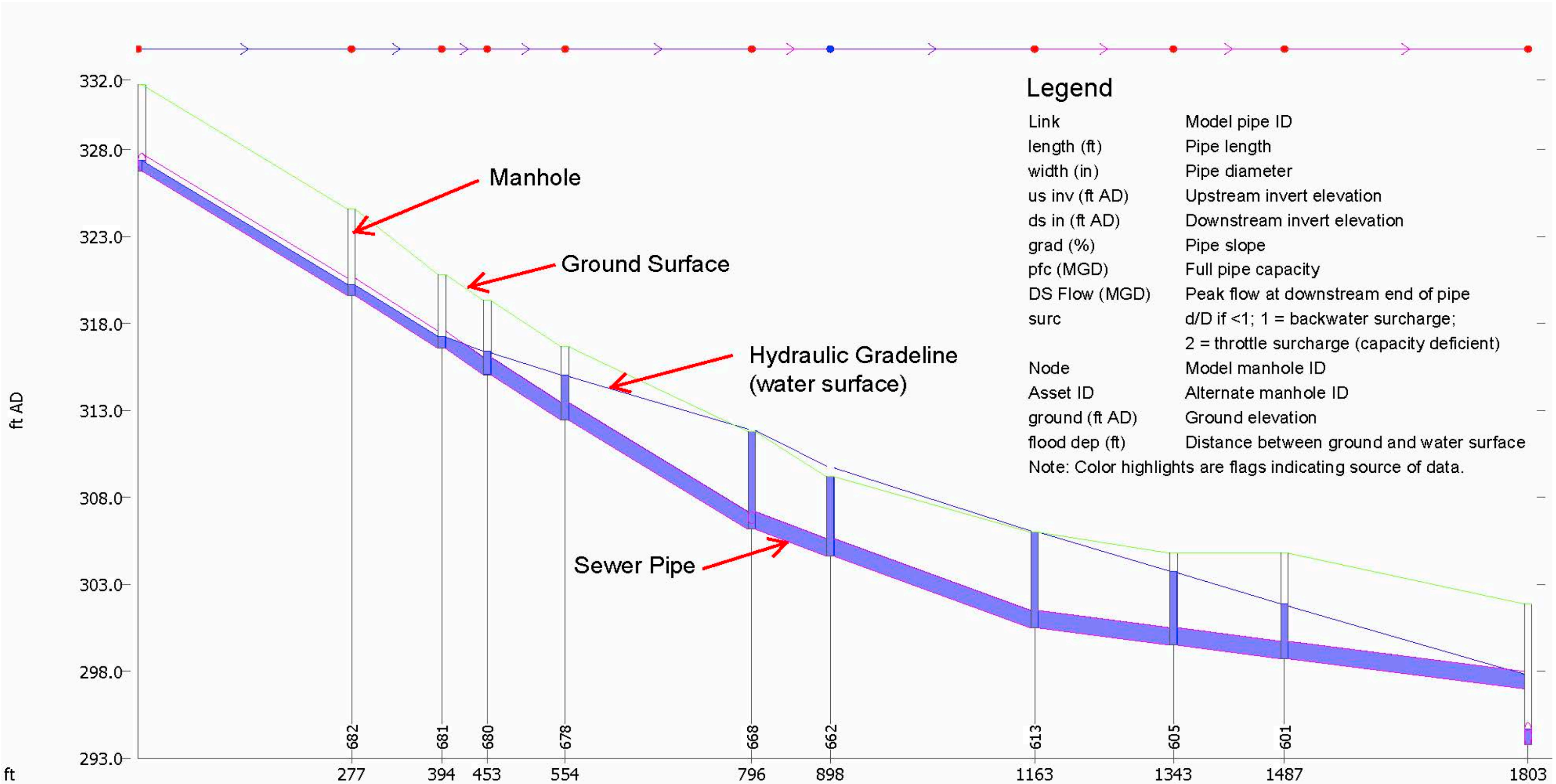
Appendix E

Model Hydraulic Profiles



City of Antioch Wastewater Collection System Master Plan

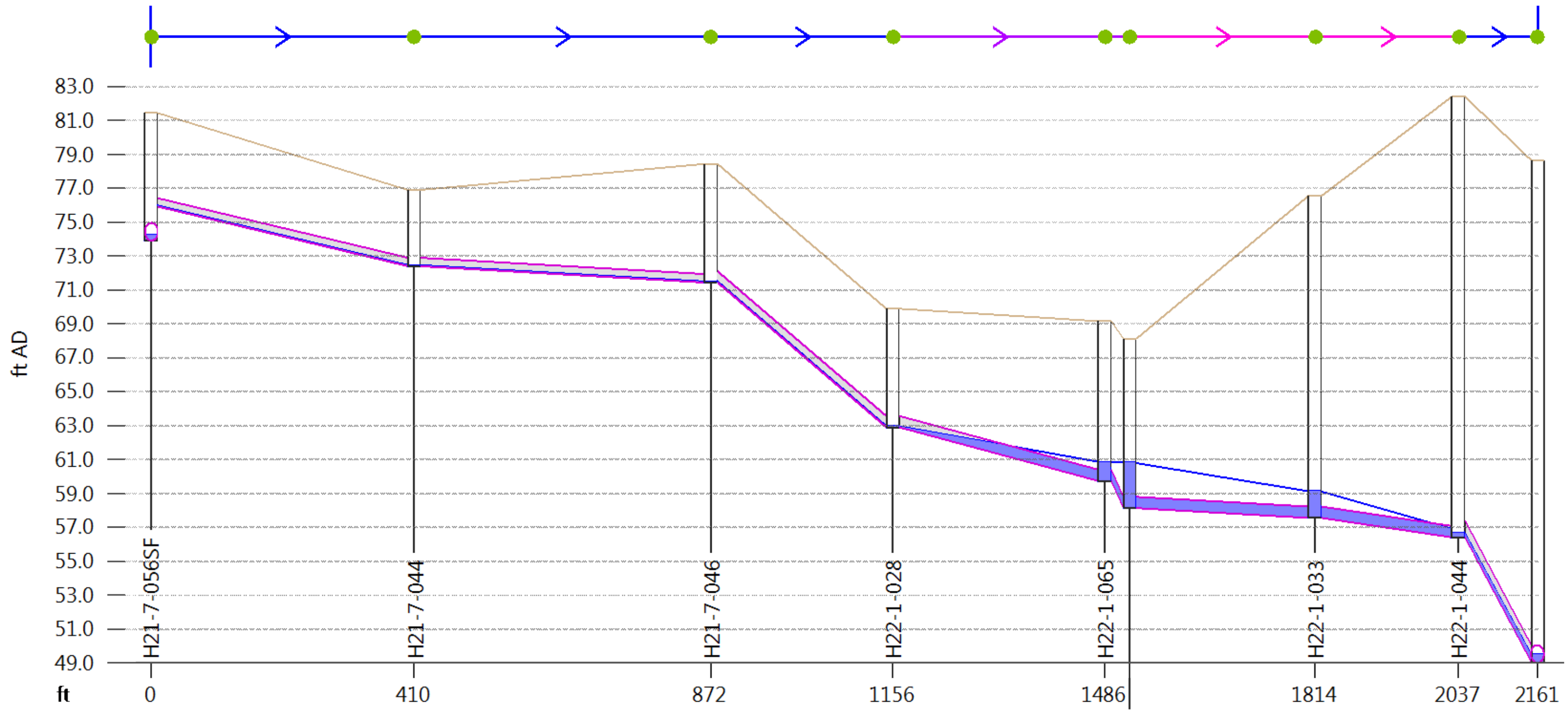
Profile Legend



Link	5837.1	682.1	681.1	680.1	678.1	668.1	662.1	613.1	605.1	601.1
length (ft)	277.0	117.0	59.0	101.0	242.0	102.0	265.0	180.0	144.0	316.0
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
us inv (ft AD)	326.783	319.613	-	315.058	312.444	306.180	304.630	300.500	299.510	298.730
ds inv (ft AD)	319.613	316.585	-	312.444	306.180	304.630	300.500	299.510	298.730	297.000
grad (%)	2.588	2.588	2.588	2.588	2.588	1.520	1.558	0.550	0.542	0.547
pfc (MGD)	3.71	3.71	3.71	3.71	3.71	2.84	2.88	1.71	1.70	1.70
DS Flow (MGD)	2.30485	2.30576	-	2.53147	2.54765	3.45051	2.62876	2.55746	2.54577	2.54206
surc	0.61	0.67	1.00	1.00	1.00	2.00	1.00	2.00	2.00	2.00

Node	5837	682	681	680	678	668	662	613	605	601	593
Asset ID											
ground (ft AD)	331.750	324.583	-	-	316.667	311.800	309.200	306.000	304.800	304.800	301.880
flood dep (ft)	-4.370	-4.361	-3.582	-2.929	-1.630	-0.000	0.000	-0.000	-1.040	-2.921	-7.190

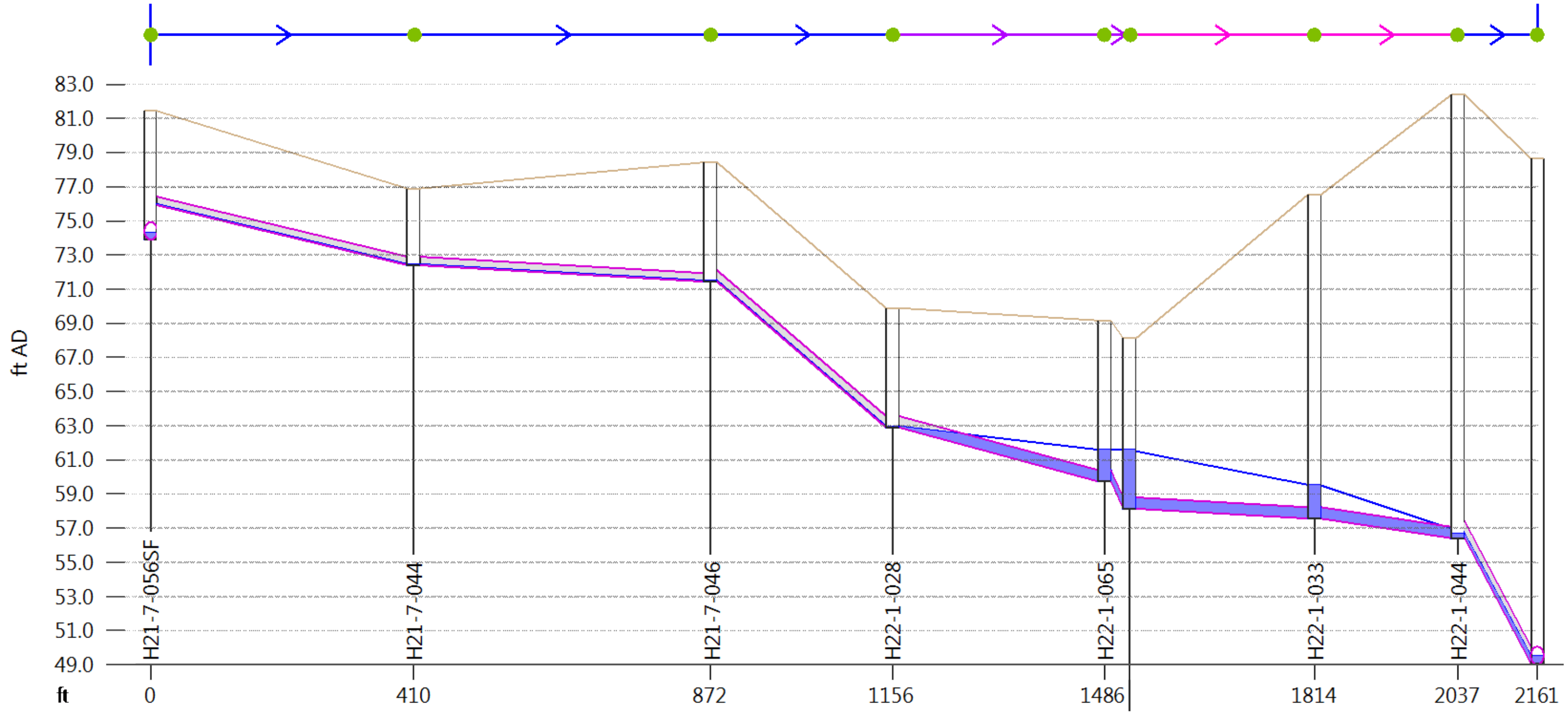
Location 1: Existing Scenario



Link		H21-7-056SF.2	H21-7-044.1	H21-7-046.1	H22-1-028.1	-	H22-1-029.1	H22-1-033.1	-	
length (ft)		410.0	462.4	283.4	330.2	-	288.5	223.1	123.9	
width (in)		6.0	6.0	8.0	8.0	-	8.0	8.0	12.0	
us inv (ft AD)		75.920	72.400	71.440	62.900	-	58.140	57.560	56.410	
ds inv (ft AD)		72.403	71.440	62.900	59.740	-	57.563	56.410	49.050	
grad (%)		0.858	0.208	3.014	0.957	-	0.200	0.515	5.942	
pfc (MGD)		0.34	0.17	1.36	0.76	-	0.35	0.56	5.61	
surc		0.13	0.13	0.10	1.00	-	2.00	2.00	0.45	
DS flow (MGD)		0.00000	0.00000	-0.00000	-0.00580	-	0.58301	0.75504	-	

Node	-	H21-7-044	H21-7-046	H22-1-028	-	-	H22-1-033	-	-
ground (ft AD)	81.440	76.903	78.440	69.900	69.170	68.142	76.563	82.410	-
flood dep (ft)	-7.176	-4.437	-6.934	-6.934	-8.301	-7.274	-17.429	-25.728	-

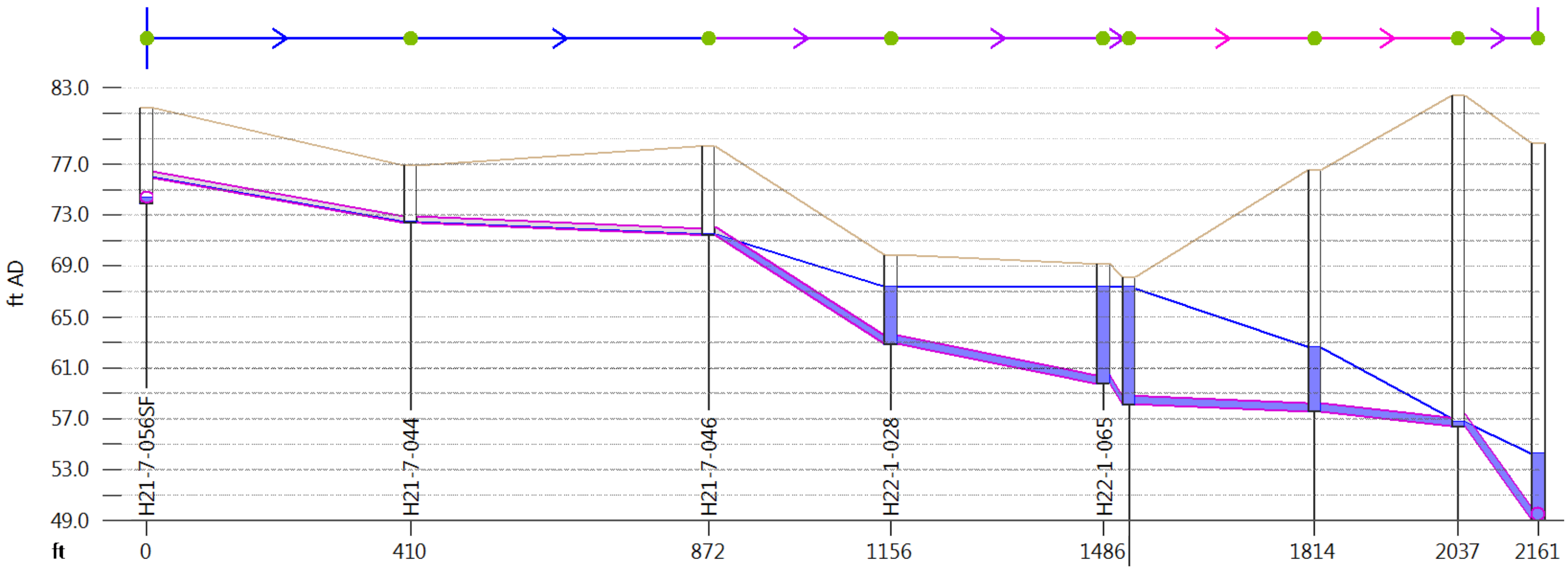
Location 1: Future Scenario A/ Scenario B



Link		H21-7-056SF.2	H21-7-044.1	H21-7-046.1	H22-1-028.1	-	H22-1-029.1	H22-1-033.1	-
length (ft)		410.0	462.4	283.4	330.2	-	288.5	223.1	123.9
width (in)		6.0	6.0	8.0	8.0	-	8.0	8.0	12.0
us inv (ft AD)		75.920	72.400	71.440	62.900	-	58.140	57.560	56.410
ds inv (ft AD)		72.403	71.440	62.900	59.740	-	57.563	56.410	49.050
grad (%)		0.858	0.208	3.014	0.957	-	0.200	0.515	5.942
pfc (MGD)		0.34	0.17	1.36	0.76	-	0.35	0.56	5.61
surc		0.13	0.13	0.10	1.00	-	2.00	2.00	0.48
DS flow (MGD)		0.00000	0.00000	-0.00000	-0.01335	-	0.63683	0.82006	-

Node	-	H21-7-044	H21-7-046	H22-1-028	-	-	H22-1-033	-	-
ground (ft AD)	81.440	76.903	78.440	69.900	69.170	68.142	76.563	82.410	-
flood dep (ft)	-7.136	-4.437	-6.934	-6.934	-7.573	-6.546	-17.030	-25.719	-

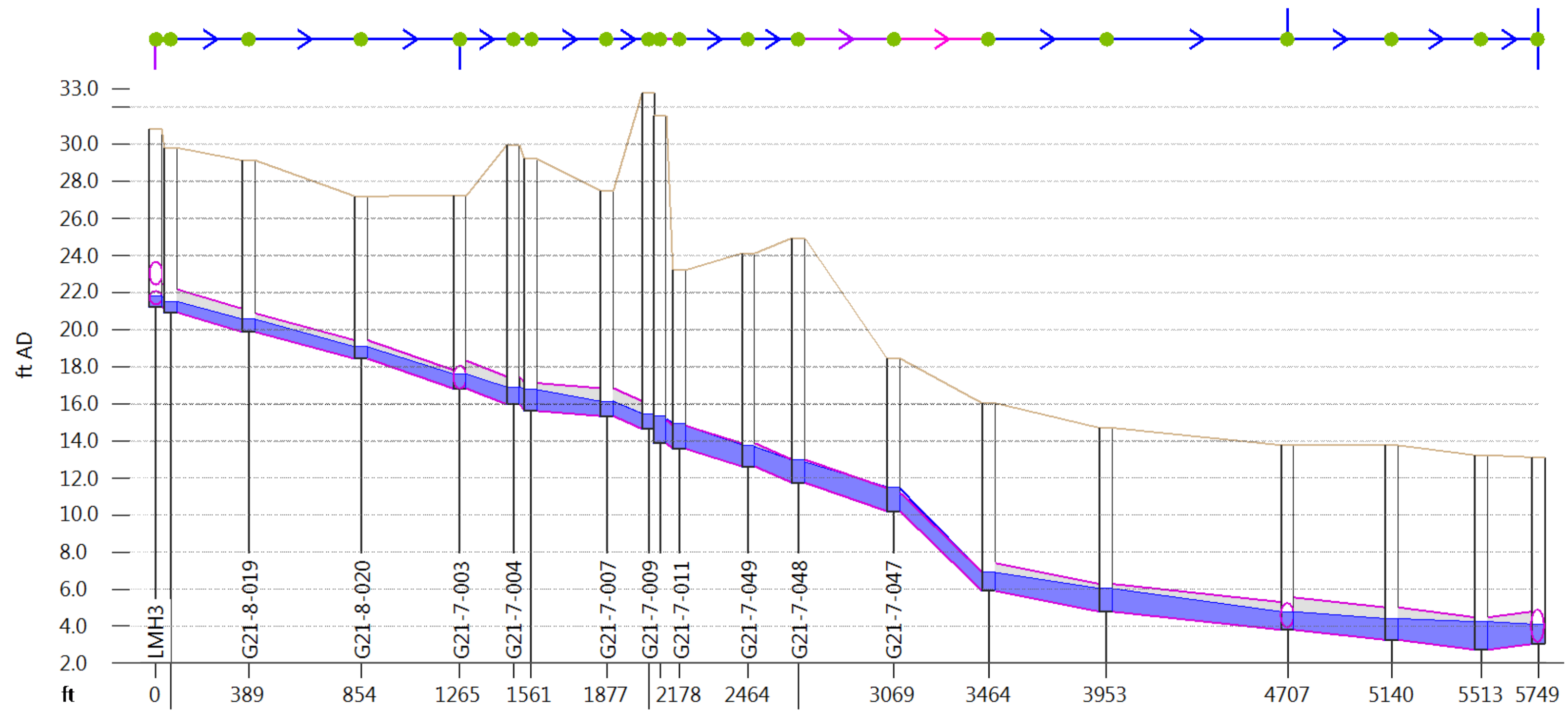
Location 1: Future Scenario C



Link		H21-7-056SF.2	H21-7-044.1	H21-7-046.1	H22-1-028.1	-	H22-1-029.1	H22-1-033.1	-
length (ft)		410.0	462.4	283.4	330.2	-	288.5	223.1	123.9
width (in)		6.0	6.0	8.0	8.0	-	8.0	8.0	12.0
us inv (ft AD)		75.920	72.400	71.440	62.900	-	58.140	57.560	56.410
ds inv (ft AD)		72.403	71.440	62.900	59.740	-	57.563	56.410	49.050
grad (%)		0.858	0.208	3.014	0.957	-	0.200	0.515	5.942
pfc (MGD)		0.34	0.17	1.36	0.76	-	0.35	0.56	5.61
surc		0.13	0.13	1.00	1.00	-	2.00	2.00	1.00
DS flow (MGD)		0.00000	0.00000	-0.01140	-0.03083	-	0.97377	1.21514	-

Node	-	H21-7-044	H21-7-046	H22-1-028	-	-	H22-1-033	-	-
ground (ft AD)	81.440	76.903	78.440	69.900	69.170	68.142	76.563	82.410	-
flood dep (ft)	-7.086	-4.437	-6.934	-2.518	-1.789	-0.762	-13.927	-25.662	-

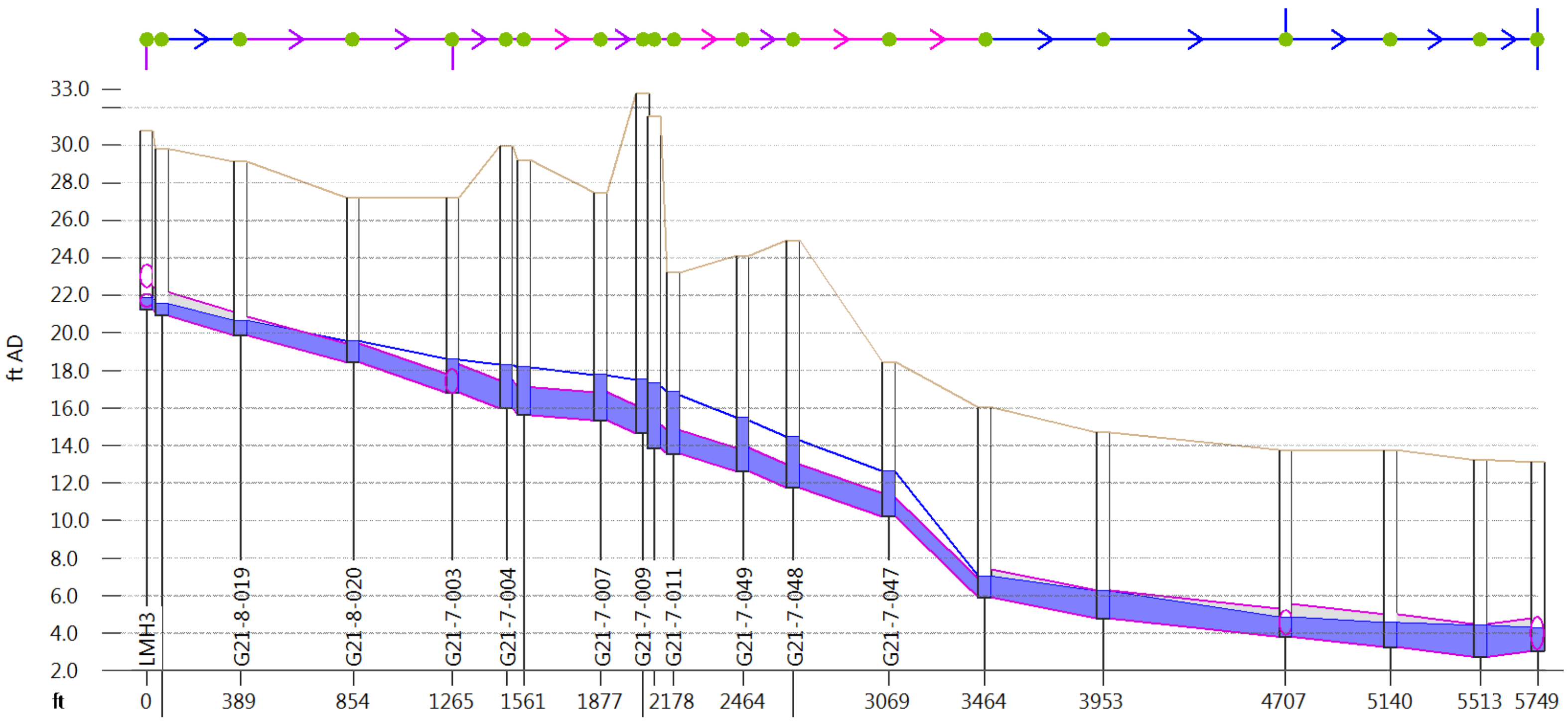
Location 2: Existing Scenario



Link	-	-	-	-	-	-	-	-	-	-	-	F21-9-025.1	-	-	-
length (ft)	325.1	465.4	410.8	-	316.0	-	286.1	-	395.8	395.3	488.7	754.0	433.4	372.3	-
width (in)	15.0	12.0	12.0	18.0	18.0	-	15.0	15.0	15.0	12.0	18.0	18.0	21.0	21.0	21.0
us inv (ft AD)	20.920	19.870	18.430	-	15.610	-	13.560	-	11.740	10.200	5.900	4.780	3.800	3.260	-
ds inv (ft AD)	19.870	18.430	16.820	-	15.340	-	12.620	-	10.200	5.900	4.780	3.800	3.260	2.730	-
grad (%)	0.323	0.309	0.392	-	0.085	-	0.329	-	0.389	1.088	0.229	0.130	0.125	0.142	-
pfc (MGD)	2.37	1.28	1.44	4.20	1.98	-	2.39	2.71	2.60	2.40	3.25	2.45	3.62	3.86	-3.71
surc	0.53	0.66	0.76	0.60	0.75	-	0.96	0.96	1.00	2.00	0.82	0.82	0.64	0.85	0.85
DS flow (MGD)	-	0.98880	0.98876	-	-	-	-	-	2.41781	2.41774	2.41728	2.46914	1.91585	1.91787	-

Node	-	-	-	-	-	-	-	-	-	-	-	F21-9-025	F21-9-024SF	-	-
ground (ft AD)	-	29.130	27.210	-	-	-	-	-	-	18.450	16.040	14.700	13.770	13.760	-
flood dep (ft)	-	-8.597	-8.158	-	-	-	-	-	-	-6.961	-9.160	-8.690	-9.016	-9.378	-

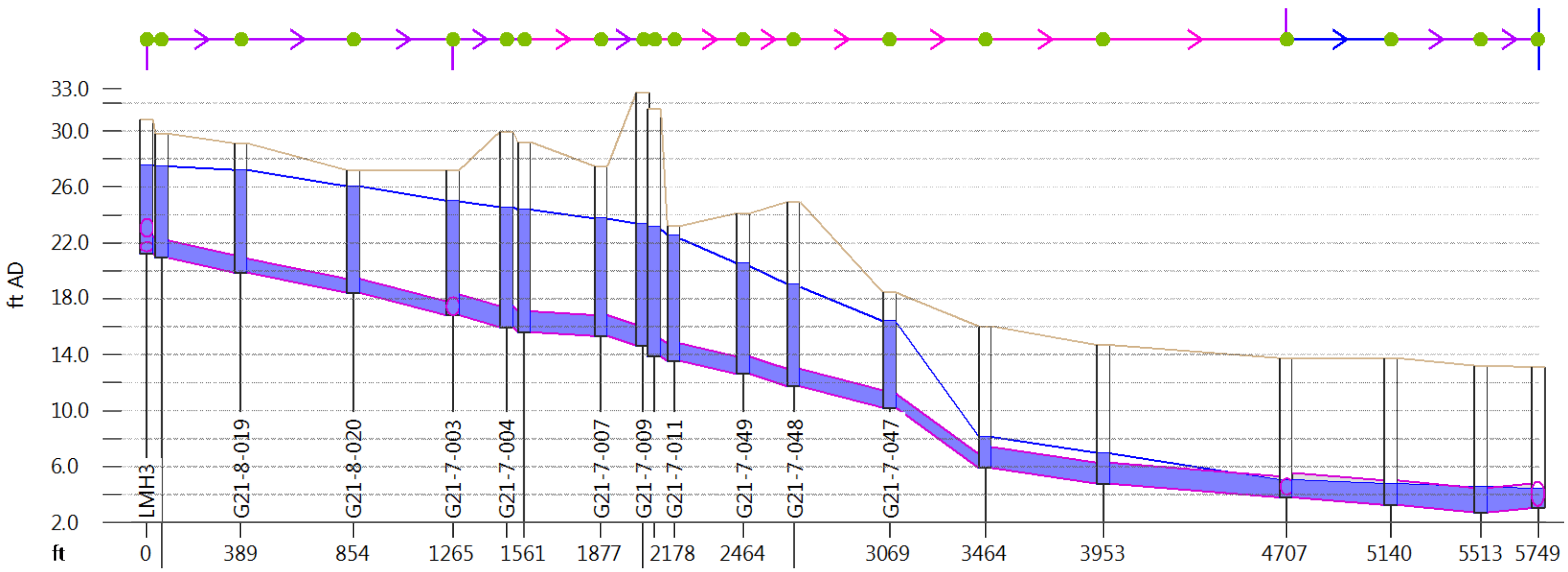
Location 2: Future Scenario A/Scenario B



Link	-	-	-	-	-	-	-	-	-	-	-	F21-9-025.1	-	-	-
length (ft)	325.1	465.4	410.8	-	316.0	-	286.1	-	395.8	395.3	488.7	754.0	433.4	372.3	-
width (in)	15.0	12.0	12.0	18.0	18.0	-	15.0	15.0	15.0	12.0	18.0	18.0	21.0	21.0	21.0
us inv (ft AD)	20.920	19.870	18.430	-	15.610	-	13.560	-	11.740	10.200	5.900	4.780	3.800	3.260	-
ds inv (ft AD)	19.870	18.430	16.820	-	15.340	-	12.620		10.200	5.900	4.780	3.800	3.260	2.730	-
grad (%)	0.323	0.309	0.392	-	0.085	-	0.329	-	0.389	1.088	0.229	0.130	0.125	0.142	-
pfc (MGD)	2.37	1.28	1.44	4.20	1.98	-	2.39	2.71	2.60	2.40	3.25	2.45	3.62	3.86	-3.71
surc	0.62	1.00	1.00	1.00	2.00	-	2.00	1.00	2.00	2.00	0.97	0.96	0.74	0.95	0.95
DS flow (MGD)	-	1.10486	1.09296	-	-	-	-	-	2.67624	2.67613	2.67475	2.72616	2.04270	2.04384	-

Node	-	-	-	-	-	-	-	-	-	-	-	F21-9-025	F21-9-024SF	-	-
ground (ft AD)	-	29.130	27.210	-	-	-	-	-	-	18.450	16.040	14.700	13.770	13.760	-
flood dep (ft)	-	-8.484	-7.638	-	-	-	-	-	-	-5.825	-9.014	-8.472	-8.929	-9.211	-

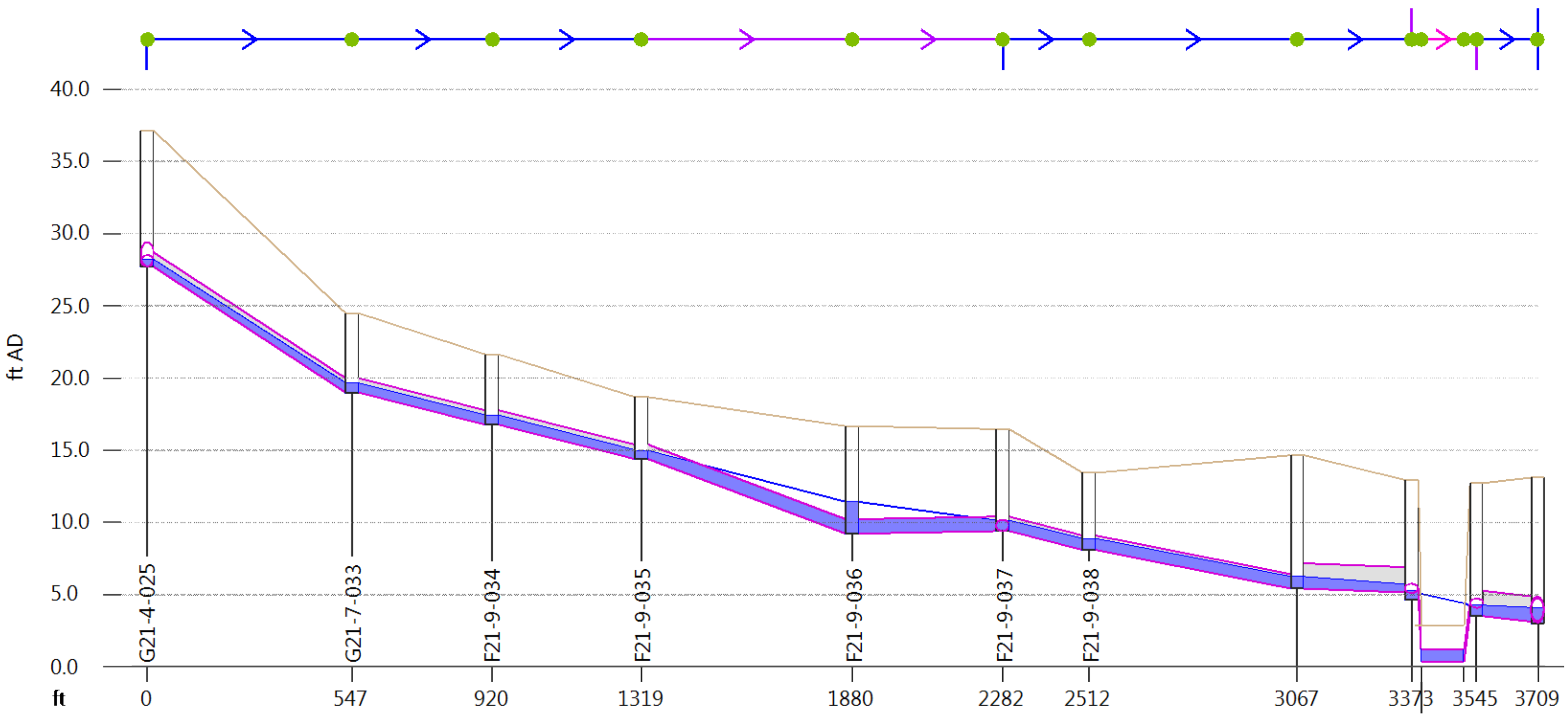
Location 2: Future Scenario C



Link	-	-	-	-	-	-	-	-	-	-	-	F21-9-025.1	-	-	-
length (ft)	325.1	465.4	410.8	-	316.0	-	286.1	-	395.8	395.3	488.7	754.0	433.4	372.3	236.3
width (in)	15.0	12.0	12.0	18.0	18.0	-	15.0	15.0	15.0	12.0	18.0	18.0	21.0	21.0	21.0
us inv (ft AD)	20.920	19.870	18.430	-	15.610	-	13.560	-	11.740	10.200	5.900	4.780	3.800	3.260	2.730
ds inv (ft AD)	19.870	18.430	16.820	-	15.340	-	12.620	-	10.200	5.900	4.780	3.800	3.260	2.730	3.040
grad (%)	0.323	0.309	0.392	-	0.085	-	0.329	-	0.389	1.088	0.229	0.130	0.125	0.142	-
pfc (MGD)	2.37	1.28	1.44	4.20	1.98	-	2.39	2.71	2.60	2.40	3.25	2.45	3.62	3.86	-3.71
surc	1.00	1.00	1.00	1.00	2.00	-	2.00	2.00	2.00	2.00	2.00	2.00	0.86	1.00	1.00
DS flow (MGD)	-	1.20665	1.16611	-	-	-	-	-	3.26177	3.26178	3.26183	3.35970	2.40716	2.40717	-

Node	-	-	-	-	-	-	-	-	-	-	-	F21-9-025	F21-9-024SF	-	-
ground (ft AD)	-	29.130	27.210	-	-	-	-	-	-	18.450	16.040	14.700	13.770	13.760	-
flood dep (ft)	-	-1.910	-1.162	-	-	-	-	-	-	-2.052	-7.893	-7.723	-8.738	-8.999	-

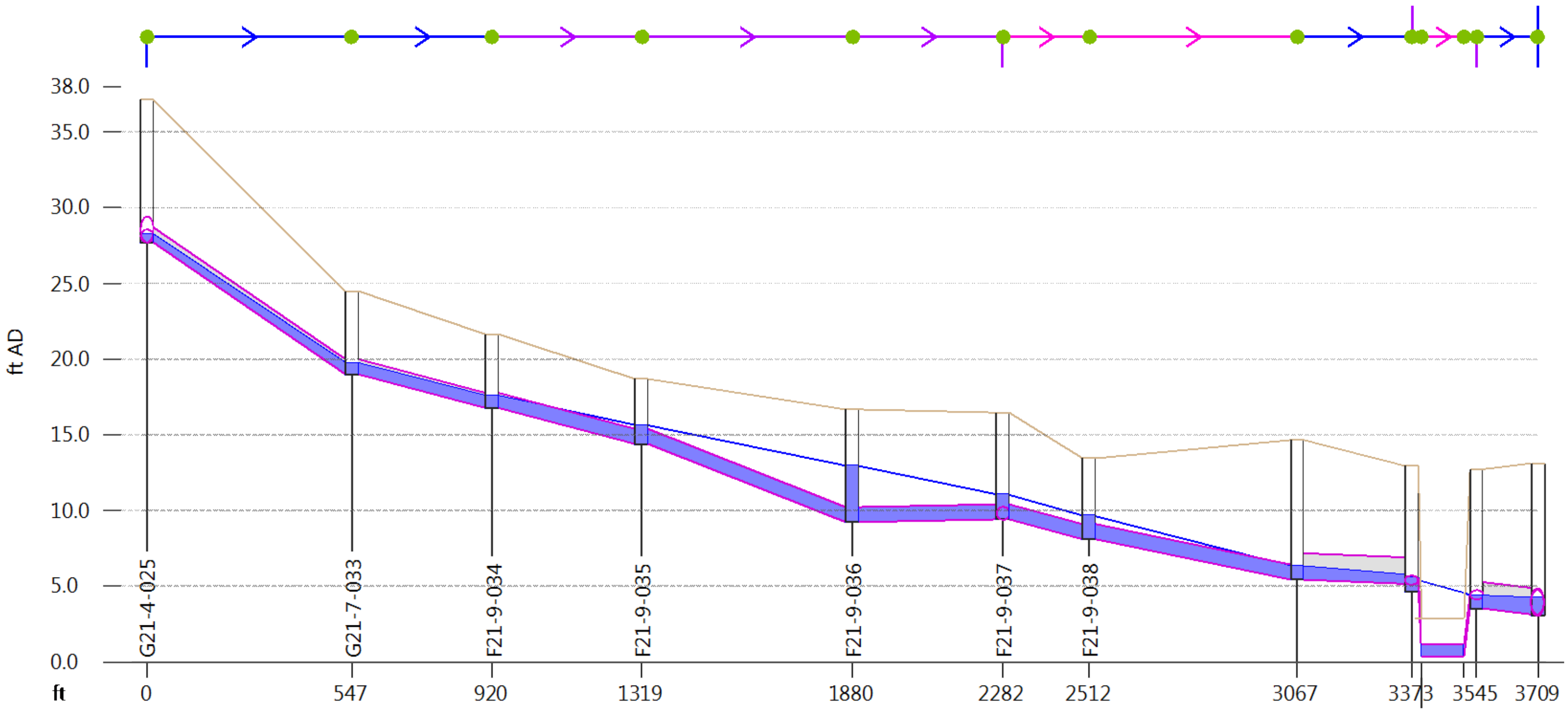
Location 3: Existing Scenario



Link	G21-4-025.1	G21-7-033.1	F21-9-034.1	F21-9-035.1	F21-9-036.1	-	F21-9-038.1	-	-	-
length (ft)	547.3	372.4	399.2	561.5	401.2	230.7	554.8	305.5	-	164.0
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	21.0	-	21.0
us inv (ft AD)	27.700	18.990	16.770	14.390	9.230	9.410	8.100	5.430	-	3.520
ds inv (ft AD)	18.990	16.770	14.390	9.230	9.410	8.100	5.430	5.160	-	3.140
grad (%)	1.591	0.596	0.596	0.919	-0.045	0.568	0.481	0.088	-	0.232
pfc (MGD)	2.91	1.78	1.78	2.21	-0.49	1.74	1.60	3.04	-	4.93
surc	0.65	0.64	0.64	1.00	1.00	0.77	0.81	0.46	-	0.54
DS flow (MGD)	1.28341	1.28338	1.28335	1.28297	1.28294	1.44697	1.44661	1.44650	-	-

Node	-	G21-7-033	F21-9-034	F21-9-035	F21-9-036	-	F21-9-038	F21-8-012	-		-
ground (ft AD)	37.140	24.490	21.650	18.690	16.680	16.470	13.450	14.660	-		-
flood dep (ft)	-8.957	-4.855	-4.236	-3.739	-5.240	-6.341	-4.579	-8.429	-		-

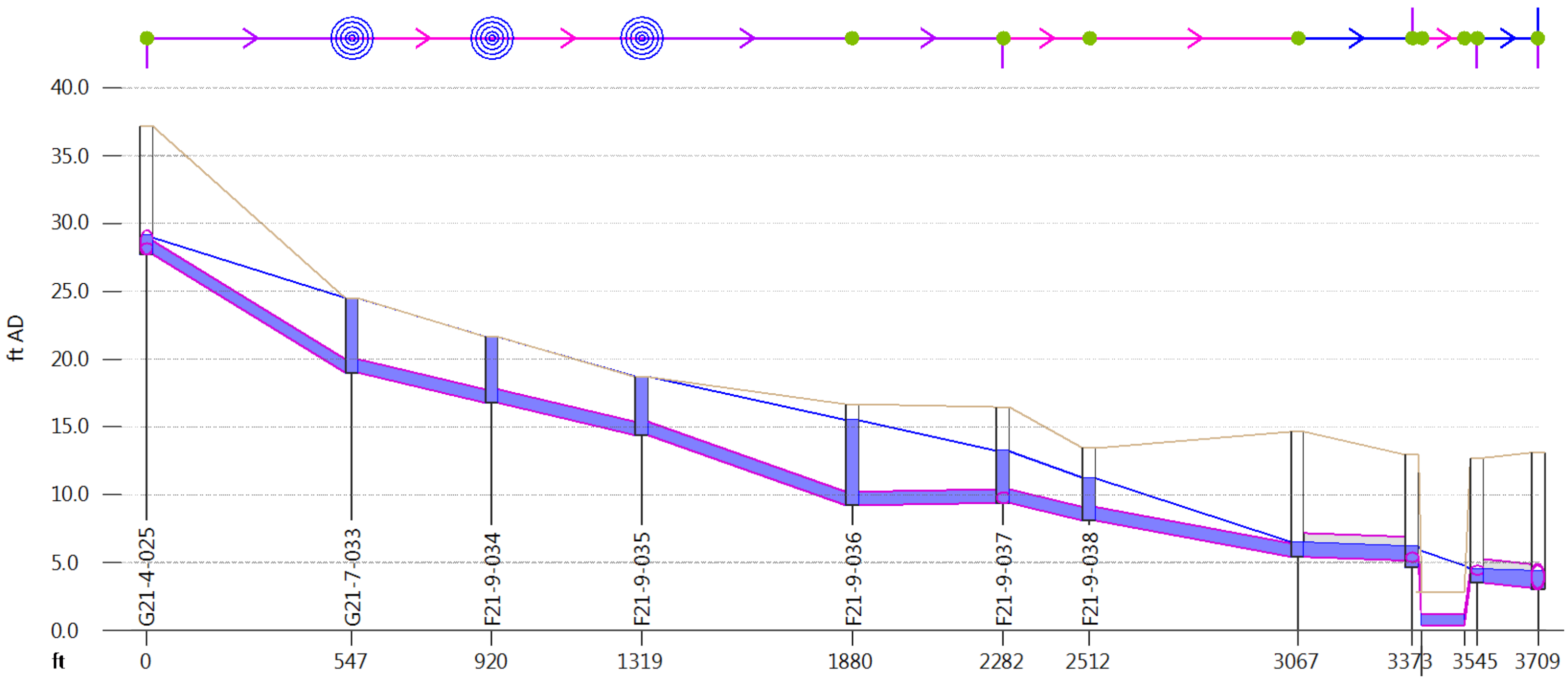
Location 3: Future Scenario A/Scenario B



Link	G21-4-025.1	G21-7-033.1	F21-9-034.1	F21-9-035.1	F21-9-036.1	-	F21-9-038.1	-	-	-
length (ft)	547.3	372.4	399.2	561.5	401.2	230.7	554.8	305.5	-	164.0
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	21.0	-	21.0
us inv (ft AD)	27.700	18.990	16.770	14.390	9.230	9.410	8.100	5.430	-	3.520
ds inv (ft AD)	18.990	16.770	14.390	9.230	9.410	8.100	5.430	5.160	-	3.140
grad (%)	1.591	0.596	0.596	0.919	-0.045	0.568	0.481	0.088	-	0.232
pfc (MGD)	2.91	1.78	1.78	2.21	-0.49	1.74	1.60	3.04	-	4.93
surc	0.75	0.82	1.00	1.00	1.00	2.00	2.00	0.51	-	0.63
DS flow (MGD)	1.58692	1.58422	1.56895	1.56824	1.56789	1.75292	1.75288	1.75284	-	-

Node	-	G21-7-033	F21-9-034	F21-9-035	F21-9-036	-	F21-9-038	F21-8-012	-	-
ground (ft AD)	37.140	24.490	21.650	18.690	16.680	16.470	13.450	14.660	-	-
flood dep (ft)	-8.879	-4.749	-4.066	-3.040	-3.723	-5.396	-3.784	-8.343	-	-

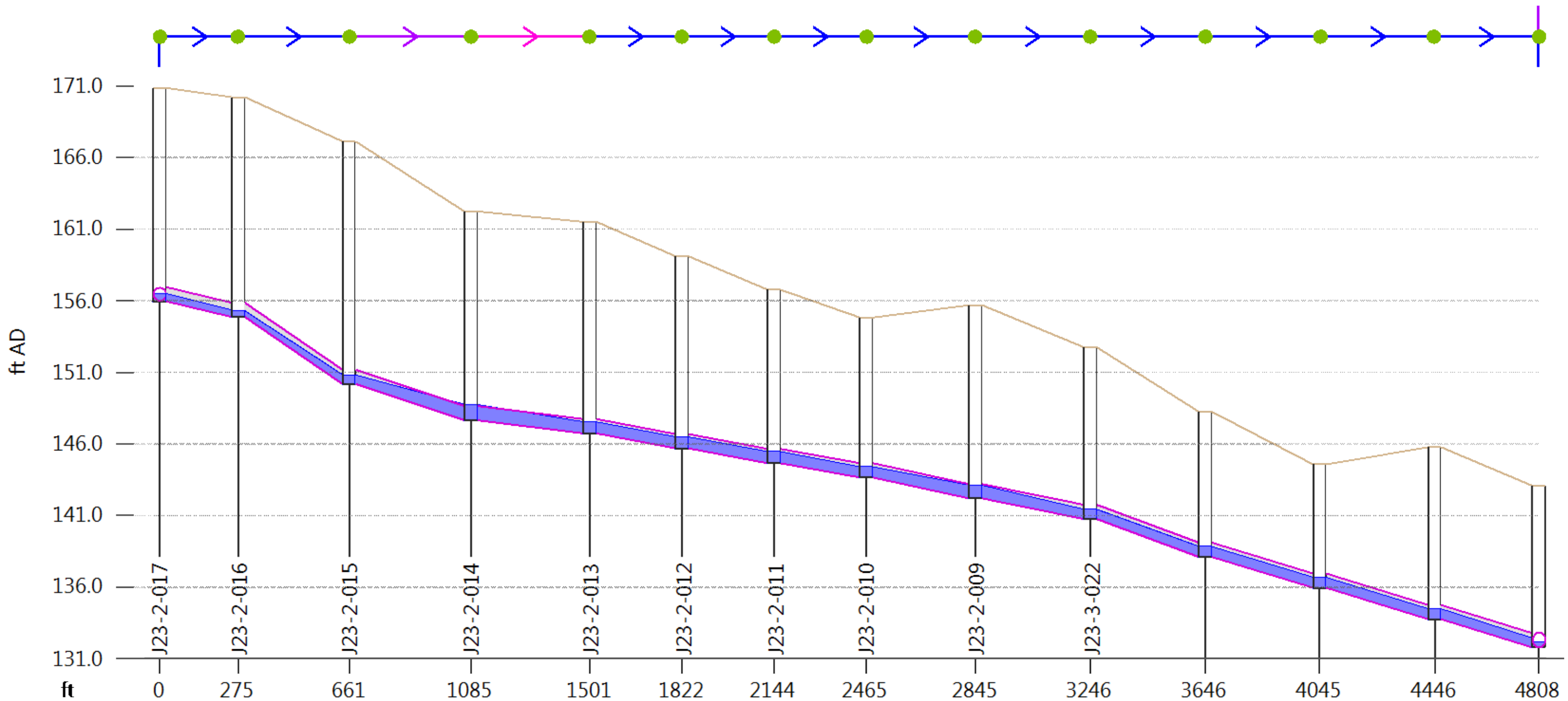
Location 3: Future Scenario C



Link	G21-4-025.1	G21-7-033.1	F21-9-034.1	F21-9-035.1	F21-9-036.1	-	F21-9-038.1	-	-	-
length (ft)	547.3	372.4	399.2	561.5	401.2	230.7	554.8	305.5	-	164.0
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	21.0	-	21.0
us inv (ft AD)	27.700	18.990	16.770	14.390	9.230	9.410	8.100	5.430	-	3.520
ds inv (ft AD)	18.990	16.770	14.390	9.230	9.410	8.100	5.430	5.160	-	3.140
grad (%)	1.591	0.596	0.596	0.919	-0.045	0.568	0.481	0.088	-	0.232
pfc (MGD)	2.91	1.78	1.78	2.21	-0.49	1.74	1.60	3.04	-	4.93
surc	1.00	2.00	2.00	1.00	1.00	2.00	2.00	0.61	-	0.72
DS flow (MGD)	2.01367	1.98438	1.94765	1.76005	1.74760	2.10120	2.10118	2.10079	-	-

Node	-	G21-7-033	F21-9-034	F21-9-035	F21-9-036	-	F21-9-038	F21-8-012	-		-
ground (ft AD)	37.140	24.490	21.650	18.690	16.680	16.470	13.450	14.660	-		-
flood dep (ft)	-8.046	-0.000	-0.000	0.000	-1.171	-3.228	-2.196	-8.154	-		-

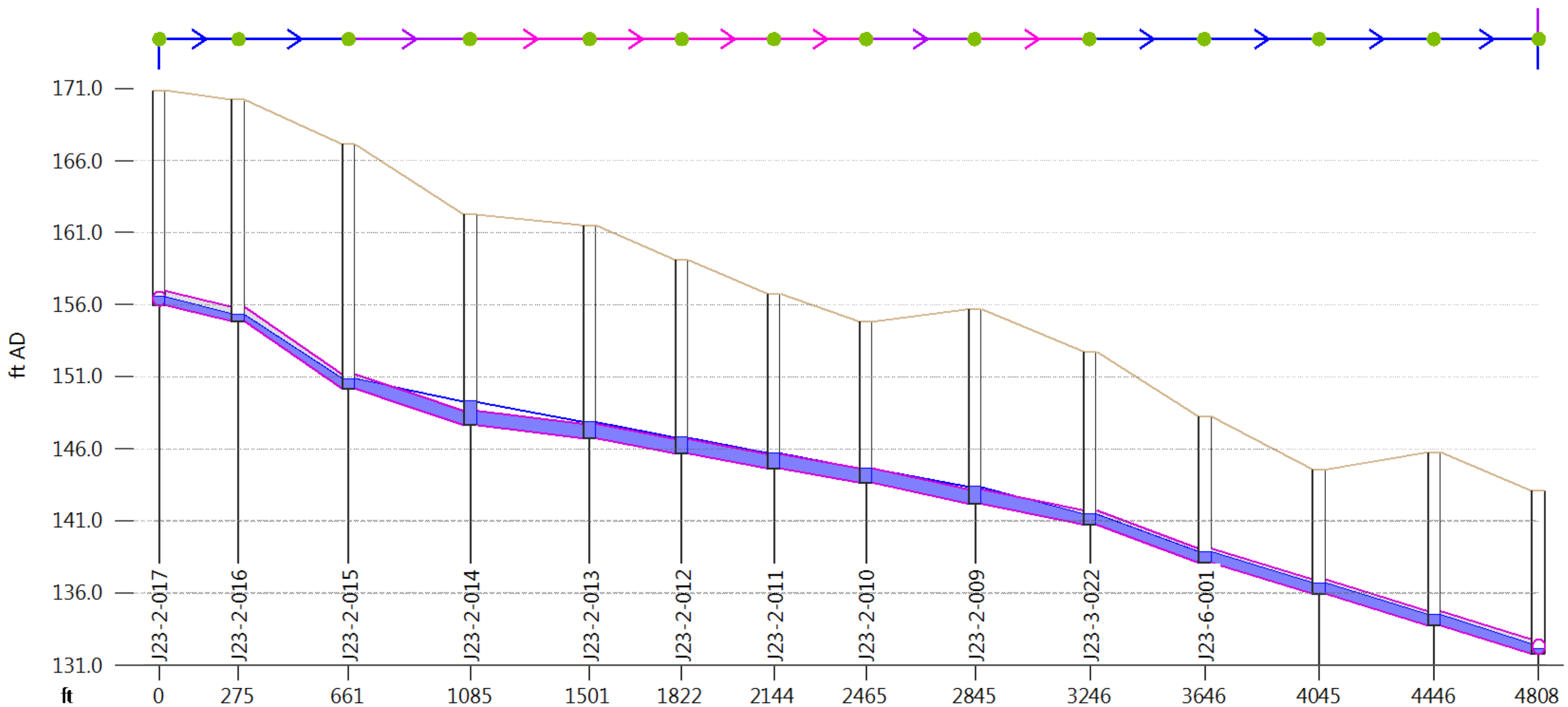
Location 4: Existing Scenario



Link	-	-	J23-2-015.1	J23-2-014.1	-	-	-	-	-	-	-	-	-
length (ft)	275.1	385.8	424.5	415.9	320.9	321.5	320.9	380.6	400.2	400.9	398.6	401.0	361.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
us inv (ft AD)	-	154.860	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760
ds inv (ft AD)	-	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760	131.800
grad (%)	0.400	1.213	0.596	0.219	0.327	0.324	0.308	0.384	0.360	0.661	0.539	0.549	0.542
pfc (MGD)	1.46	2.54	1.78	1.08	1.32	1.31	1.28	1.43	1.38	1.87	1.69	1.71	1.69
surc	0.52	0.62	1.00	2.00	0.78	0.79	0.78	0.90	0.88	0.71	0.71	0.71	0.70
DS flow (MGD)	-	0.76810	1.20131	1.20069	1.20057	1.20050	1.20039	1.19904	1.38111	1.38108	1.38103	1.38097	1.38090

Node	-	-	-	J23-2-014	-	-	-	-	-	-	-	-	-	-
ground (ft AD)	-	-	167.130	162.250	161.510	-	-	154.830	155.700	152.760	148.260	144.580	145.780	-
flood dep (ft)	-	-14.968	-16.334	-13.513	-13.996	-	-	-10.452	-12.601	-11.349	-9.441	-7.916	-11.312	-

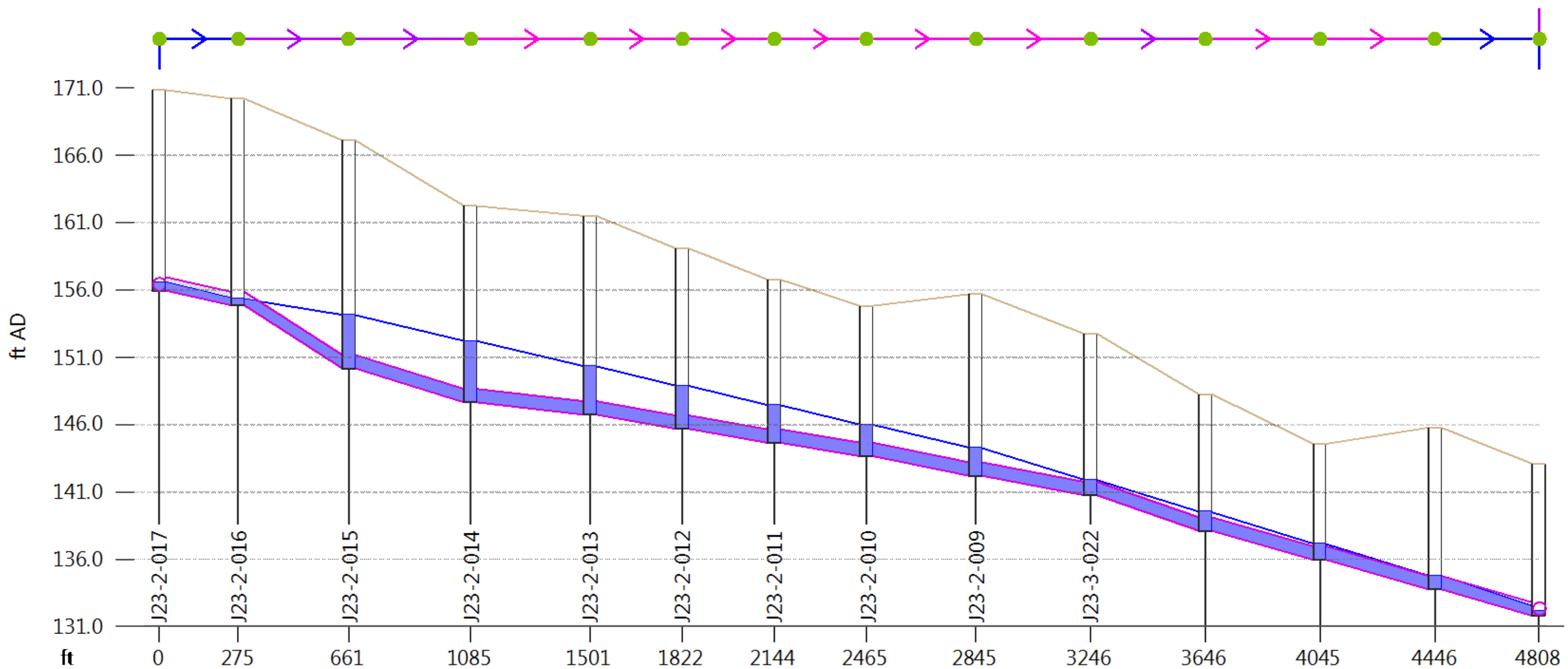
Location 4: Future Scenario A/Scenario B



Link	-	-	J23-2-015.1	J23-2-014.1	-	-	-	-	-	-	-	-	-
length (ft)	275.1	385.8	424.5	415.9	320.9	321.5	320.9	380.6	400.2	400.9	398.6	401.0	361.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
us inv (ft AD)	-	154.860	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760
ds inv (ft AD)	-	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760	131.800
grad (%)	0.400	1.213	0.596	0.219	0.327	0.324	0.308	0.384	0.360	0.661	0.539	0.549	0.542
pfc (MGD)	1.46	2.54	1.78	1.08	1.32	1.31	1.28	1.43	1.38	1.87	1.69	1.71	1.69
surc	0.56	0.68	1.00	2.00	2.00	2.00	2.00	1.00	2.00	0.76	0.75	0.75	0.74
DS flow (MGD)	-	0.86591	1.32667	1.32499	1.32022	1.31596	1.31229	1.31164	1.51685	1.51676	1.51647	1.51629	1.51624

Node	-	-	J23-2-015	J23-2-014	-	-	-	-	-	-	-	-	-	-
ground (ft AD)	-	-	167.130	162.250	161.510	-	-	154.830	155.700	152.760	148.260	144.580	145.780	-
flood dep (ft)	-	-14.941	-16.268	-12.967	-13.634	-	-	-10.191	-12.323	-11.293	-9.396	-7.875	-11.270	-

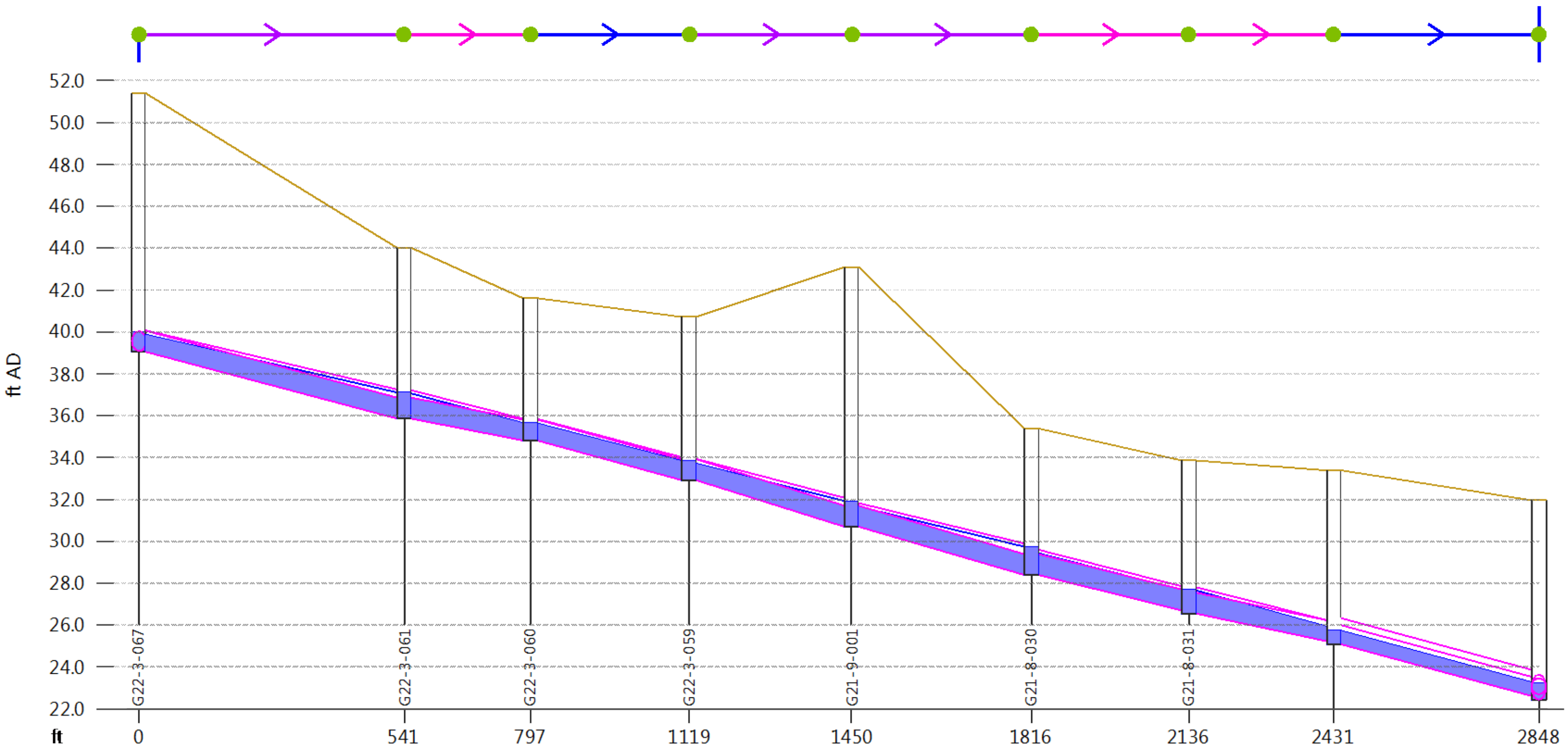
Location 4: Future Scenario C



Link	-	-	J23-2-015.1	J23-2-014.1	-	-	-	-	-	-	-	-	-
length (ft)	275.1	385.8	424.5	415.9	320.9	321.5	320.9	380.6	400.2	400.9	398.6	401.0	361.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
us inv (ft AD)	-	154.860	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760
ds inv (ft AD)	-	150.180	147.650	146.740	145.690	144.650	143.660	142.200	140.760	138.110	135.960	133.760	131.800
grad (%)	0.400	1.213	0.596	0.219	0.327	0.324	0.308	0.384	0.360	0.661	0.539	0.549	0.542
pfc (MGD)	1.46	2.54	1.78	1.08	1.32	1.31	1.28	1.43	1.38	1.87	1.69	1.71	1.69
surc	0.62	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	1.00
DS flow (MGD)	-	1.00272	1.53951	1.53662	1.53426	1.53196	1.52966	1.52719	1.74978	1.74724	1.74682	1.74643	1.74624

Node	-	-	J23-2-015	J23-2-014	-	-	-	-	-	-	-	-	-	-
ground (ft AD)	-	-	167.130	162.250	161.510	-	-	154.830	155.700	152.760	148.260	144.580	145.780	-
flood dep (ft)	-	-14.890	-12.977	-10.027	-11.161	-	-9.318	-8.822	-11.403	-10.849	-8.729	-7.423	-11.002	-

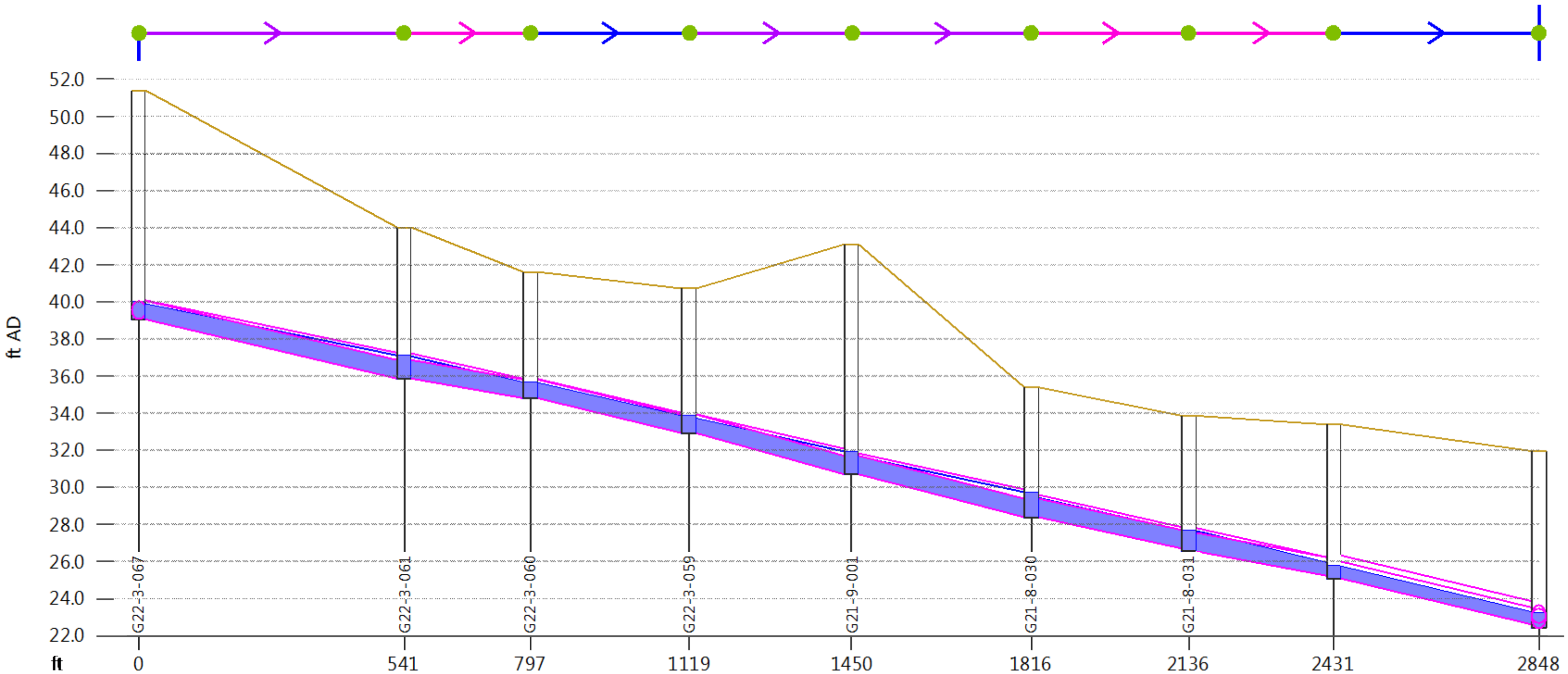
Location 5: Existing Scenario



Link	G22-3-067.1	G22-3-061.1	G22-3-060.1	G22-3-059.1	G21-9-001.1	G21-8-030.1	G21-8-031.1	G21-8-032.1
length (ft)	540.7	256.4	322.2	330.5	366.2	319.9	295.0	416.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	15.0
us inv (ft AD)	39.050	35.860	34.810	32.920	30.700	28.390	26.550	25.080
ds inv (ft AD)	35.860	34.810	32.920	30.700	28.390	26.700	25.230	22.610
grad (%)	0.590	0.410	0.587	0.672	0.631	0.528	0.447	0.592
surc	1.00	2.00	0.92	1.00	1.00	2.00	2.00	0.52
r.pfc (MGD)	1.77	1.47	1.76	1.89	1.83	1.67	1.54	3.21
DS flow (MGD)	1.6190	1.6646	1.6602	1.6524	1.6517	1.6868	1.6868	1.7237

Node	G22-3-067	G22-3-061	G22-3-060	G22-3-059	G21-9-001	G21-8-030	G21-8-031	G21-8-032	-
ground (ft AD)	51.400	44.010	41.610	40.720	43.100	35.390	33.860	33.390	31.960
flood dep (ft)	-11.415	-6.909	-5.968	-6.891	-11.194	-5.676	-6.182	-7.642	-8.746

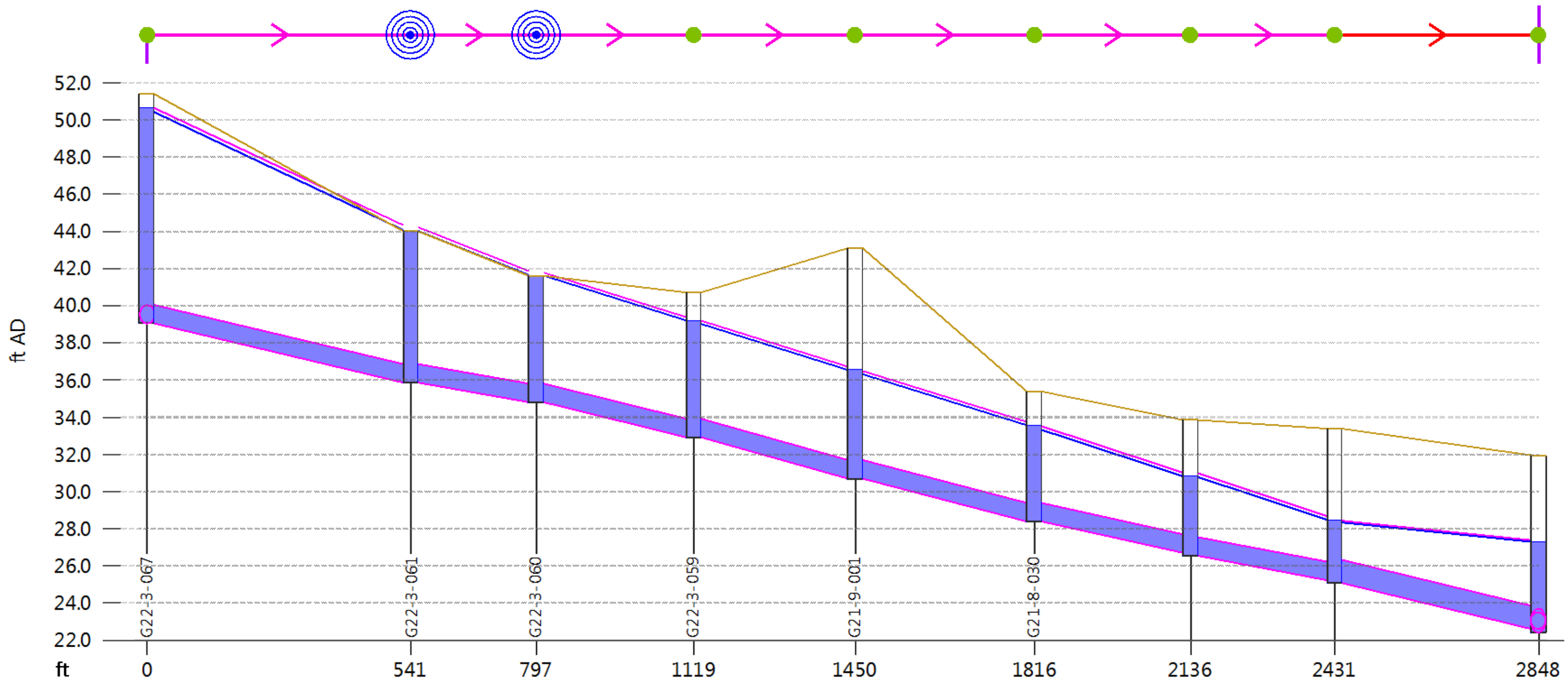
Location 5: Future Scenario A/Scenario B



Link	G22-3-067.1	G22-3-061.1	G22-3-060.1	G22-3-059.1	G21-9-001.1	G21-8-030.1	G21-8-031.1	G21-8-032.1
length (ft)	540.7	256.4	322.2	330.5	366.2	319.9	295.0	416.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	15.0
us inv (ft AD)	39.050	35.860	34.810	32.920	30.700	28.390	26.550	25.080
ds inv (ft AD)	35.860	34.810	32.920	30.700	28.390	26.700	25.230	22.610
grad (%)	0.590	0.410	0.587	0.672	0.631	0.528	0.447	0.592
surc	1.00	2.00	0.92	1.00	1.00	2.00	2.00	0.52
r.pfc (MGD)	1.77	1.47	1.76	1.89	1.83	1.67	1.54	3.21
DS flow (MGD)	1.6190	1.6646	1.6602	1.6524	1.6517	1.6868	1.6868	1.7237

Node	G22-3-067	G22-3-061	G22-3-060	G22-3-059	G21-9-001	G21-8-030	G21-8-031	G21-8-032	-
ground (ft AD)	51.400	44.010	41.610	40.720	43.100	35.390	33.860	33.390	31.960
flood dep (ft)	-11.415	-6.909	-5.968	-6.891	-11.194	-5.676	-6.182	-7.642	-8.746

Location 5: Future Scenario C

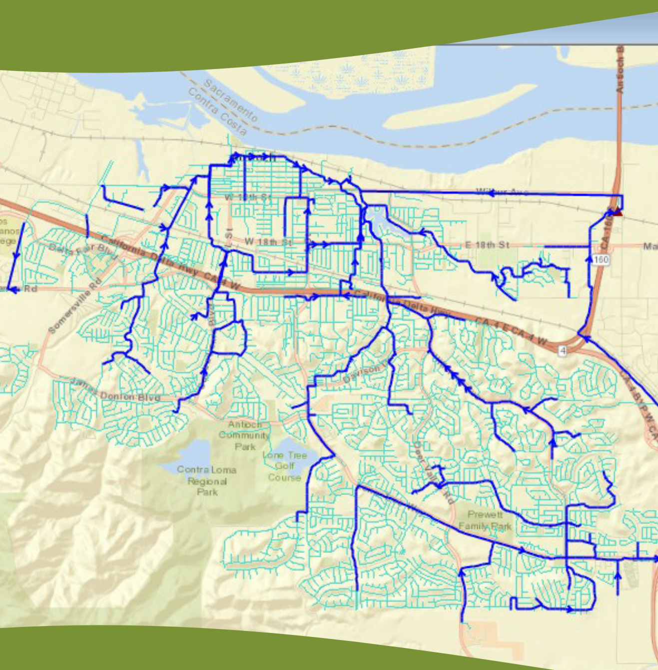


Link	G22-3-067.1	G22-3-061.1	G22-3-060.1	G22-3-059.1	G21-9-001.1	G21-8-030.1	G21-8-031.1	G21-8-032.1
length (ft)	540.7	256.4	322.2	330.5	366.2	319.9	295.0	416.9
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	15.0
us inv (ft AD)	39.050	35.860	34.810	32.920	30.700	28.390	26.550	25.080
ds inv (ft AD)	35.860	34.810	32.920	30.700	28.390	26.700	25.230	22.610
grad (%)	0.590	0.410	0.587	0.672	0.631	0.528	0.447	0.592
surc	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00
r.pfc (MGD)	1.77	1.47	1.76	1.89	1.83	1.67	1.54	3.21
DS flow (MGD)	2.4802	2.2006	2.1587	2.1501	2.1468	2.1959	2.1958	2.1924

Node	G22-3-067	G22-3-061	G22-3-060	G22-3-059	G21-9-001	G21-8-030	G21-8-031	G21-8-032	-
ground (ft AD)	51.400	44.010	41.610	40.720	43.100	35.390	33.860	33.390	31.960
flood dep (ft)	-0.765	0.000	-0.000	-1.527	-6.573	-1.839	-3.045	-4.940	-4.665

Appendix F

Reverse Slope Segments



City of Antioch Wastewater Collection System Master Plan

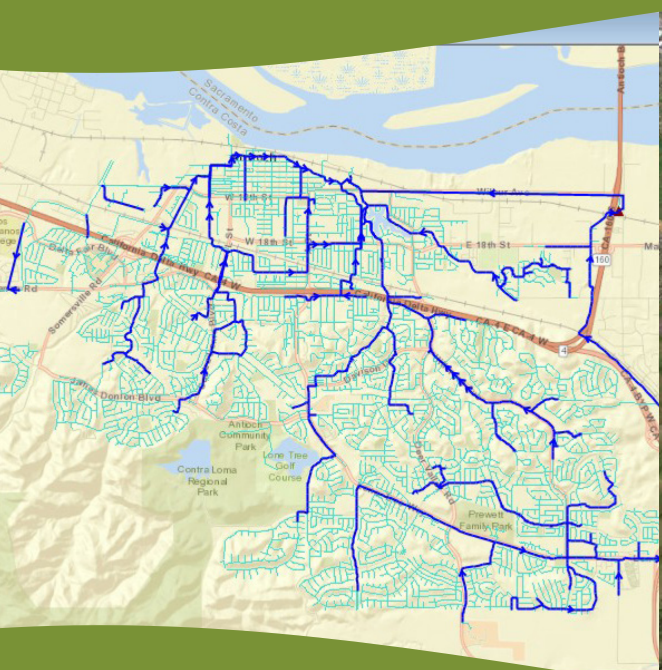
Reverse Slopes Segments

Upstream Node	Downstream Node	Upstream Invert	Downstream Invert
H21-8-026	H21-8-027	110.81	113.15
H21-8-034	H21-8-035	91.45	92.10
H21-7-054	H21-7-055	74.58	74.70
G22-3-069	G22-3-068	41.31	42.14
F21-9-036[a]	F21-9-037	9.23	9.41
F21-9-059	F21-8-020	1.98	2.08
F21-8-020	F21-8-019SF	2.08	2.25
F21-8-011	F21-8-006	1.8	2.27
F22-6-040	F22-6-037	8.19	8.40
F22-5-008	F22-5-007	-5.20	-4.63
F22-6-102	F22-6-103	-5.29	-4.97
F22-6-101	F22-6-067	-5.63	-5.37
G22-7-012	G22-7-07SF	1.29	1.71
G23-3-007	G22-3-013	53.18	53.41
G23-3-041	G23-3-039	52.12	52.30
G23-3-040	G23-3-039	51.84	52.30
H23-5-012	H23-5-011	104.75	104.98
H23-9-004	H23-9-003	133.60	134.54
H23-8-001	H23-8-002	110.64	111.07
J24-3-011	J24-3-010	109.26	109.81
J24-3-034	J24-3-036	118.87	120.00
G23-5-006	G23-5-005	14.53	14.59
G23-5-004	G23-5-003	12.05	12.17
G23-8-008	G23-8-007	41.15	41.50
G23-8-002	G23-8-001	39.38	40.16
G23-8-001	G23-5-045	40.16	40.25

a. See Location 3 described in Report.

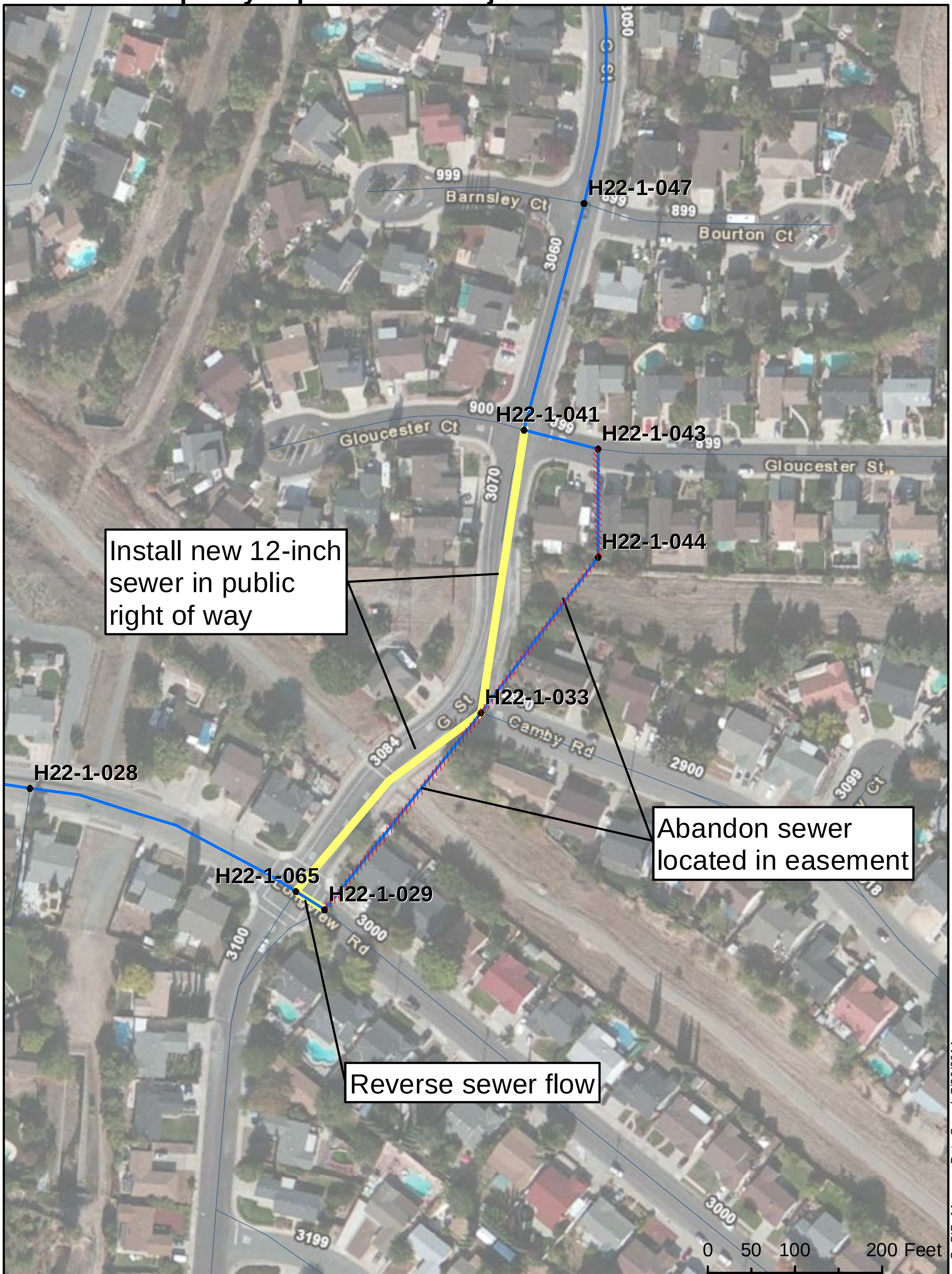
Appendix G

Capital Improvement Project Details



City of Antioch Wastewater Collection System Master Plan

Capacity Improvement Project 1 - Scenario A/B/C



City of Antioch
Wastewater Collection System Master Plan

Date Saved: 7/30/2014
Document Name: AppG_CIP_1A

Project 1 Scenario A/B/C: G Street

PROJECT DESCRIPTION

Project ID .... 1 Scenario A/B/C
Project Name .... G Street
Project Location .... G Street from Longview Drive to Gloucester Street
Description .... Upsize 8-inch sewer to 12-inch and relocate from backyard easement to G Street.
Scenario .... Base
Estimated Capital Improvement Cos $299,000
Comments .... (i) Pipes are listed in order from upstream to downstream
(ii) Pipe from H22-1-065 to H22-1-041 are new pipes on G Street to replace pipes currently in an easement connecting the same manholes.
(iii) Project recommendations would not change under the high infiltration scenarios.

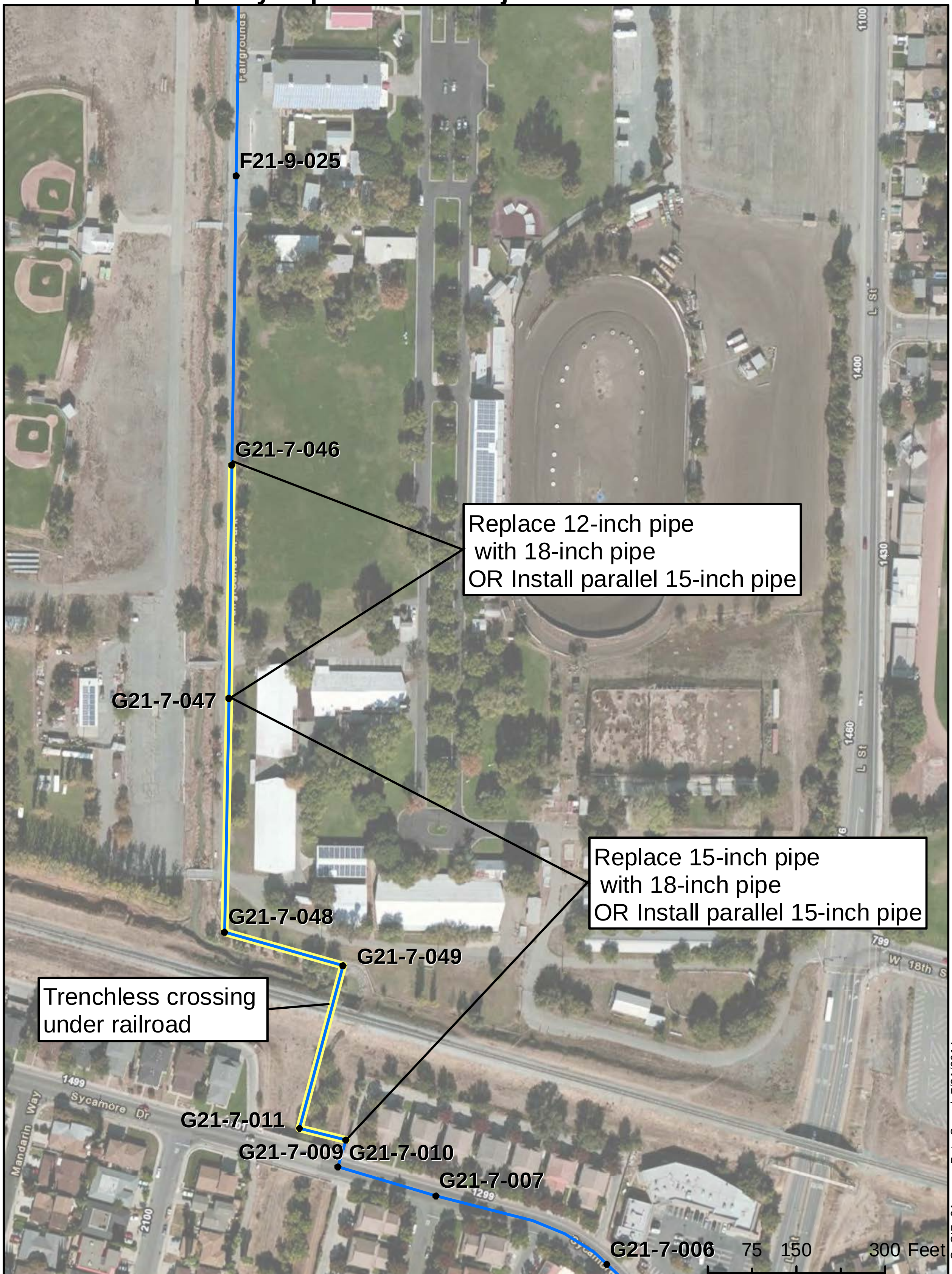
Assumptions .... (i) Cost assumes pipe will be upsized using pipe bursting for existing pipes, and new construction via open cut.
(ii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives .... None

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
H22-1-029	H22-1-065	8	8	39	0.33	15	Open Cut	$178	$ 6,982
H22-1-065	H22-1-033	8	12	296	1.53	18	Open Cut	$217	$ 64,312
H22-1-033	H22-1-041	8	12	328	1.53	23	Open Cut	$244	$ 80,215

Total Baseline Pipe Construction Cost	$ 151,510
Lower Lateral Replacement and Cleanout Cost, Total of 2	$ 8,600
Baseline Construction Cost:	**$ 160,110**
Bypass Pumping (10% of pipe construction cost)	$ -
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$ 15,151
Subtotal:	**$ 175,260**
Mobilization/Demobilization (5% of subtotal)	$ 8,763
Estimated Construction Cost Subtotal:	**$ 184,023**
Contingencies (30% of construction subtotal)	$ 55,207
Total Estimated Construction Cost:	**$ 239,231**
Engineering, Administration, Legal (25% of construction cost)	$ 59,808
Estimated Capital Improvement Cost:	**$ 299,000**

Capacity Improvement Project 2 - Scenario A/B



Date Saved: 7/31/2014

Document Name: AppG_CIP_2A

City of Antioch
Wastewater Collection System Master Plan

Project 2 Scenario A/B: O Street

PROJECT DESCRIPTION

Project ID	2 Scenario A/B
Project Name	O Street
Project Location	Easement sewer from Sycamore Drive at Lemontree Way to O Street (Contra Costa County Fairgrounds) at approximately 14th street.
Description	Replace approximately 1,400 feet of 12-in to 15-in pipe with 18-in pipe
Scenario	Base
Estimated Capital Improvement Cost	$1,105,000
Comments	(i) Pipes are listed in order from upstream to downstream (ii) Project includes replacing a 15-inch pipe located underneath a railroad (iii) Under the high infiltration scenario (Scenario C), project length would increase to 3,500 feet (between MHID G21-8-019 and F21-9-024), and diameter would increase to 21-inches (see Project 2.1 Scenario C)
Assumptions	(i) Cost assumes pipe will be upsized using open cut remove and replace (ii) Cost estimates are based on April 2014 ENR CCI of 10208 (iii) Costs assume 120 lf of trenchless crossing underneath Union Pacific Railroad (between MH G21-7-011 to MH G21-7-049), with a 51-inch casing pipe (iv) Costs assume open cut construction across West Antioch Creek (construction during summer only)
Alternatives	(i) Install parallel pipe

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-7-010	G21-7-011	15	18	81	0.37	14	Open Cut	$226	$ 18,269
G21-7-011	G21-7-049	15	18	120	0.33	11	Trenchless	$1,240	$ 148,800
G21-7-011	G21-7-049	15	18	166	0.33	11	Open Cut	$226	$ 37,556
G21-7-049	G21-7-048	15	18	209	0.42	12	Open Cut	$226	$ 47,143
G21-7-048	G21-7-047	15	18	396	0.39	11	Open Cut	$226	$ 89,493
G21-7-047	G21-7-046	12	18	395	1.09	9	Open Cut	$226	$ 89,380

Total Baseline Pipe Construction Cost	$	430,641
1 Jacking Pit	$	81,000
1 Receiving Pit	$	48,000
New Manholes/Junction Structures, Total of 1	$	16,000
Lower Lateral Replacement and Cleanout Cost, Total of 3	$	12,900
Baseline Construction Cost:	**$**	**588,541**
Bypass Pumping (10% of pipe construction cost)	$	43,064
Remove & Replace Factor (5% of pipe construction cost)	$	14,092
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	1,827
Subtotal:	**$**	**647,524**
Mobilization/Demobilization (5% of subtotal)	$	32,376
Estimated Construction Cost Subtotal:	**$**	**679,900**
Contingencies (30% of construction subtotal)	$	203,970
Total Estimated Construction Cost:	**$**	**883,870**
Engineering, Administration, Legal (25% of construction cost)	$	220,968
Estimated Capital Improvement Cost:	**$**	**1,105,000**

Project 2 Scenario A/B: O Street Parallel Pipeline Alternative

PROJECT DESCRIPTION

Project ID .... 2 Scenario A/B
Project Name .... O Street Parallel Pipeline Alternative
Project Location .... Easement sewer from Sycamore Drive at Lemontree Way to O Street (Contra Costa County Fairgrounds) at approximately 14th street.
Description .... Replace approximately 1,400 feet of 12-in to 15-in pipe with 15-in pipe
Scenario .... Base
Estimated Capital Improvement Cos $951,000
Comments .... (i) Pipes are listed in order from upstream to downstream
(ii) Project includes replacing a 15-inch pipe located underneath a railroad
(iii) Under the high infiltration scenario (Scenario C), project length would increase to 3,500 feet (between MHID G21-8-019 and F21-9-024)

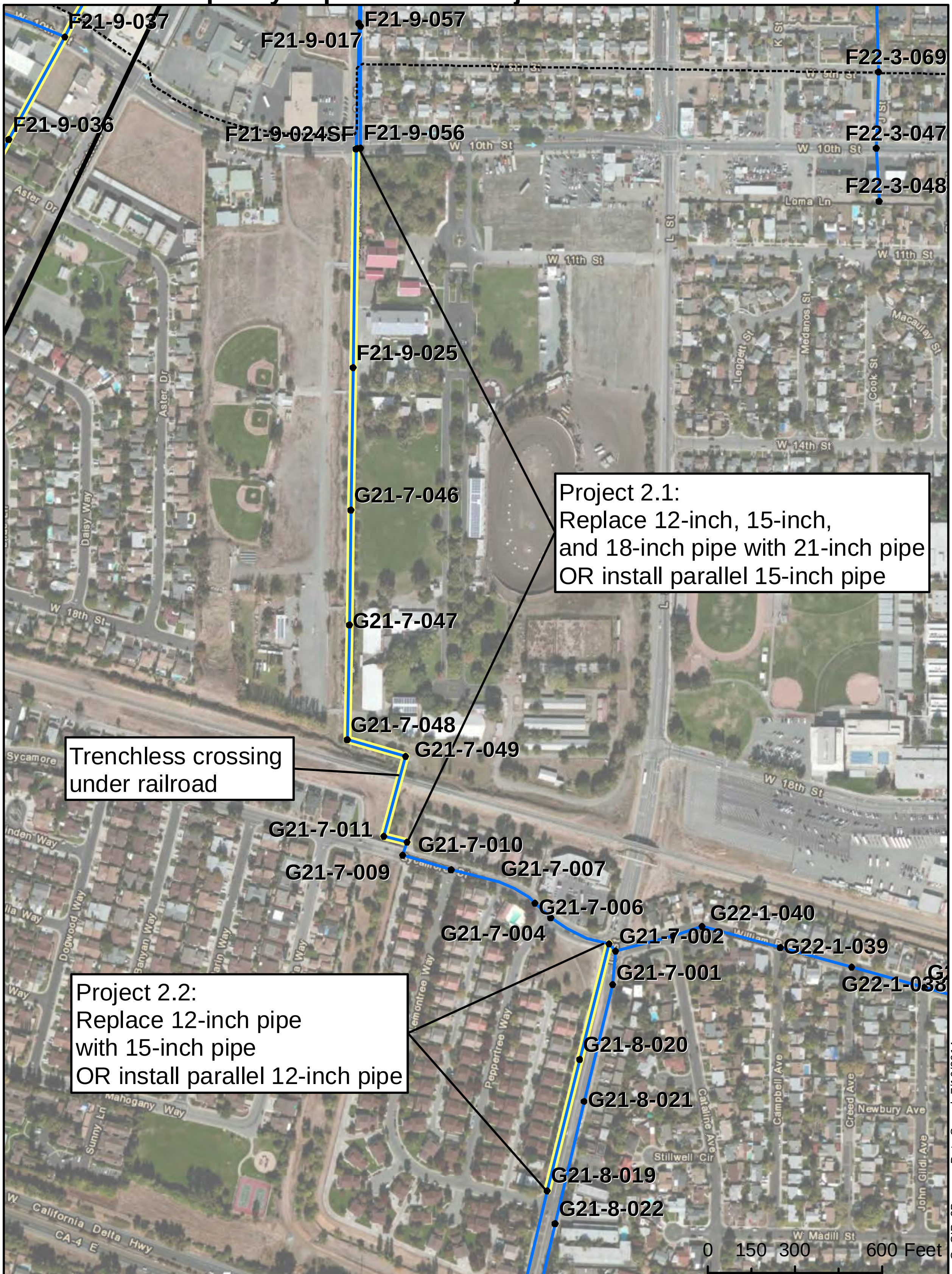
Assumptions .... (i) Cost assumes pipe will be installed using open cut construction
(ii) Cost estimates are based on April 2014 ENR CCI of 10208
(iii) Costs assume 120 lf of trenchless crossing underneath Union Pacific Railroad (between MH G21-7-011 to MH G21-7-049), with a 49-inch casing pipe
(iv) Costs assume open cut construction across West Antioch Creek (construction during summer only)

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-7-010	G21-7-011	15	15	81	0.37	14	Open Cut	$215	$ 17,399
G21-7-011	G21-7-049	15	15	120	0.33	11	Trenchless	$1,184	$ 142,124
G21-7-011	G21-7-049	15	15	166	0.33	11	Open Cut	$215	$ 35,768
G21-7-049	G21-7-048	15	15	209	0.42	12	Open Cut	$215	$ 44,898
G21-7-048	G21-7-047	15	15	396	0.39	11	Open Cut	$215	$ 85,231
G21-7-047	G21-7-046	12	15	395	1.09	9	Open Cut	$215	$ 85,123

Total Baseline Pipe Construction Cost	$	410,544
1 Jacking Pit	$	81,000
1 Receiving Pit	$	48,000
New Manholes/Junction Structures, Total of 1	$	16,000
Baseline Construction Cost:	**$**	**555,544**
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	1,740
Subtotal:	**$**	**557,283**
Mobilization/Demobilization (5% of subtotal)	$	27,864
Estimated Construction Cost Subtotal:	**$**	**585,148**
Contingencies (30% of construction subtotal)	$	175,544
Total Estimated Construction Cost:	**$**	**760,692**
Engineering, Administration, Legal (25% of construction cost)	$	190,173
Estimated Capital Improvement Cost:	**$**	**951,000**

Capacity Improvement Project 2 - Scenario C



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City of Antioch
Wastewater Collection System Master Plan

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Project 2.1 Scenario C: O Street

PROJECT DESCRIPTION

Project ID	2.1 Scenario C
Project Name	O Street
Project Location	Easement sewer from Sycamore Drive at Lemontree Way to O Street (Contra Costa County Fairgounds) at 10th street.
Description	Replace approximately 2,600 feet of 12-in to 18-in pipe with 21-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$1,801,000
Comments	(i) Pipes are listed in order from upstream to downstream (ii) Project includes replacing a 15-inch pipe located underneath a railroad
Assumptions	(i) Cost assumes pipe will be upsized using open cut remove and replace (ii) Cost estimates are based on April 2014 ENR CCI of 10208 (iii) Costs assume 120 lf of trenchless crossing underneath Union Pacific Railroad (between MH G21-7-011 to MH G21-7-049), with a 56-inch casing pipe (iv) Costs assume open cut construction across West Antioch Creek (construction during summer only)
Alternatives	(i) Install parallel pipe

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-7-010	G21-7-011		15	21	81	0.37	14	Open Cut	$248	$ 20,009
G21-7-011	G21-7-049		15	21	120	0.33	11	Trenchless	$1,380	$ 165,600
G21-7-011	G21-7-049		15	21	166	0.33	11	Open Cut	$248	$ 41,133
G21-7-049	G21-7-048		15	21	209	0.42	12	Open Cut	$248	$ 51,633
G21-7-048	G21-7-047		15	21	396	0.39	11	Open Cut	$248	$ 98,016
G21-7-047	G21-7-046		12	21	395	1.09	9	Open Cut	$248	$ 97,892
G21-7-046	F21-9-025		18	21	489	0.23	10	Open Cut	$248	$ 121,022
F21-9-025	F21-9-024SF		18	21	754	0.13	10	Open Cut	$248	$ 186,720

Total Baseline Pipe Construction Cost	$	782,025
1 Jacking Pit	$	81,000
1 Receiving Pit	$	48,000
New Manholes/Junction Structures, Total of 1	$	16,000
Lower Lateral Replacement and Cleanout Cost, Total of 4	$	17,200
Baseline Construction Cost:	**$**	**944,225**
Bypass Pumping (10% of pipe construction cost)	$	78,202
Remove & Replace Factor (5% of pipe construction cost)	$	30,821
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	2,001
Subtotal:	**$**	**1,055,249**
Mobilization/Demobilization (5% of subtotal)	$	52,762
Estimated Construction Cost Subtotal:	**$**	**1,108,012**
Contingencies (30% of construction subtotal)	$	332,404
Total Estimated Construction Cost:	**$**	**1,440,415**
Engineering, Administration, Legal (25% of construction cost)	$	360,104
Estimated Capital Improvement Cost:	**$**	**1,801,000**

Project 2.2 Scenario C: L Street

PROJECT DESCRIPTION

Project ID	2.2 Scenario C
Project Name	L Street
Project Location	L Street from Lemontreet Way to Sycamore Drive
Description	Replace approximately 900 feet of 12-in pipe with 15-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$267,000
Comments	(i) Pipes are listed in order from upstream to downstream
Assumptions	(i) Cost assumes pipe will be upsized using Pipe-Burst construction method
	(ii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives	(i) Install parallel pipe

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-8-019	G21-8-020		12	15	465	0.31	9	Pipe Burst	$97	$ 45,098
G21-8-020	G21-7-003		12	15	411	0.39	10	Pipe Burst	$97	$ 39,808

Total Baseline Pipe Construction Cost	$	84,906
Insertion Trenches, Total of 3	$	6,600
Lower Lateral Replacement and Cleanout Cost, Total of 11	$	47,300
Baseline Construction Cost:	**$**	**138,806**
Bypass Pumping (10% of pipe construction cost)	$	8,491
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	9,151
Subtotal:	**$**	**156,447**
Mobilization/Demobilization (5% of subtotal)	$	7,822
Estimated Construction Cost Subtotal:	**$**	**164,270**
Contingencies (30% of construction subtotal)	$	49,281
Total Estimated Construction Cost:	**$**	**213,550**
Engineering, Administration, Legal (25% of construction cost)	$	53,388
Estimated Capital Improvement Cost:	**$**	**267,000**

Project 2.1 Scenario C: O Street Parallel Pipeline Alternative

PROJECT DESCRIPTION

Project ID	2.1 Scenario C
Project Name	O Street Parallel Pipeline Alternative
Project Location	Easement sewer from Sycamore Drive at Lemontree Way to O Street (Contra Costa County Fairgounds) at 10th street.
Description	Replace approximately 2,600 feet of 12-in to 18-in pipe with 15-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$1,407,000
Comments	(i) Pipes are listed in order from upstream to downstream (ii) Project includes replacing a 15-inch pipe located underneath a railroad
Assumptions	(i) Cost assumes pipe will be installed using open cut construction (ii) Cost estimates are based on April 2014 ENR CCI of 10208 (iii) Costs assume 120 lf of trenchless crossing underneath Union Pacific Railroad (between MH G21-7-011 to MH G21-7-049), with a 49-inch casing pipe (iv) Costs assume open cut construction across West Antioch Creek (construction during summer only)

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-7-010	G21-7-011		15	15	81	0.37	14	Open Cut	$215	$ 17,399
G21-7-011	G21-7-049		15	15	120	0.33	11	Trenchless	$1,184	$ 142,124
G21-7-011	G21-7-049		15	15	166	0.33	11	Open Cut	$215	$ 35,768
G21-7-049	G21-7-048		15	15	209	0.42	12	Open Cut	$215	$ 44,898
G21-7-048	G21-7-047		15	15	396	0.39	11	Open Cut	$215	$ 85,231
G21-7-047	G21-7-046		12	15	395	1.09	9	Open Cut	$215	$ 85,123
G21-7-046	F21-9-025		18	15	489	0.23	10	Open Cut	$215	$ 105,236
F21-9-025	F21-9-024SF		18	15	754	0.13	10	Open Cut	$215	$ 162,366

Total Baseline Pipe Construction Cost	$	678,145
1 Jacking Pit	$	81,000
1 Receiving Pit	$	48,000
New Manholes/Junction Structures, Total of 1	$	16,000
Baseline Construction Cost:	**$**	**823,145**
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	1,740
Subtotal:	**$**	**824,885**
Mobilization/Demobilization (5% of subtotal)	$	41,244
Estimated Construction Cost Subtotal:	**$**	**866,129**
Contingencies (30% of construction subtotal)	$	259,839
Total Estimated Construction Cost:	**$**	**1,125,968**
Engineering, Administration, Legal (25% of construction cost)	$	281,492
Estimated Capital Improvement Cost:	**$**	**1,407,000**

Project 2.2 Scenario C: L Street Parallel Pipeline Alternative

PROJECT DESCRIPTION

Project ID .... 2.2 Scenario C
Project Name .... L Street Parallel Pipeline Alternative
Project Location .... L Street from Lemontreet Way to Sycamore Drive

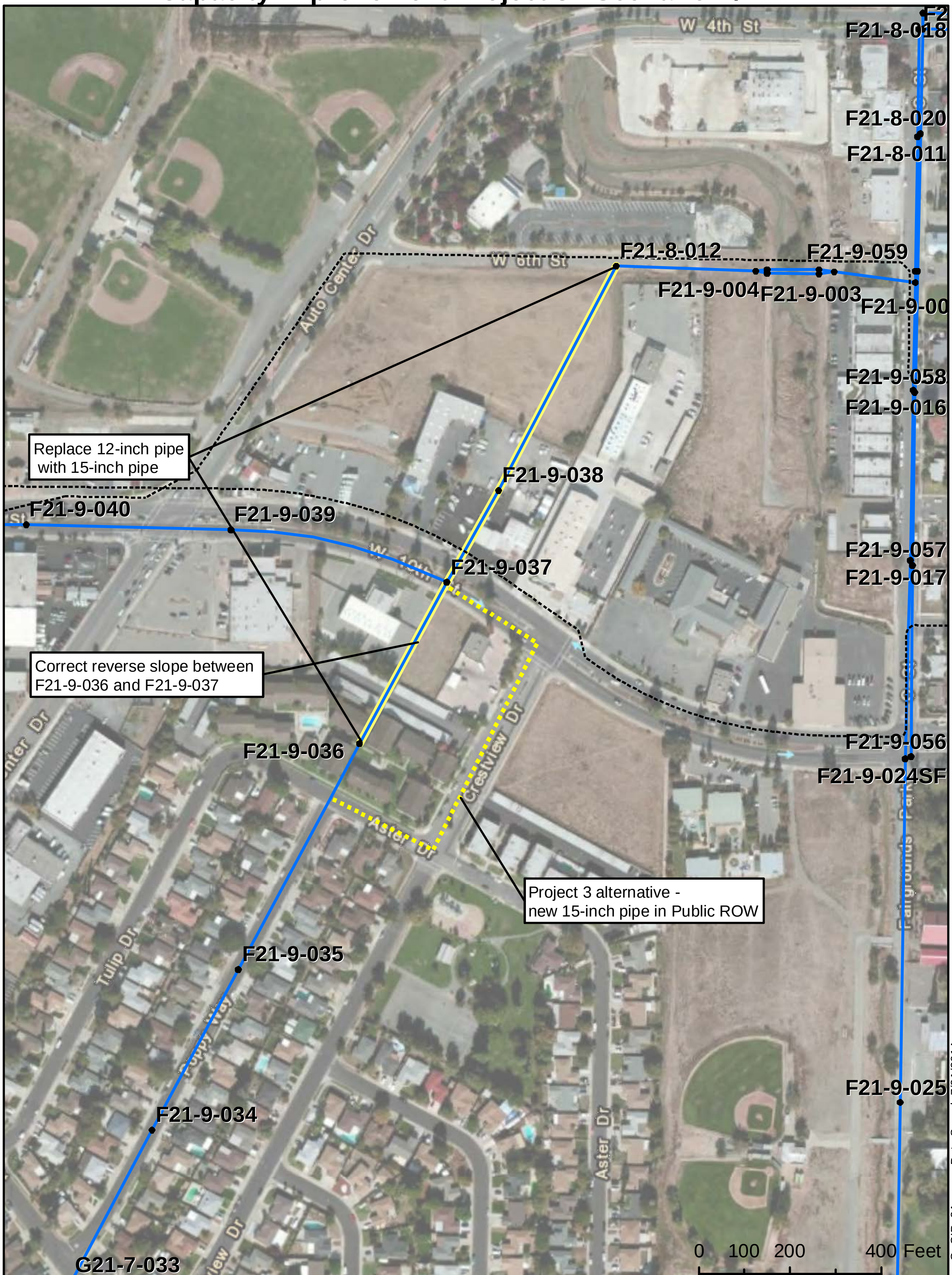
Description .... Replace approximately 900 feet of 12-in pipe with 12-in pipe
Scenario .... High RDI/I
Estimated Capital Improvement Cost $349,000
Comments .... (i) Pipes are listed in order from upstream to downstream
Assumptions .... (i) Cost assumes pipe will be installed using open cut construction
(ii) Cost estimates are based on April 2014 ENR CCI of 10208

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-8-019	G21-8-020		12	12	465	0.31	9	Open Cut	$205	$ 95,208
G21-8-020	G21-7-003		12	12	411	0.39	10	Open Cut	$205	$ 84,038

Total Baseline Pipe Construction Cost	$ 179,246
Insertion Trenches, Total of 3	$ 6,600
Lower Lateral Replacement and Cleanout Cost, Total of 0	$ -
Baseline Construction Cost:	**$ 185,846**
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$ 18,585
Subtotal:	**$ 204,431**
Mobilization/Demobilization (5% of subtotal)	$ 10,222
Estimated Construction Cost Subtotal:	**$ 214,652**
Contingencies (30% of construction subtotal)	$ 64,396
Total Estimated Construction Cost:	**$ 279,048**
Engineering, Administration, Legal (25% of construction cost)	$ 69,762
Estimated Capital Improvement Cost:	**$ 349,000**

Capacity Improvement Project 3 - Scenario A/B



City of Antioch
Wastewater Collection System Master Plan

Legend
- Modeled node
- DDSD pipeline
- Modeled pipeline
- Proposed project

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Project 3 Scenario A/B: Aster to 6th St. Easement

PROJECT DESCRIPTION

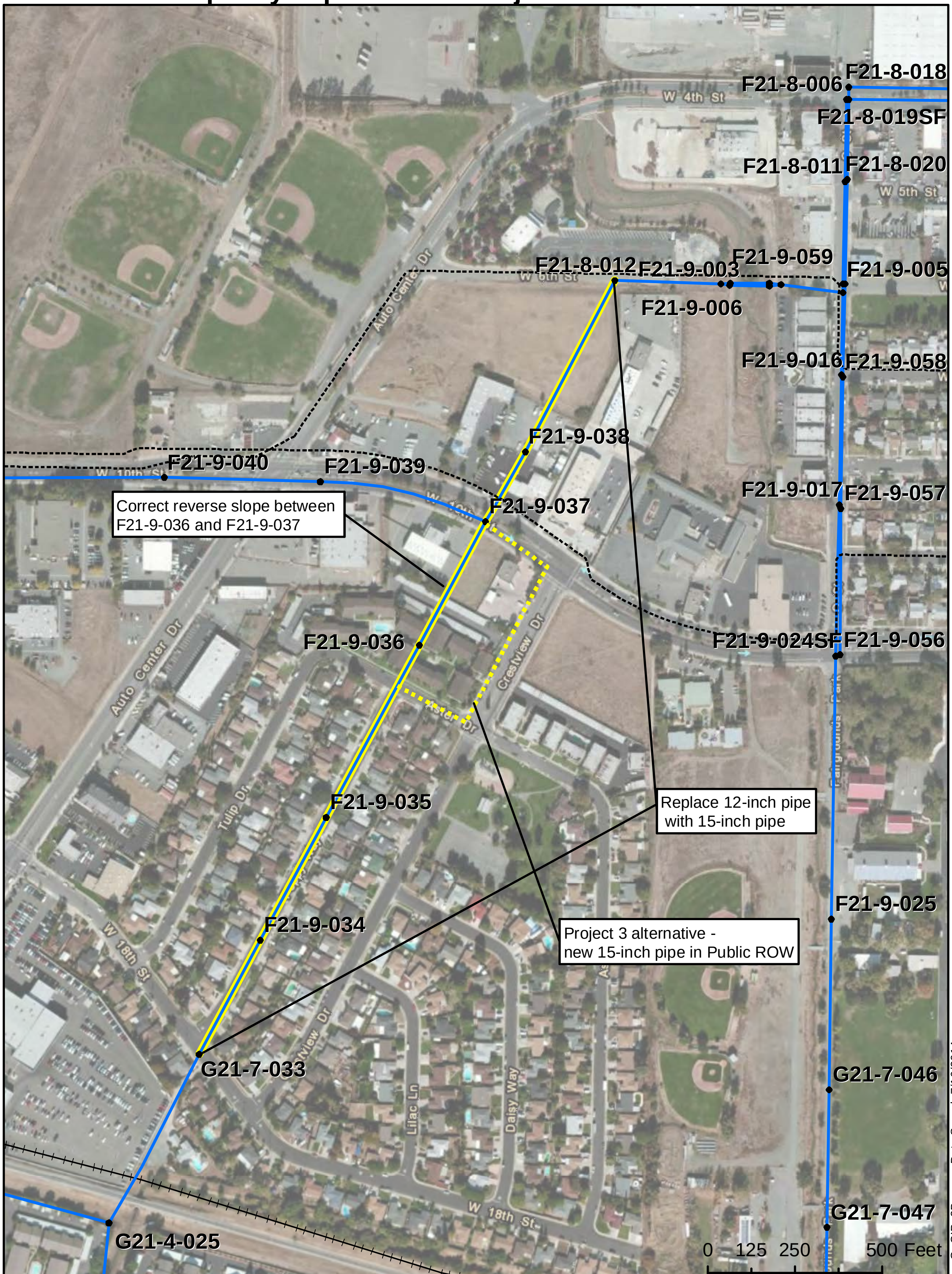
Project ID	3 Scenario A/B
Project Name	Aster to 6th St. Easement
Project Location	Easement sewer (extension of Poppy Way) from Aster Drive to 6th Street.
Description	Replace approximately 1,200 feet of 12-in pipe with 15-in pipe
Scenario	Base
Estimated Capital Improvement Cos	$435,000
Comments	(i) Pipes are listed in order from upstream to downstream (ii) Under the high infiltration scenario (Scenario C), project length would increase to 3,100 feet (MHID G21-4-025 to MHID F21-8-012). Diameter would not change.
Assumptions	(i) Cost assumes pipe will be upsized using open cut construction from F21-9-036 to F21-9-038 to correct reverse slope, and pipe bursting between MH F21-9-038 and F21-8-012. (ii) Cost assumes the construction of a new manhole when pipe bursting length exceeds 500 feet (iii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives	(i) Route new 15-inch pipeline from upstream of F21-9-036 SE on Aster Dr., NW on Crestview Dr, and NE on W 10th St. - reconnect at MH F21-9-037. Abandon existing easement sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
F21-9-036	F21-9-037	12	15	401	0.51	7	Open Cut	$215	$ 86,394
F21-9-037	F21-9-038	12	15	231	0.51	6	Open Cut	$215	$ 49,679
F21-9-038	F21-8-012	12	15	555	0.48	7	Pipe Burst	$97	$ 53,762

Total Baseline Pipe Construction Cost	$	189,834
Insertion Trenches, Total of 1	$	2,200
New Manholes/Junction Structures, Total of 1	$	6,000
Lower Lateral Replacement and Cleanout Cost, Total of 6	$	25,800
Baseline Construction Cost:	**$**	**223,834**
Bypass Pumping (10% of pipe construction cost)	$	19,203
Remove & Replace Factor (5% of pipe construction cost)	$	6,804
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	4,968
Subtotal:	**$**	**254,809**
Mobilization/Demobilization (5% of subtotal)	$	12,740
Estimated Construction Cost Subtotal:	**$**	**267,549**
Contingencies (30% of construction subtotal)	$	80,265
Total Estimated Construction Cost:	**$**	**347,814**
Engineering, Administration, Legal (25% of construction cost)	$	86,954
Estimated Capital Improvement Cost:	**$**	**435,000**

Capacity Improvement Project 3 - Scenario C



City of Antioch
Wastewater Collection System Master Plan

Legend
- Modeled node
- DDSD pipeline
- Modeled pipeline
- Proposed project

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Document Name: AppG_CIP_3B

Project 3 Scenario C: Poppy Way/Aster to 6th St. Easement

PROJECT DESCRIPTION

Project ID	3 Scenario C
Project Name	Poppy Way/Aster to 6th St. Easement
Project Location	Poppy Way from W. 18th Street to Aster Dr; easement from Aster Dr. to 6th St.
Description	Replace approximately 2,500 feet of 12-in pipe with 15-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$1,034,000
Comments	(i) Pipes are listed in order from upstream to downstream
Assumptions	(i) Cost assumes pipe will be upsized using open cut construction from F21-9-036 to F21-9-038 to correct reverse slope, and pipe bursting from MH G21-7-033 to MH F21-9-036, and from F21-9-038 to F21-8-012. (ii) Cost assumes the construction of a new manhole when pipe bursting length exceeds 500 feet (iii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives	(i) Route new 15-inch pipeline from upstream of F21-9-036 SE on Aster Dr., NW on Crestview Dr, and NE on W 10th St. - reconnect at MH F21-9-037. Abandon existing easement sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G21-7-033	F21-9-034		12	15	372	0.60	5	Pipe Burst	$97	$ 36,086
F21-9-034	F21-9-035		12	15	399	0.60	5	Pipe Burst	$97	$ 38,683
F21-9-035	F21-9-036		12	15	562	0.92	6	Pipe Burst	$97	$ 54,411
F21-9-036	F21-9-037		12	15	401	-0.05	7	Open Cut	$226	$ 90,714
F21-9-037	F21-9-038		12	15	231	0.57	6	Open Cut	$226	$ 52,163
F21-9-038	F21-8-012		12	15	555	0.48	7	Pipe Burst	$97	$ 53,762

Total Baseline Pipe Construction Cost	$	325,818
Insertion Trenches, Total of 7	$	15,400
New Manholes/Junction Structures, Total of 2	$	12,000
Lower Lateral Replacement and Cleanout Cost, Total of 45	$	193,500
Baseline Construction Cost:	**$**	**546,718**
Bypass Pumping (10% of pipe construction cost)	$	32,582
Remove & Replace Factor (5% of pipe construction cost)	$	7,144
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	19,674
Subtotal:	**$**	**606,118**
Mobilization/Demobilization (5% of subtotal)	$	30,306
Estimated Construction Cost Subtotal:	**$**	**636,424**
Contingencies (30% of construction subtotal)	$	190,927
Total Estimated Construction Cost:	**$**	**827,352**
Engineering, Administration, Legal (25% of construction cost)	$	206,838
Estimated Capital Improvement Cost:	**$**	**1,034,000**

Capacity Improvement Project 4 - Scenario C

City of Antioch
Wastewater Collection System Master Plan

Legend
- Modeled node
- DDSD pipeline
- Modeled pipeline
- Proposed project

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Project 4 Scenario C: Lone Tree Way

PROJECT DESCRIPTION	
Project ID	4 Scenario C
Project Name	Lone Tree Way
Project Location	Lone Tree Way near Mokelumne Drive to Sagebrush Drive.
Description	Replace approximately 3,800 feet of 12-in pipe with 15-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$794,000
Comments	(i) Pipes are listed in order from upstream to downstream
Assumptions	(i) Cost assumes pipe will be upsized using Pipe-Burst construction method
	(ii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives	(i) Install parallel pipe

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
J23-2-014	J23-2-013		12	15	416	0.22	15	Pipe Burst	$97	$ 40,302
J23-2-013	J23-2-012		12	15	321	0.33	14	Pipe Burst	$97	$ 31,096
J23-2-012	J23-2-011		12	15	322	0.32	13	Pipe Burst	$97	$ 31,154
J23-2-011	J23-2-010		12	15	321	0.31	12	Pipe Burst	$97	$ 31,096
J23-2-010	J23-2-009		12	15	381	0.38	12	Pipe Burst	$97	$ 36,881
J23-2-009	J23-3-022		12	15	400	0.36	13	Pipe Burst	$97	$ 38,780
J23-3-022	J23-6-001		12	15	401	0.66	11	Pipe Burst	$97	$ 38,848
J23-6-001	J23-6-002		12	15	399	0.54	9	Pipe Burst	$97	$ 38,625
J23-6-002	J23-6-003		12	15	401	0.55	10	Pipe Burst	$97	$ 38,858
J23-6-003	J23-6-004		12	15	362	0.54	12	Pipe Burst	$97	$ 35,069
J23-6-004	J23-6-005		12	15	48	18.95	16	Pipe Burst	$97	$ 4,671

Total Baseline Pipe Construction Cost	$ 365,381
Insertion Trenches, Total of 11	$ 24,200
Baseline Construction Cost:	**$ 389,581**
Bypass Pumping (10% of pipe construction cost)	$ 36,538
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$ 38,958
Subtotal:	**$ 465,077**
Mobilization/Demobilization (5% of subtotal)	$ 23,254
Estimated Construction Cost Subtotal:	**$ 488,330**
Contingencies (30% of construction subtotal)	$ 146,499
Total Estimated Construction Cost:	**$ 634,830**
Engineering, Administration, Legal (25% of construction cost)	$ 158,707
Estimated Capital Improvement Cost:	**$ 794,000**

Project 4 Scenario C: Lone Tree Way Parallel Pipeline Alternative

PROJECT DESCRIPTION

Project ID .... 4 Scenario C
Project Name .... Lone Tree Way Parallel Pipeline Alternative
Project Location .... Lone Tree Way near Mokelumne Drive to Sagebrush Drive.

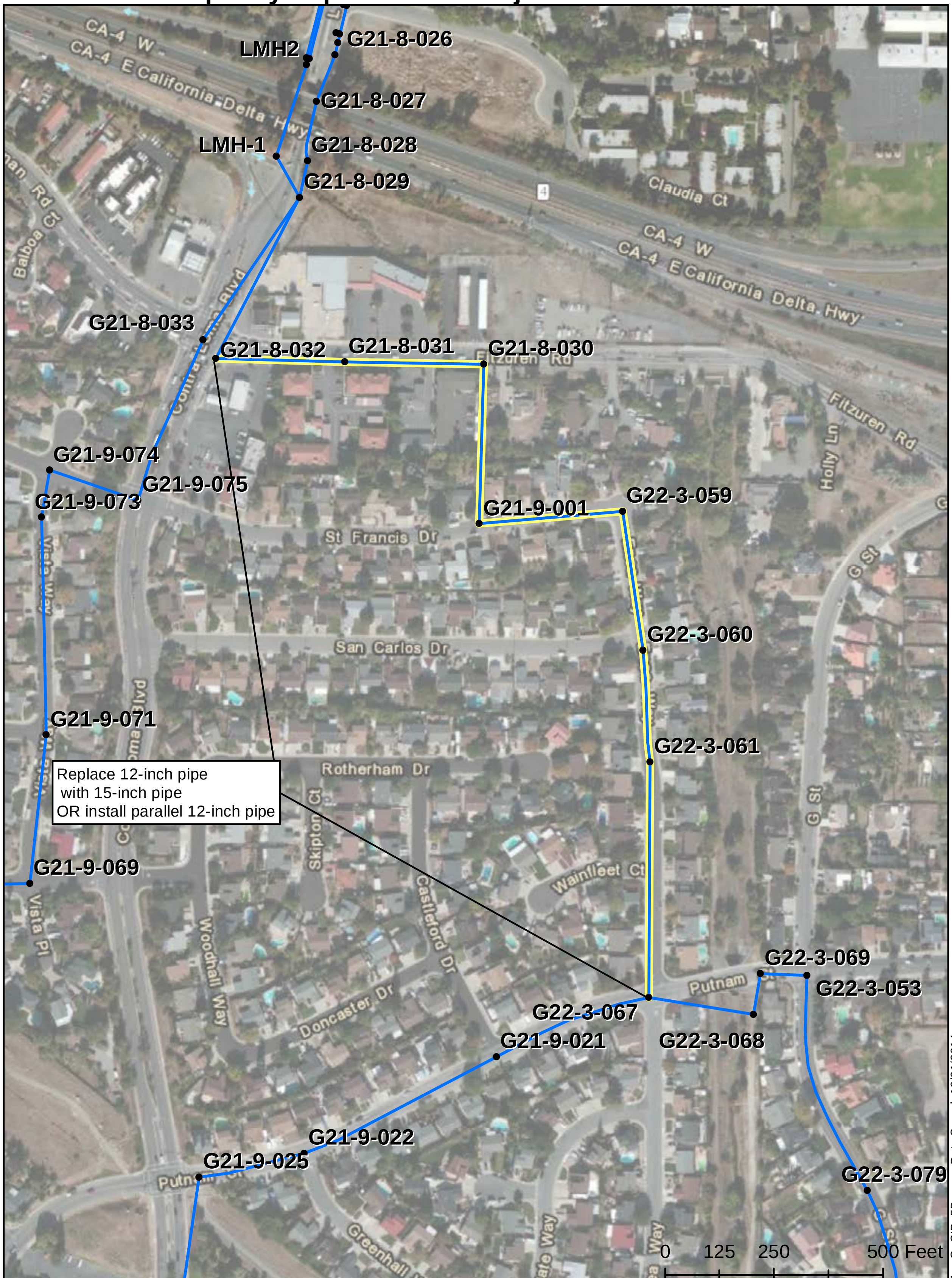
Description .... Replace approximately 3,800 feet of 12-in pipe with 12-in pipe
Scenario .... High RDI/I
Estimated Capital Improvement Cost $1,475,000
Comments .... (i) Pipes are listed in order from upstream to downstream
Assumptions .... (i) Cost assumes pipe will be installed using open cut construction
(ii) Cost estimates are based on April 2014 ENR CCI of 10208

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	InfoWork Link ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
J23-2-014	J23-2-013		12	12	416	0.22	15	Open Cut	$205	$ 85,081
J23-2-013	J23-2-012		12	12	321	0.33	14	Open Cut	$205	$ 65,647
J23-2-012	J23-2-011		12	12	322	0.32	13	Open Cut	$205	$ 65,770
J23-2-011	J23-2-010		12	12	321	0.31	12	Open Cut	$205	$ 65,647
J23-2-010	J23-2-009		12	12	381	0.38	12	Open Cut	$205	$ 77,860
J23-2-009	J23-3-022		12	12	400	0.36	13	Open Cut	$205	$ 81,870
J23-3-022	J23-6-001		12	12	401	0.66	11	Open Cut	$205	$ 82,013
J23-6-001	J23-6-002		12	12	399	0.54	9	Open Cut	$205	$ 81,542
J23-6-002	J23-6-003		12	12	401	0.55	10	Open Cut	$205	$ 82,033
J23-6-003	J23-6-004		12	12	362	0.54	12	Open Cut	$205	$ 74,035
J23-6-004	J23-6-005		12	12	48	18.95	16	Open Cut	$205	$ 9,860

Total Baseline Pipe Construction Cost	$	771,359
New Manholes/Junction Structures, Total of 1	$	16,000
Baseline Construction Cost:	**$**	**787,359**
Bypass Pumping (10% of pipe construction cost)	$	-
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	77,136
Subtotal:	**$**	**864,495**
Mobilization/Demobilization (5% of subtotal)	$	43,225
Estimated Construction Cost Subtotal:	**$**	**907,720**
Contingencies (30% of construction subtotal)	$	272,316
Total Estimated Construction Cost:	**$**	**1,180,035**
Engineering, Administration, Legal (25% of construction cost)	$	295,009
Estimated Capital Improvement Cost:	**$**	**1,475,000**

Capacity Improvement Project 5 - Scenario C



Date Saved: 10/21/2014

Document Name: AppG_CIP_5B

City of Antioch
Wastewater Collection System Master Plan

Legend
- Modeled node
- DDSD pipeline
- Modeled pipeline
- Proposed project

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Project 5 Scenario C: Enea Way

PROJECT DESCRIPTION

Project ID	5 Scenario C
Project Name	Enea Way
Project Location	Enea Way at Putnam Street to Fitzuren Road near Contra Loma Boulevard
Description	Replace approximately 2,400 feet of 12-in pipe with 15-in pipe
Scenario	High RDI/I
Estimated Capital Improvement Cost	$834,000
Comments	(i) Pipes are listed in order from upstream to downstream
Assumptions	(i) Cost assumes pipe will be upsized using Pipe-Burst construction method
	(ii) Cost assumes the construction of a new manhole when pipe bursting length exceeds 500 feet
	(iii) Cost estimates are based on April 2014 ENR CCI of 10208
Alternatives	(i) Install parallel pipe

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G22-3-067	G22-3-061	12	15	541	0.59	10	Pipe Burst	$97	$ 52,395
G22-3-061	G22-3-060	12	15	256	0.41	7	Pipe Burst	$97	$ 24,846
G22-3-060	G22-3-059	12	15	322	0.59	7	Pipe Burst	$97	$ 31,222
G22-3-059	G21-9-001	12	15	331	0.67	10	Pipe Burst	$97	$ 32,026
G21-9-001	G21-8-030	12	15	366	0.63	10	Pipe Burst	$97	$ 35,486
G21-8-030	G21-8-031	12	15	320	0.53	7	Pipe Burst	$97	$ 30,999
G21-8-031	G21-8-032	12	15	295	0.45	8	Pipe Burst	$97	$ 28,586

Total Baseline Pipe Construction Cost	$	235,560
Insertion Trenches, Total of 8	$	17,600
New Manholes/Junction Structures, Total of 1	$	6,000
Lower Lateral Replacement and Cleanout Cost, Total of 42	$	180,600
Baseline Construction Cost:	**$**	**439,760**
Bypass Pumping (10% of pipe construction cost)	$	23,556
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	25,316
Subtotal:	**$**	**488,632**
Mobilization/Demobilization (5% of subtotal)	$	24,432
Estimated Construction Cost Subtotal:	**$**	**513,064**
Contingencies (30% of construction subtotal)	$	153,919
Total Estimated Construction Cost:	**$**	**666,983**
Engineering, Administration, Legal (25% of construction cost)	$	166,746
Estimated Capital Improvement Cost:	**$**	**834,000**

Project 5 Scenario C: Enea Way Parallel Pipeline Alternative

PROJECT DESCRIPTION

Project ID .... 5 Scenario C
Project Name .... Enea Way Parallel Pipeline Alternative
Project Location .... Enea Way at Putnam Street to Fitzuren Road near Contra Loma Boulevard
Description .... Replace approximately 2,400 feet of 12-in pipe with 12-in pipe
Scenario .... High RDI/I
Estimated Capital Improvement Cost ... $1,115,000
Comments .... (i) Pipes are listed in order from upstream to downstream
Assumptions .... (i) Cost assumes pipe will be installed using open cut construction
(ii) Cost estimates are based on April 2014 ENR CCI of 10208

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)	New Diameter (inches)	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	Construction Method	Unit Cost ($/LF)	Total Cost ($)
G22-3-067	G22-3-061	12	12	541	0.59	10	Open Cut	$205	$ 110,612
G22-3-061	G22-3-060	12	12	256	0.41	7	Open Cut	$205	$ 52,452
G22-3-060	G22-3-059	12	12	322	0.59	7	Open Cut	$205	$ 65,913
G22-3-059	G21-9-001	12	12	331	0.67	10	Open Cut	$205	$ 67,611
G21-9-001	G21-8-030	12	12	366	0.63	10	Open Cut	$205	$ 74,914
G21-8-030	G21-8-031	12	12	320	0.53	7	Open Cut	$205	$ 65,443
G21-8-031	G21-8-032	12	12	295	0.45	8	Open Cut	$205	$ 60,349

Total Baseline Pipe Construction Cost	$	497,294
New Manholes/Junction Structures, Total of 1	$	16,000
Lower Lateral Replacement and Cleanout Cost, Total of 21	$	90,300
Baseline Construction Cost:	**$**	**603,594**
Traffic Control (10% of pipe construction cost for basic control plus additional 10% for complex)	$	49,729
Subtotal:	**$**	**653,323**
Mobilization/Demobilization (5% of subtotal)	$	32,666
Estimated Construction Cost Subtotal:	**$**	**685,989**
Contingencies (30% of construction subtotal)	$	205,797
Total Estimated Construction Cost:	**$**	**891,786**
Engineering, Administration, Legal (25% of construction cost)	$	222,947
Estimated Capital Improvement Cost:	**$**	**1,115,000**

Prepared by:

RMC
water and environment