CITY OF SOUTH SAN FRANCISCO

2022

CITY-WIDE SEWER SYSTEM MASTER PLAN

Final

July 2022

AKEL ENGINEERING GROUP, INC.

July 28, 2022

Engineering Division,
315 Maple Avenue
South San Francisco, CA, 94080

Attention: Jason Hallare, P.E.
Senior Engineer

Subject: 2022 City-Wide Sewer System Master Plan – Final Report

Dear Jason,

We are pleased to submit the Final Report for the City of South San Francisco City-Wide Sewer System Master Plan. The 2022 Sewer System Master Plan documents the following:

- Existing collection system facilities, acceptable hydraulic performance criteria, and projected sewer flows consistent with future growth assumptions
- Development and calibration of the City's GIS-based hydraulic sewer model.
- Capacity evaluation of the existing sewer system with improvements to mitigate existing deficiencies and to accommodate future growth.
- Capital improvement program (CIP) with an opinion of probable construction costs and suggestions for cost allocations to meet AB 1600.

We extend our thanks to you, Eunejune Kim, Public Works Director; Brian Schumacker, WQCP Superintendent; and other City staff whose courtesy and cooperation were valuable components in completing this study.

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E.
Senior Principal

Enclosure: Report

Acknowledgements

2022 City Council

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City of South San Francisco
City-Wide Sewer System Master Plan

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APPENDICES

EXECUTIVE SUMMARY

This executive summary presents a brief background of the City of South San Francisco sewer system, the planning area characteristics, the planning and design criteria and the hydraulic model development

The hydraulic model was used to evaluate the capacity adequacy of the existing wastewater collection system and for recommending improvements to mitigate existing deficiencies and for servicing future growth. The prioritized capital improvement program accounts for growth through the South San Francisco Planning Area

ES.1 STUDY OBJECTIVES

Recognizing the importance of planning, developing, and financing system facilities to provide reliable sewer collection system service to existing customers and for servicing anticipated growth within the sphere of influence, the City initiated the 2022 City-Wide Sewer System Master Plan.

The City of South San Francisco authorized Akel Engineering Group Inc. to complete the following tasks:

- Summarize the City's existing collection system facilities.
- Document growth planning assumptions and known future developments.
- Summarize the sewer collection system performance criteria and design storm event.
- Project future sewer flows.
- Develop and calibrate a new hydraulic model.
- Evaluate the adequacy of capacity for the sewer collection system facilities to meet existing and projected peak dry weather flows and peak wet weather flows.
- Recommend a capital improvement program (CIP) within opinion of probably construction costs.
- Perform a capacity allocation analysis for cost sharing purposes between existing users and future growth.
- Develop a 2022 Sewer System Master Plan Report.

ES.2 STUDY AREA DESCRIPTION

The City of South San Francisco (City) is located on the San Francisco Peninsula in San Mateo County, north of the City of San Bruno and south of Daly City (**Figure ES.1**). United States Highway 101 (Highway 101) bisects the City in a north-south direction; the western portion of the City is primarily comprised of residential and commercial development while the eastern portion is primarily industrial and research and development offices. The City limits currently encompass 9.1 square miles, with an estimated population of 67,135 residents, according to California Department of Finance (DOF) 2021 population estimates.

The study area for this master plan is located within the City's boundaries and is generally bound by Interstate 280 to the west, the San Francisco Bay to the east, the San Bruno mountain to the north, and San Bruno to the south (**Figure ES.2**).

ES.3 SYSTEM PERFORMANCE AND DESIGN CRITERIA

Gravity sewer capacities depend on several factors including: material and roughness of the pipe, the limiting velocity and slope, and the maximum allowable depth of flow. The hydraulic modeling software used for evaluation the capacity adequacy of the City's sewer collection system, InfoSWMM by Innovyze Inc., utilizes the fully dynamic St. Venant's equation which has a more accurate engine for simulating backwater and surcharge, in addition to manifolded force mains. The software also incorporates the use of the Manning's Equation in other calculations including upstream pipe flow conditions.

Partial Flow Criteria (d/D)

Partial flow in gravity sewers is expressed as a depth of flow to pipe diameter ratio (d/D). For circular gravity conduits, the maximum capacity is generally reached at 92 percent of the full height of the pipe (d/D ratio of 0.92). This is due to the additional wetted perimeter and increased friction of a gravity pipe.

When designing sewer pipelines, it is common practice to use variable flow depth criteria that allow higher safety factors in larger pipes. Thus, design d/D ratios may range between 0.5 and 0.92, with the lower values used for smaller pipes. The smaller pipes may experience peak flows greater than planned or may experience blockages from debris. The City's design standards pertaining to the d/D criteria are summarized in **Table ES.1**.

During peak dry weather flows (PDWF), the maximum allowable d/D ratio for proposed pipes (all diameters) is 0.75. The maximum allowable d/D ratio for all existing pipes (all diameters) is 0.90. This criterion for existing pipe replacement is to maximize the use of the existing pipes before costly pipe improvements are required.

During peak wet weather flows (PWWF), to avoid premature or unnecessary trunk line replacements, the capacity analysis allowed the d/D ratio to exceed the dry weather flow criteria

Legend

- Major Highways
- Study Area
- Protected Open Space
- Urbanized Area

Update: August 27, 2018

0 0.5 1 2 Miles

N W E S

Figure ES.1
Regional Location Map

City-Wide Sewer System
Master Plan
City of South San Francisco

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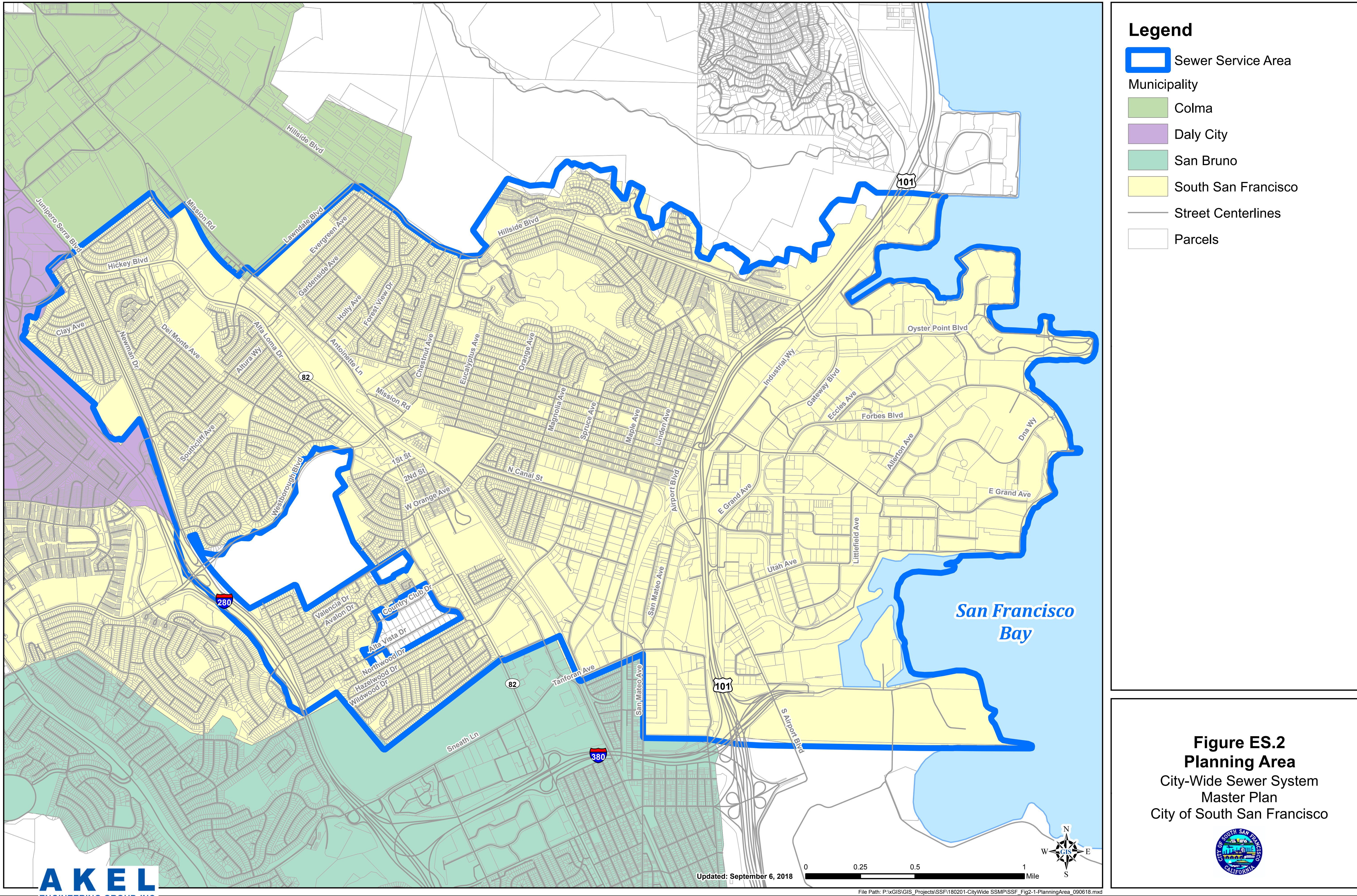

Figure ES.2
Planning Area
City-Wide Sewer System
Master Plan
City of South San Francisco

Table ES.1 Sewer System Performance and Design Criteria

City-Wide Sewer System Master Plan
City of South San Francisco

Dry Weather Flow Criteria	
Sewer Trunk	**d/D**
Existing System	0.90
Future System	0.75
Wet Weather Flow Criteria[2]	
HGL must be at least 1 foot below manhole rim elevation	
Pipe Slope Criteria	
Pipe Size	**Minimum Slope (ft/ft)**
8"	0.0026
10"	0.0019
12"	0.0015
15"	0.0011
18"	0.0009
21" and Up[1]	0.0008
Pipe Velocity Criteria	
Pipe Type	**Minimum / Maximum Velocity (fps)**
Gravity Sewer	Minimum 2 / Maximum 10
Force Main	Desired 2 to 6.5 / Maximum 10

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Notes:

1. Source: 2002 East of 101 Sewer System Master Plan
2. Wet Weather Flow Criteria reduced from 3 feet to 1 foot below manhole rim elevation per City instruction on April 5, 2021.

listed on **Table ES.1**, which stipulates that the hydraulic grade line (HGL), even during a surcharged condition, should be at least one foot below the manhole rim elevation.

ES.4 EXISTING SEWER COLLECTION SYSTEM OVERVIEW

The City provides sewer collection services to approximately 13,100 residential, commercial, industrial, and institutional accounts. The City's collection system consists of gravity mains and force mains, with pipe sizes up to 42-inches, that convey flows towards the WQCP, south of the San Bruno Canal, as shown on **Figure ES.3**.

The west of Highway 101 east of Highway 101 pipe inventory, listing the total length by pipe diameter, is documented on **Table ES.2** and **Table ES.3**. This table is based on GIS information provided by City staff. The 6-inch and 8-inch diameter pipes account for more than 78 percent of the total gravity main pipe lengths.

ES.5 SEWER FLOWS

The sewer flows collected and treated at the Water Quality Control Plant (WQCP) vary monthly, daily, and hourly. While the dry weather flows are influenced by customer uses, the wet weather flow are influenced by the severity and length of storm events and the condition of the system.

Influent flow data at the WQCP was obtained from City operation staff. The flow data covered a period from 2008 to 2018. From this data, monthly, daily, and peak daily flows were determined.

The land use methodology was used to estimate the buildout flows from the City's Planning area and to be consistent with the General Plan. The undeveloped lands were multiplied by the corresponding unit flow factor to estimate the sewer flows The buildout average daily flows for the West of Highway 101 and East of Highway 101 systems were calculated at 4.05 mgd and 3.08 mgd respectively.

ES.6 HYDRAULIC MODEL DEVELOPMENT AND CALIBRATION

The City's hydraulic model combines information of the physical characteristics of the sewer collection system (pipelines, pump station) and other operation characteristics (how they operate). The hydraulic model then performs calculations and solves series of equations to simulate flows in pipes, including backwater calculation for surcharged conditions.

There are several network analysis software products released by different manufacturers that can equally perform the hydraulic analysis satisfactorily. The selection of a particular software depends on user preferences, the sewer collection system's unique requirements, and the costs of purchasing and maintaining the software.

The hydraulic modeling software used for evaluating the capacity adequacy of the City's sewer collection system, InfoSWMM by Innovyze Inc, utilizes the fully dynamic St. Venant's equation which has a more accurate engine for simulating backwater and surcharge conditions, in addition

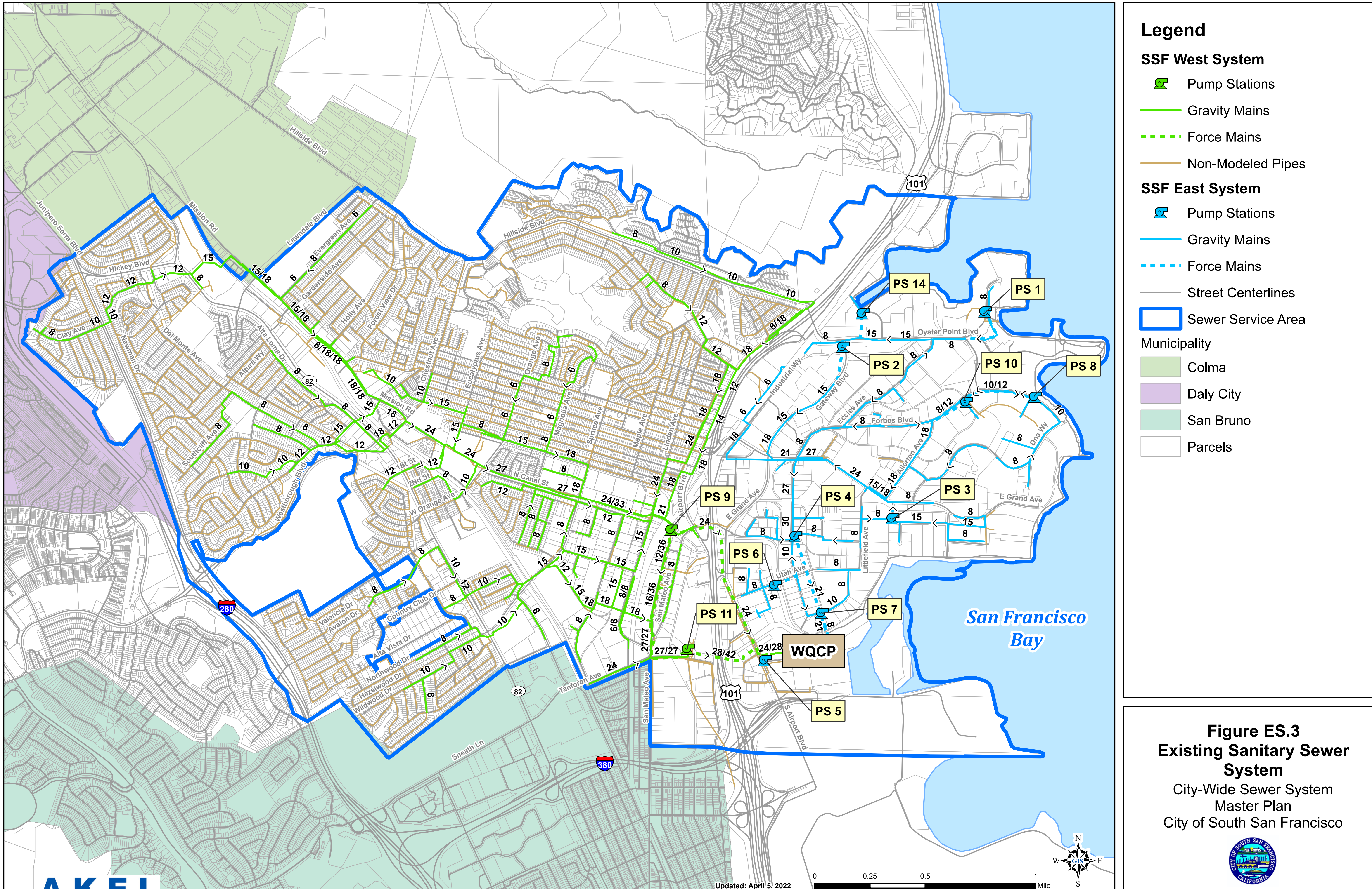

Figure ES.3
Existing Sanitary Sewer System

City-Wide Sewer System Master Plan
City of South San Francisco

Table ES.2 Existing GIS Pipe Inventory (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
4	492	0.1
6	371,728	70.4
8	63,335	12.0
10	18,603	3.5
12	13,824	2.6
14	1,084	0.2
15	16,852	3.2
16	1,177	0.2
18	18,453	3.5
21	2,928	0.6
24	10,173	1.9
27	6,267	1.2
30	96	0.0
33	2,606	0.5
36	3,270	0.6
Unknown	7,453	1.4
SubTotal	538,340	102.0
Force Mains		
24	4,674	0.9
27	1,869	0.4
28	2,281	0.4
36	2,219	0.4
SubTotal	11,044	2.1
Total East of Highway 101 Pipe Length		
Total	**549,384**	**104.1**

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Note:

1. Information extracted from GIS shapefiles provided by City Staff on 03/13/2018.

Table ES.3 Existing GIS Pipeline Inventory (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
6	5,150	1.0
8	39,240	7.4
10	5,949	1.1
12	3,161	0.6
15	10,603	2.0
18	2,275	0.4
20	0	0.0
21	793	0.2
24	924	0.2
27	2,045	0.4
30	315	0.1
Unknown	801	0.2
Subtotal	71,256	13.5
Force Mains		
6	595	0.1
8	2,493	0.5
10	2,000	0.4
12	2,746	0.5
21	2,649	0.5
SubTotal	10,484	2.0
Total East of Highway 101 Pipe Length		
Total	**81,740**	**15.5**

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to having the capability for simulating manifolded force mains. The software also incorporates the use of the Manning Equation in other calculations including upstream pipe flow conditions. The St. Venant's and Manning's equations are discussed in the System Performance and Design Criteria chapter.

Model Development

The hydraulic model for the City of South San Francisco was skeletonized to include the pipelines essential to the hydraulic analysis.

Skeletonizing the model refers to the process where pipes not essential to the hydraulic analysis of the system are stripped from the model. Skeletonizing the model is useful in creating a system that accurately reflects the hydraulics of the pies within the system. In addition, skeletonizing the model will reduce both the complexities of large models and the time of analysis while maintaining accuracy, but will also comply with the limitations imposed by the computer program.

In the City of South San Francisco's case, skeletonizing was necessary to reduce the model from approximately 119 miles of pipeline extracted from the GIS to 70 miles of pipeline. The modeled pies include pipes 8-inches in diameter and larger, in addition to some critical smaller gravity sewer pipes The inventory pipelines included in the hydraulic model are approximately 58 percent of the overall system .

Model Calibration

Calibration can be performed for steady state conditions, which model the peak hour flows, or for dynamic conditions (24 hours or more). Dynamic calibration consists of comparing the model predictions to diurnal operational changes in the wastewater flows. The City's hydraulic model was calibrated for dynamic conditions.

In sewer collection system, and when using dynamic hydraulic modeling to evaluate the impact of wet weather flows, it is common practice to calibrate the model to the following three conditions.

- Peak dry weather flows on a weekday and a weekend
- Peak wet weather flows from storm rainfall Event No. 1.
- Peak wet weather flows from storm rainfall Event No. 2.

After the model is calibrated to these conditions, it is benchmarked and used for evaluating the capacity adequacy of the sewer collection system, under dry and wet weather conditions.

The hydraulic model is a valuable investment that will continue to prove its worth to the City as future planning issues or other operational conditions surface. It is recommended that the model be maintained and updated with new construction projects to preserve its integrity.

ES.7 CONDITION AND RISK ASSESSMENT

Risk assessment and analysis is at the heart of asset management planning, and is one of the primary tools used for identifying and prioritizing renewal projects with highest urgency. The results of this process guide optimized decisions on financial planning, and are used for choosing where the limited available public funds are more wisely spent.

Methodology

Risk analysis consist of assessing the probability (or likelihood) of an asset failing, and more importantly linking it to a consequence if such failure was to occur. This analysis allows the agency to identify existing and future risks that potentially impact the level of customer service and the associated costs. Thus, the risk, also known as the business risk exposure (BRE), is calculated by multiplying the probability or likelihood of failure (LOF) by the consequence of failure (COF).

The probability (or likelihood) of failure analysis allows a prediction of failure timing for a particular asset. Did the asset fail to meet the level of service? Has capacity become inadequate? How is the structural condition? Is the lifecycle cost efficient? A numerical LOF score is assigned to each asset based on this assessment.

The consequence of failure analysis assesses the impact of such failure on the residential or commercial environment, and the resulting anticipated economic loss.

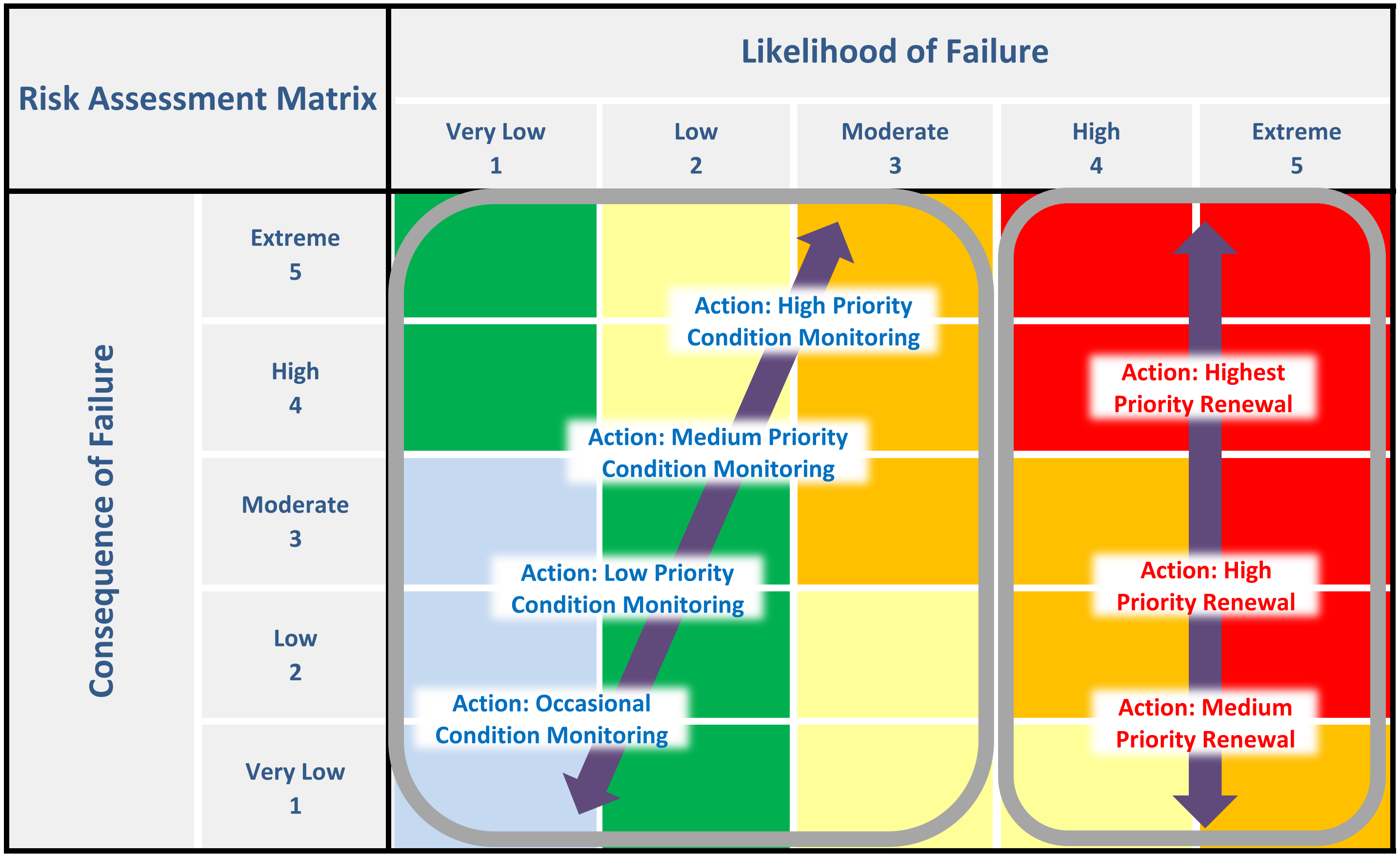
A total of 5 categories were used to assign numerical scores to each likelihood of failure and consequence of failure category. Furthermore, each identified category was assigned a weight based on its criticality. A higher weight means the score for a pipeline from a particular criterion will contribute more to total COF or LOF score than a criterion with a lower weight. The five Risk rating categories include: Extreme, High, Moderate, Low, and Very Low. High scores are associated with the Extreme and High Rating categories and represent at risk assets that require immediate attention. Low scores are associated with the Very Low or Low rating categories and may represent new or low risk assets.

The Risk Assessment Matrix on **Figure ES.4** illustrates how assets are classified in the Extreme rating category (red) or High rating category (orange), by combining their LOF and COF scores.

The red and orange zone on this figure indicate the projects requiring immediate attention for either renewal or replacement. The yellow zone highlights assets for aggressive monitoring. The green and blue zone require simple monitoring .

ES.8 CAPACITY EVALUATION

The system performance and design criteria were used as a basis to judge the adequacy of capacity for the existing sewer collection system. The design flows simulated in the hydraulic model for existing conditions are listed as follow:



LEGEND

Risk Color Coding

Extreme | *High* | *Moderate* | *Low* | *Very Low*

Renewal Actions Levels

Highest Priority | *High Priority* | *Medium Priority*

Condition Monitoring Levels

High Priority | *Medium Priority* | *Low Priority* | *Occasional*

July 20, 2022

Figure ES.4

Risk Assessment Scoring and Action Plan

City-Wide Sewer System Master Plan

South San Francisco

West of Highway 101

- Existing PDWF = 12.5 mgd
- Existing PWWF = 64.5 mgd

East of Highway 101

- Existing PDWF = 3.9 mgd
- Existing PWWF = 5.5 mgd

During the peak dry weather simulation, the maximum allowable pipe d/D criteria of 0.75 was used for new pipes. For existing pipes, the criteria was relaxed to allow a maximum d/D ratio of 0.90 (full pipe capacity) to prevent unnecessary pipe replacements. During the peak wet weather simulations, capacity deficiencies included pipe segments with a hydraulic grade line (HGL) that rises within one foot of the manhole rim elevation.

In general, the hydraulic model indicated that the sewer collection system exhibited acceptable performance to service the existing customers during peak dry weather flows, with some areas of noted deficiency. Future flows were then added to the hydraulic model and the existing system was expanded in order to serve these future customers. The proposed improvements for the future system are shown with pipes sizes on **Figure ES.5** and **Figure ES.6**.

ES.8 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Program includes pipeline improvements recommended in this master plan (**Table ES.5** and **Table ES.6**). Each improvement was assigned a uniquely coded identifier associated with its tributary area. The baseline costs for pipelines and lift stations are shown in **Table ES.4**.

The estimated costs include the baseline costs plus 30 percent contingency allowance to account for unforeseen events and unknown field conditions. Capital improvement costs include the estimate construction costs plus 50 percent project related costs (engineering design, project administration, construction management and inspection, and legal costs).

The costs in this City-Wide Sewer System Master Plan were benchmarked using the City of San Francisco ENR CCI of 15,327, reflecting a date of June 2022. In total, the CIP for the West of Highway 101 system includes approximately 4.4 miles of gravity main improvements with a total cost totaling over 94.0 million dollars. Additionally, the CIP for the East of Highway 101 system includes approximately 4,500 feet of gravity main improvements with a total cost totaling over 16.2 million dollars.

Lastly, the Risk and Condition Assessment improvements include approximately 12.2 miles of gravity main improvements and rehab actions with a cost totaling over 19.4 million dollars.

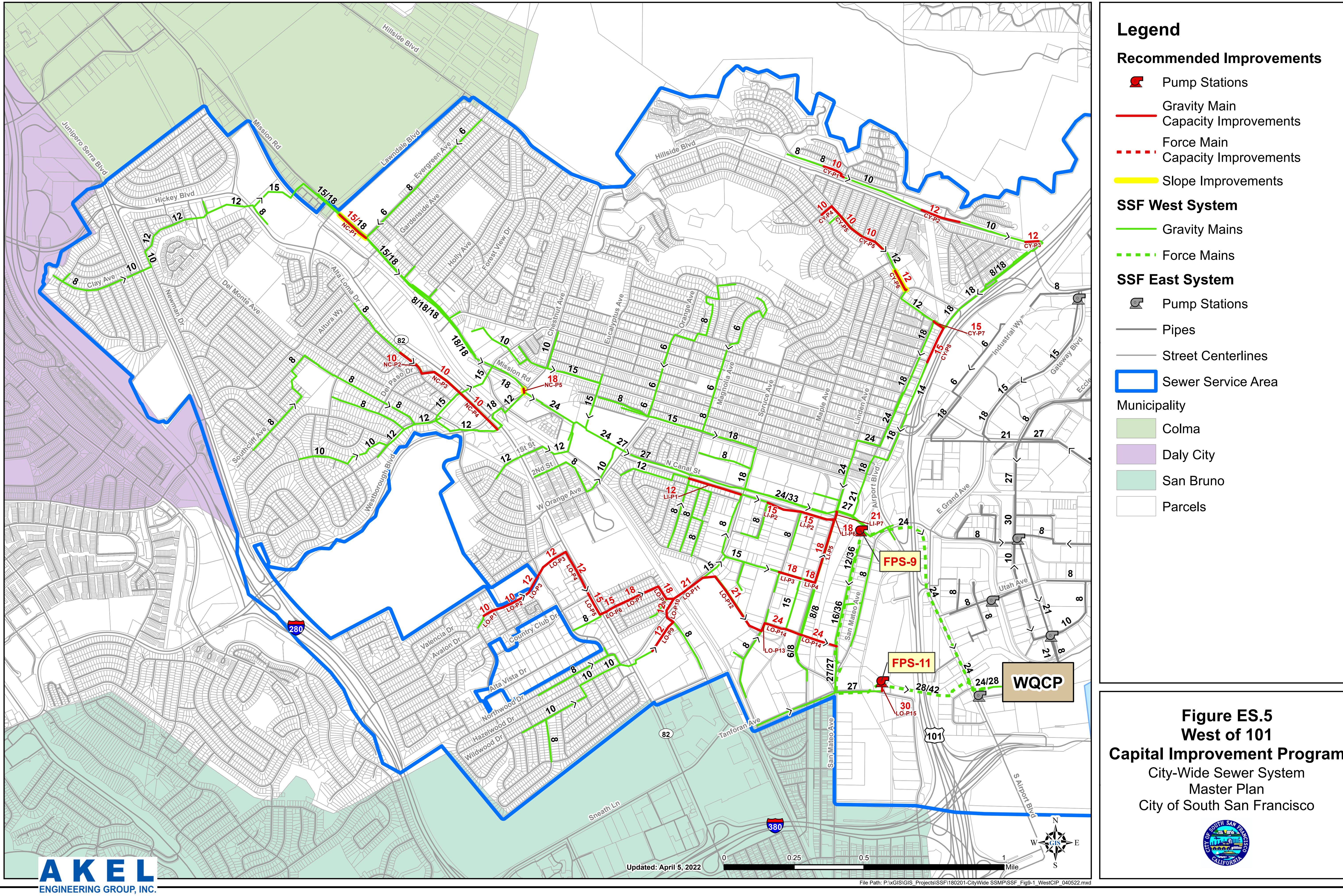
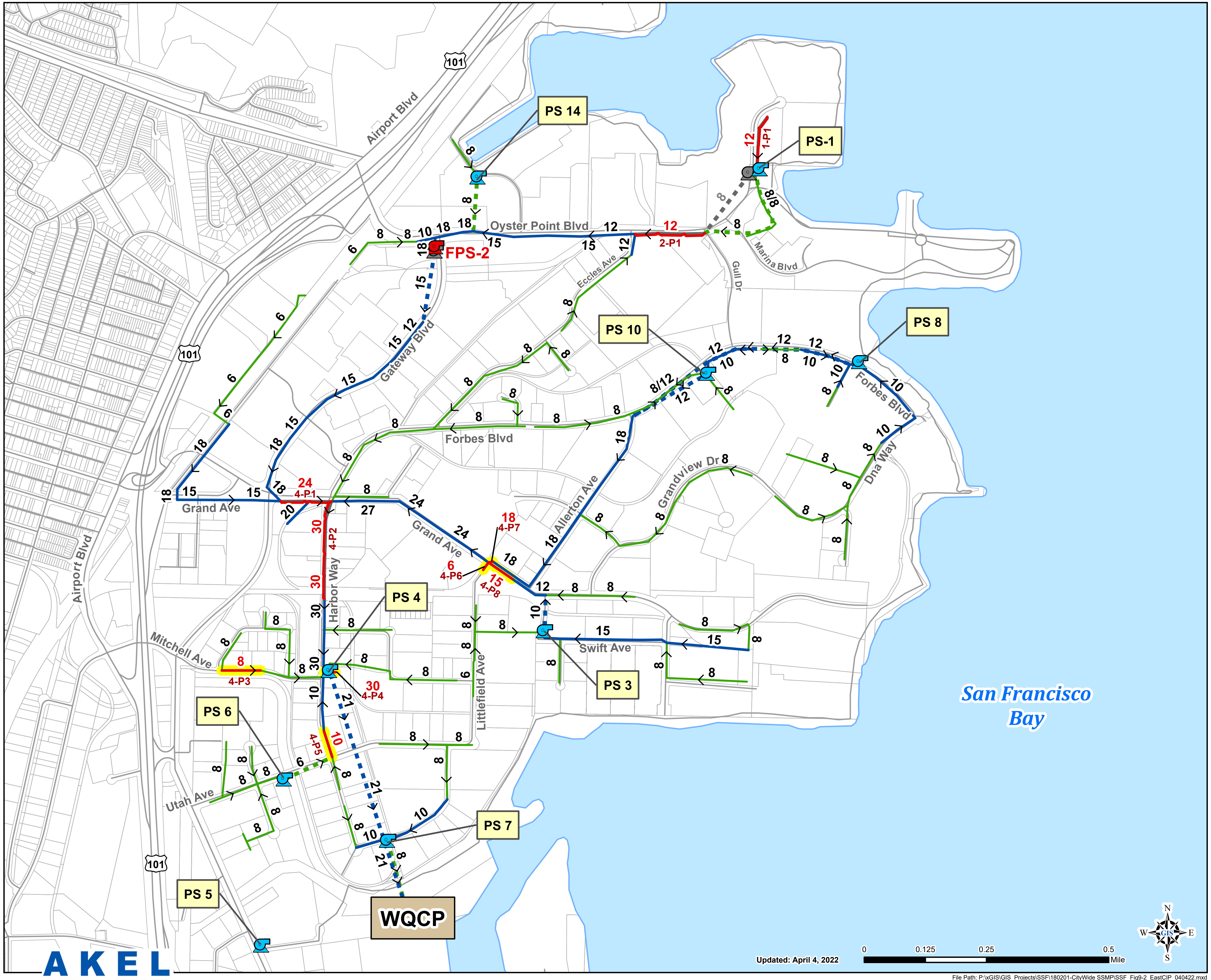


Figure ES.5
West of 101
Capital Improvement Program
City-Wide Sewer System
Master Plan
City of South San Francisco



Legend

Recommended Improvements

- Pump Station
- Gravity Pipes
- Slope Improvements

To be Abandoned

- Pump Stations
- Gravity Pipes
- Force Mains

Existing System

- Pump Stations
- Gravity Pipes
  - 8" and Smaller
  - 10" and Larger
- Force Mains
  - 8" and Smaller
  - 10" and Larger
- Street Centerlines
- Parcels

Figure ES.6
East of 101
Capital Improvement Program
City-Wide Sewer System
Master Plan
City of South San Francisco

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Table ES.4 Unit Costs

City-Wide Sewer System Master Plan
South San Franciscc

Pipeline Replacement and Renewal						
Pipe Size	Improvement Type Unit Cost					
	New/Parallel/ Replace	Pipe Bursting	Lining	Force Main Condition Assessment	CCTV	Cleaning
(in)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)
4	$289	$62	$15	$6.7	$2.7	$2.3
6	$271	$107	$22	$6.7	$2.7	$2.3
8	$334	$145	29.63	$6.7	$2.7	$2.3
10	$390	$167	$37	$6.7	$2.7	$2.3
12	$446	$177	$44	$6.7	$2.7	$2.3
14	$519	$180	$52	$6.7	$2.7	$2.3
15	$556	$181	$56	$6.7	$2.7	$2.3
16	$593	$201	$59	$6.7	$2.7	$2.3
18	$668	$221	$67	$6.7	$2.7	$2.3
21	$780	$160	$105	$6.7	$2.7	$2.3
24	$836	$141	$143	$6.7	$2.7	$2.3
27	$890	$159	$181	$6.7	$2.7	$2.3
28	$937	$164	$194	$6.7	$2.7	$2.3
30	$1,005	$176	$219	$6.7	$2.7	$2.3
33	$1,097	$194	$257	$6.7	$2.7	$2.3
36	$1,188	$212	$295	$6.7	$2.7	$2.3
42	$1,372	$169	$371	$6.7	$2.7	$2.3
48	$1,554	$283	$448	$6.7	$2.7	$2.3

Manhole Replacement and Rehabilitation[4]

Manhole Rehabilitation is estimated to cost approximately $4,350 per manhole

Manhoe Replacement is estimated to cost approximately $32,800 per manhole

Lift Stations

Estimated Pump Station Project Cost = 1,914,694*$Q^{0.60}$ (where Q is in mgd)

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7/11/2022

Notes:

1. Units Costs are based on an ENR CCI Index Value of 15,327 June 2022.
2. Units Costs for Pipe Bursting are based on study of underground construction costs.
3. Units Costs for Lining are based on a USDA summary of trenchless technology.
4. Unit Costs for Manhole Replacement and Rehabilitation are based on bid sheets for comparable projects.

Table ES.5 Capital Improvement Program (West of 101)
City-Wide Sewer System Master Plan
City of South San Francisco

Improvement No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	New/Parallel/ Replace	Pipeline Improvements Diameter (in)	Length (in)	Pipe Unit Cost[3,4] ($/unit)	Infrastructure Costs Baseline Constr. Costs ($)	Estimated Constr. Costs[5] ($)	Capital Improv. Costs[6] ($)	Construction Trigger (gpm)	Suggested Cost Allocation Existing Users (%)	Future Users (%)	Cost Sharing Existing Users ($)	Future Users ($)
Gravity Main Improvements																	
North Canal Trunk																	
NC-P1[7]	Existing-Slope	Mission Rd	From Lawndale Blvd to Evergreen Dr	15	3	Replace	15	675	556	563,250	732,300	1,098,500	-	69%	31%	762,939	335,561
NC-P2	Existing-Capacity	Alta Loma Dr	From 550' nw/o Del Paso Dr to Del Paso Dr	8	3	Replace	10	600	390	234,000	304,200	456,300	-	100%	0%	456,300	0
NC-P3	Existing-Capacity	Del Paso Dr	From Alta Loma Dr to Arroyo Dr	8	3	Replace	10	825	390	321,700	418,300	627,500	-	100%	0%	627,500	0
NC-P4	Existing-Capacity	El Camino Real	From Arroyo Dr to 270' s/o Westborough Blvd	8	4	Replace	10	1,050	390	409,500	532,400	798,600	-	100%	0%	798,600	0
NC-P5[7]	Existing-Slope	Mission Rd	From 75' w/o Chestnut Ave to Chestnut Ave	18	5	Replace	18	100	668	100,350	130,500	195,800	-	97%	3%	189,660	6,140
									Subtotal - North Canal Trunk	**1,628,800**	**2,117,700**	**3,176,700**				**2,834,998**	**341,702**
Lowrie Trunk																	
LO-P1	Existing-Capacity	Avalon Dr	From 65' e/o Dana Ct to Constitution Wy	8	5	Replace	10	250	390	97,500	126,800	190,200	-	46%	54%	87,152	103,048
LO-P2	Existing-Capacity	ROW	From Constitution Wy to Pisa Ct	8	5	Replace	10	350	390	136,500	177,500	266,300	-	45%	55%	120,753	145,547
LO-P3	Existing-Capacity	ROW	From Pisa Ct to El Camino Real	8	5	Replace	12	1,450	446	646,500	840,500	1,260,800	-	45%	55%	563,647	697,153
LO-P4	Existing-Capacity	El Camino Real	From 230' s/o Ponderosa Rd to 325' n/o Country Club Dr	10	5	Replace	12	625	446	278,700	362,400	543,600	-	42%	58%	230,507	313,093
LO-P5	Existing-Capacity	El Camino Real	From 325' n/o Country Club Dr to Portola Ave	10 / 12	5	Replace	15	750	556	417,200	542,400	813,600	-	39%	61%	320,054	493,546
LO-P6	Existing-Capacity	Portola Ave	From El Camino Real to Ramona Ave	12	5	Replace	15	350	556	194,700	253,200	379,800	-	38%	62%	142,992	236,808
LO-P7	Existing-Capacity	Portola Ave	From Ramona Drive to Francisco Dr	12	5	Replace	18	900	668	601,300	781,700	1,172,600	-	39%	61%	460,409	712,191
LO-P8	Existing-Capacity	Francisco Dr	From 160' w/o Centennial Way Tr to Portola Ave	10 / 12	5	Replace	18	425	668	284,000	369,200	553,800	-	46%	54%	254,760	299,040
LO-P9	Existing-Capacity	Spruce Ave	From 490' e/o El Camino Real to Huntington Ave	10	5	Replace	12	700	446	312,100	405,800	608,700	-	38%	62%	230,799	377,901
LO-P10	Existing-Capacity	Spruce Ave	From Huntington Ave to 160' w/o Centennial Way Tr	10	5	Replace	12	550	446	245,200	318,800	478,200	-	33%	67%	159,806	318,394
LO-P11	Existing-Capacity	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	15	5	Replace	21	675	780	526,400	684,400	1,026,600	-	40%	60%	408,884	617,716
LO-P12	Existing-Capacity	ROW	From Spruce Ave to Maple Ave	12 / 15 / 18	4	Replace	21	1,625	780	1,267,200	1,647,400	2,471,100	-	38%	62%	947,780	1,523,320
LO-P13	Existing-Capacity	Maple Ave	From 605' n/o Browning Wy to 765' n/o Browning Wy	18	4	Replace	21	175	780	136,500	177,500	266,300	-	43%	57%	113,379	152,921
LO-P14	Existing-Capacity	ROW	From Maple Ave to Lowrie Ave	18	4	Replace	24	1,450	836	1,211,800	1,575,400	2,363,100	-	41%	59%	973,218	1,389,882
LO-P15[7]	Existing-Capacity	ROW	From Shaw Road to Shaw Road LS-11	27	5	Replace	30	200	1,005	201,000	261,300	392,000	-	78%	22%	304,018	87,982
LO-P16	Casing	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	-	5	New	41	200	1,006	201,200	261,600	392,400	-	40%	60%	156,289	236,111
									Subtotal - Lowrie Trunk	**6,757,800**	**8,785,900**	**13,179,100**				**5,474,448**	**7,704,652**
Linden Trunk																	
LI-P1	Existing-Capacity	S Canal St	From Magnolia Ave to Spruce Ave	8	3	Replace	12	1,025	446	457,000	594,100	891,200	-	100%	0%	891,200	0
LI-P2	Existing-Capacity	S Canal St	From Starlite St to Linden Ave	8 / 12	3	Replace	15	1,300	556	723,100	940,100	1,410,200	-	79%	21%	1,115,280	294,920
LI-P3	Existing-Capacity	Victory Ave	From S Maple Ave to 280' w/o Linden Ave	15	5	Replace	18	450	668	300,700	391,000	586,500	-	53%	47%	309,331	277,169
LI-P4	Existing-Capacity	Victory Ave	From 190' w/o Linden Ave to Linden Ave	15	5	Replace	18	200	668	133,700	173,900	260,900	-	52%	48%	136,010	124,890
LI-P5	Existing-Capacity	Linden Ave	From Victory Ave to S Canal St	8 / 12 / 15	3	Replace	18	1,250	668	835,100	1,085,700	1,628,600	-	56%	44%	911,813	716,787
LI-P6	Existing-Capacity	Linden Ave	From S Canal St to N Canal St	15	3	Replace	18	125	668	83,600	108,700	163,100	-	73%	27%	118,614	44,486
LI-P7	Existing-Capacity	Linden Ave	From N Canal St to 100 ft n/o N Canal St	15	3	Replace	21	100	780	78,000	101,400	152,100	-	73%	27%	110,678	41,422
LI-P8	Casing	Linden Ave	From S Canal St to N Canal St	-	3	New	38	100	937	93,700	121,900	182,900	-	73%	27%	133,014	49,886
									Subtotal - Linden Trunk	**2,704,900**	**3,516,800**	**5,275,500**				**3,725,939**	**1,549,561**

Table ES.5 Capital Improvement Program (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Improvement No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	Pipeline Improvements				Infrastructure Costs			Construction Trigger	Suggested Cost Allocation		Cost Sharing	
						New/Parallel/ Replace	Diameter (in)	Length (in)	Pipe Unit Cost[3,4] ($/unit)	Baseline Constr. Costs ($)	Estimated Constr. Costs[5] ($)	Capital Improv. Costs[6] ($)	(gpm)	Existing Users (%)	Future Users (%)	Existing Users ($)	Future Users ($)
Cypress Trunk																	
CY-P1	Existing-Capacity	San Francisco Dr	From 430' w/o Woods Cir to Woods Cir	8	5	Replace	10	475	390	185,300	240,900	361,400	-	86%	14%	310,960	50,440
CY-P2	Existing-Capacity	Sister Cities Blvd	From 115' e/o Spruce Ave to 80' e/o Pecks Ln	10	5	Replace	12	775	446	345,600	449,300	674,000	-	81%	19%	547,696	126,304
CY-P3	Existing-Capacity	Sister Cities Blvd	From 230' w/o Airport Blvd to Airport Blvd	10	5	Replace	12	250	446	111,500	145,000	217,500	-	81%	19%	176,749	40,751
CY-P4	Existing-Capacity	Franklin Ave	From Hemlock Ave to Hillside Blvd	8	1	Replace	10	250	390	97,500	126,800	190,200	-	48%	52%	91,890	98,310
CY-P5	Existing-Capacity	Hillside Blvd	From Franklin Ave to Arden Ave	8	1	Replace	10	1,350	390	526,400	684,400	1,026,600	-	55%	45%	565,483	461,117
CY-P6	Existing-Slope	Hillside Blvd	From 185' s/o Spruce Ave	12	3	Replace	12	450	446	301,050	391,400	587,100	-	59%	41%	347,647	239,453
CY-P7	Existing-Capacity	Armour Ave	From Cypress Ave to Airport Blvd	-	3	New	15	250	556	139,100	180,900	271,400	-	9%	91%	23,974	247,426
CY-P8	Existing-Capacity	Airport Blvd	From Armour Ave to Pine Ave	12	3	Replace	15	725	556	403,300	524,300	786,500	Construction of CY-P7	9%	91%	69,474	717,026
									Subtotal - Cypress Trunk	**2,109,750**	**2,743,000**	**4,114,700**				**2,133,872**	**1,980,828**
									Subtotal - Gravity Main Improvements	**13,201,250**	**17,163,400**	**25,746,000**				**14,169,258**	**11,576,742**
Lift Station Improvements																	
PS-9[7]	Existing-Capacity				5	Capacity Upgrade	Replace Dry Weather Pumps 2 @ 5,600 gpm			10,154,300	13,200,600	19,800,900	-	92%	8%	18,230,529	1,570,371
PS-11[7]	Existing-Capacity				5	Capacity Upgrade	6 @ 8,300 gpm			24,857,400	32,314,700	48,472,100	-	92%	8%	44,441,542	4,030,558
									Subtotal - Lift Station Improvements	**35,011,700**	**45,515,300**	**68,273,000**				**62,672,071**	**5,600,929**
									Gravity Main Improvement Costs	**13,201,250**	**17,163,400**	**25,746,000**				**14,169,258**	**11,576,742**
									Lift Station Improvement Costs	**35,011,700**	**45,515,300**	**68,273,000**				**62,672,071**	**5,600,929**
									Total Improvement Costs	**48,212,950**	**62,678,700**	**94,019,000**				**76,841,330**	**17,177,670**

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Notes:

1. Improvements are categorized by the type of deficiency they are intended to mitigate.
   - Existing-Slope: This improvement is required to fix an existing pipeline with a slope beneath master plan criteria.
   - Existing-Capacity: This improvement is required to mitigate an existing capacity deficiency as observed in the hydraulic model.
   - Future-Capacity: This improvement is required to mitigate an existing system deficiency caused by buildout flows.
2. Rank Grouping:
   - Rank 1 = R-Value ≥ 75%
   - Rank 2 = 75% > R-Value ≥ 50%
   - Rank 3 = 50% > R-Value ≥ 25%
   - Rank 4 = 25% > R-Value ≥ 10%
   - Rank 5 = R-Value ≤ 10%
3. Unit costs based on San Francisco June 2022 ENR CCI of 15,327.
4. For pipeline slope improvements, a 50 percent contingency has been added to the baseline construction cost to account for addition costs such as construction of new manholes.
5. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
6. Estimated construction cost plus 50 % to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.
7. Improvement collects flows from neighboring municipality. Cost allocation for neighboring municipalities documented on Table 9.3.

Table ES.6 Capital Improvement Program (East of 101)
City-Wide Sewer System Master Plan
City of South San Francisco

Improv. No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	Pipeline Improvements: New/Parallel/ Replace	Pipeline Improvements: Diameter (in)	Pipeline Improvements: Length (ft)	Pipeline Improvements: Pipe Unit Cost[3,4] ($/unit)	Infrastructure Costs: Baseline Constr. Costs ($)	Infrastructure Costs: Estimated Constr. Costs[5] ($)	Infrastructure Costs: Capital Improv. Costs[6] ($)	Construction Trigger (gpm)	Suggested Cost Allocation: Existing Users (%)	Suggested Cost Allocation: Future Users (%)	Cost Sharing: Existing Users ($)	Cost Sharing: Future Users ($)
Gravity Main Improvements																	
Priority 1- Existing Deficiencies																	
1-P1	Future-Capacity	Oyster Point Blvd	From 750 ft n/o Lift Station to Lift Station 1	8	3	Replace	12	700	446	312,100	405,800	608,700	914 EDU	16%	84%	99,048	509,652
									Subtotal - Basin 1	**312,100**	**405,800**	**608,700**				**99,048**	**509,652**
Basin 2																	
2-P1	Existing-Capacity	Oyster Point Blvd	From Gull Dr to Eccles Ave	8	1	Replace	12	790	446	352,200	457,900	686,900	-	29%	71%	200,573	486,327
									Subtotal - Basin 2	**352,200**	**457,900**	**686,900**				**200,573**	**486,327**
Priority 2- Future Development																	
4-P1	Future-Capacity	E Grand Ave	From Gateway Blvd o Forbes Blvd	21	3	Replace	24	585	836	488,900	635,600	953,400	3,040 EDU	48%	52%	454,241	499,159
4-P2	Future-Capacity	Harbor Way	From E Grand Ave to 350 ft n/o Harris Ave	27	3	Replace	30	1,105	1,005	1,110,400	1,443,600	2,165,400	7,478 EDU	53%	47%	1,142,066	1,023,334
4-P3	Existing-Slope	Littlefield Ave	From 50 ft ne/o Grand Ave to Littlefield Ave to Grand Ave	8	2	Replace	8	425	334	213,000	276,900	415,400	-	68%	32%	281,039	134,361
4-P4	Existing-Slope	Littlefield Ave	From 100 ft s/o Grand Ave to Grand Ave	30	2	Replace	30	65	1,005	98,100	127,600	191,400	-	53%	47%	100,869	90,531
4-P5	Existing-Slope	E Grand Ave	From Littlefield Ave to 300 ft se/o Littlefield Ave	10	2	Replace	10	315	390	184,350	239,700	359,600	-	99%	1%	354,867	4,733
4-P6	Existing-Slope	Mitchell Ave	From West Harris Ave to 400 ft e/o Harris Ave	6	2	Replace	6	115	271	46,800	60,900	91,400	-	100%	0%	91,400	0
4-P7	Existing-Slope	50 feet n/o Mitchell Ave	From Harbor Way to Lift Station 4	18	2	Replace	18	50	668	50,250	65,400	98,100	-	48%	52%	47,475	50,625
4-P8	Existing-Slope	E Grand Ave	From 250 e/o Kimball Way to Kimball Way	15	2	Replace	15	330	556	275,400	358,100	537,200	-	90%	10%	481,727	55,473
									Subtotal - Basin 4	**2,467,200**	**3,207,800**	**4,811,900**				**2,953,685**	**1,858,215**
									Subtotal - Gravity Main Improvements	**3,131,500**	**4,071,500**	**6,107,500**				**3,253,306**	**2,854,194**
Pump Station Improvements																	
PS-2	Existing-Capacity	955 Gateway Blvd			1	Capacity Upgrade	2 @ 1,850 gpm			5,224,500	6,791,900	10,187,900	-	67%	33%	6,873,701	3,314,199
									Subtotal - Lift Station Improvements	**5,224,500**	**6,791,900**	**10,187,900**				**6,873,701**	**3,314,199**
									Gravity Main Improvement Costs	**3,131,500**	**4,071,500**	**6,107,500**				**3,253,306**	**2,854,194**
									Lift Station Improvement Costs	**5,224,500**	**6,791,900**	**10,187,900**				**6,873,701**	**3,314,199**
									Total Improvement Costs	**8,356,000**	**10,863,400**	**16,295,400**				**10,127,008**	**6,168,392**

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Notes:

1. Improvements are categorized by the type of deficiency they are intended to mitigate.
   - Existing-Slope: This improvement is required to fix an existing pipeline with a slope beneath master plan criteria.
   - Existing-Capacity: This improvement is required to mitigate an existing capacity deficiency as observed in the hydraulic model.
   - Future-Capacity: This improvement is required to mitigate an existing system deficiency caused by buildout flows.
2. Ranking Grouping
   - Rank 1 = Existing Capacity Deficiencies
   - Rank 2 = Existing Slope Deficiencies (City to Review and explore mitigation opportunities)
   - Rank 3: Future Capacity Deficiency Ordered by Construction Trigger (EDUs)
3. For pipeline slope improvements, a 50 percent contingency has been added to the baseline construction cost to account for addition costs such as construction of new manholes.
4. Unit costs based on San Francisco June 2022 ENR CCI of 15,327.
5. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
6. Estimated construction cost plus 50 % to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.

CHAPTER 1 – INTRODUCTION

This chapter provides a brief background of the City of South San Francisco sewer system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.

1.1 BACKGROUND

The City of South San Francisco (City) is located on the San Francisco Peninsula in San Mateo County, north of the City of San Bruno and south of Daly City (**Figure 1.1**). United States Highway 101 (Highway 101) bisects the City in a north-south direction; the western portion of the City is primarily comprised of residential and commercial development while the eastern portion is primarily industrial and research and development offices. The City limits currently encompass 9.1 square miles, with an estimated population of 67,135 residents, according to California Department of Finance (DOF) 2021 population estimates.

The service area west of Highway 101 provides sewer collection services to approximately 12,600 residential, commercial, and institutional accounts. The service area east of Highway 101 provides sewer collection services to approximately 500 commercial, industrial, and institutional accounts. The City owns, operates, and maintains the sewer collection system, which consists of force mains and gravity mains up to 42-inches in diameter. Sewer flows area ultimately conveyed to the Water Quality Control Plant (WQCP) in the southern portion of the service area.

The City completed a Sewer System Master Plan for the east portion of the City (east of Highway 101) in September 2002 (2002 SSMP) and updated in 2007 and 2011. These updates identified capacity deficiencies in the existing sewer collection system and recommended improvements intended to mitigate deficiencies and serve future redevelopments.

A sewer system master plan for the western portion of the City (west of Highway 101) has not been completed, but numerous studies for the area have been performed, including a 1999 Inflow and Infiltration Study (1999 I&I Study) that evaluated the existing flows of the sewer system and identified potential improvements to mitigate capacity issues.

Recognizing the importance of planning, developing, and financing system facilities to provide reliable sewer collection service to existing customers and for servicing anticipated growth, the City initiated the development of the 2022 City-Wide Sewer System Master Plan (2022 CWSSMP).

1.2 SCOPE OF WORK

In 2016, the City initiated work with Akel Engineering Group, Inc to update the East of Highway 101 Sewer System Master Plan (E101SSMP). This 2017 E101SSMP was intended to serve as a

Legend

- Major Highways
- Study Area
- Protected Open Space
- Urbanized Area

Update: August 27, 2018

0 0.5 1 2 Miles

Figure 1.1
Regional Location Map

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\SSF_Fig1-1_RLM_082718.mxd tool for planning and phasing the construction of future sewer collection system facilities for the City's projected planning horizon up to year 2040 and a draft was submitted to City staff in November 2017. Following the submittal of the draft E101SSMP, City staff initiated work with Akel Engineering Group, Inc in 2018 to prepare a City-Wide Sewer System Master Plan (CWSSMP) that includes both the East of 101 and West of 101 sewer systems; the 2017 E101SSMP will be incorporated into this CWSSMP and updated as necessary. This 2022 CWSSMP also includes a condition assessment of the existing sewer pipelines and pump stations. Should planning conditions change, and depending on their magnitude, adjustments to the master plan recommendations might be necessary.

The project included the following major tasks:

- Summarize the City's existing collection system facilities.
- Document growth planning assumptions and known future developments.
- Summarize the sewer collection system performance criteria and design storm event.
- Project future sewer flows.
- Develop and calibrate a new hydraulic model.
- Evaluate the adequacy of capacity for the sewer collection system facilities to meet existing and projected peak dry weather flows and peak wet weather flows.
- Recommend a capital improvement program (CIP) with an opinion of probable construction costs.
- Perform a capacity allocation analysis for cost sharing purposes between existing users and future growth.
- Develop a 2022 Sewer System Master Plan Report.

1.3 PREVIOUS MASTER PLANS

The City completed a Sewer System Master Plan for the east portion of the City (east of Highway 101) in September 2002 (2002 SSMP). The master plan documented the design criteria, evaluated the capacity of the existing sewer system, recommended improvements to service expansions, mitigated existing deficiencies, and summarized improvement costs in a capital improvement program.

The 2002 Sewer System Master Plan was subsequently updated in May 2007 (2007 SSMP Update) and again in 2011 (2011 East of Highway 101 SSMP Update) to reflect changes to growth assumptions. These master plan updates included revisions to the sewer flow projections, the hydraulic analysis, and the corresponding capital improvement program.

The 1999 I&I Study estimated the existing sewer flows, inflow and infiltration flow rates, and recommended improvements to mitigate existing deficiencies. This is the latest planning and evaluation study completed for the areas west of Highway 101.

1.4 RELEVANT REPORTS

The City has completed a previous sewer system master plan and other various planning studies to document the impact of growth on the sewer collection and treatment facilities. These reports are referenced and used during this capacity analysis. The following lists relevant reports that were used in the completion of this master plan, as well as a brief description of each document:

- **City of South San Francisco West of Highway 101 Infiltration and Inflow Study 1999 (1999 I&I Study)** This report documents the planning and performance criteria, evaluates the sewer system, recommends improvements and provides an estimate of costs.
- **City of South San Francisco East of Highway 101 Sewer System Master Plan 2002**. This report documents the planning and performance criteria, evaluates the sewer system, recommends improvements and provides an estimate of costs.
- **City of South San Francisco, East of Highway 101 2002 Sewer System Master Plan (2007 SSMP Update)**. This document is an update to the 2002 SSMP, and included sewer flow projections update and capacity evaluation to address significant changes to growth assumptions. The report updated the recommended improvements and CIP.
- **City of South San Francisco, East of Highway 101 2011 Update (2011 SSMP Update)**. This document provides an update to the sewer system master plan due to revised projected sewer flows and updates the recommended improvements and cost estimates.
- **City of South San Francisco 1999 General Plan.** This document outlines the City's long-range plan for physical and economic development. This document was used to quantify the future land use development condition.
- **Town of Colma, 2019 Wastewater Collection System Master Plan.** This document assesses the Town of Colma's wastewater collection system and its collection and conveyance capacity. This document was used as a basis for quantifying flows conveyed by the Town of Colma to the City's sewer system.
- **City of San Bruno 2014 Sewer Master Plan.** This document updates the City of San Bruno's previous Sewer Master Plan and Infiltration/Inflow Study. This document was used as a basis for quantifying flows conveyed by the City of San Bruno to the City's sewer system.

1.5 REPORT ORGANIZATION

The 2022 City-Wide Sewer System Master Plan report contains the following chapters:

- **Chapter 1 – Introduction.** This chapter provides a brief background of the City of South San Francisco sewer system, the need for this master plan, and the objectives of the study. Abbreviations and definitions are also provided in this chapter.
- **Chapter 2 – Planning Area Characteristics.** This chapter presents a discussion of the planning area characteristics and includes a study area description, defines the land use classification, and documents the population for the City's service area.
- **Chapter 3 – System Performance and Design Criteria.** This chapter presents the City's performance and design criteria that were used in this master plan for evaluating the adequacy of capacity for the existing sewer collection system and for sizing improvements required to mitigate deficiencies and to accommodate future growth. The design criteria include: capacity requirements for the sewer facilities, flow peaking factors, and minimum slope requirements.
- **Chapter 4 – Existing Sewer System Facilities.** This chapter provides a description of the City's existing sewer system facilities including gravity trunks, force mains, pump stations, and sewer collection basins. The chapter also includes a brief description of the Water Quality Control Plant (WQCP).
- **Chapter 5 –Sewer Flows.** This chapter summarizes historical sewer flows experienced at the Water Quality Control Plant and defines flow terminologies relevant to this evaluation. This chapter discusses the sewer flow distribution within the nine defined basins, and identifies the design flows used in the hydraulic modeling effort and capacity evaluation. The design flows include the existing condition (existing customers) and the projected ultimate buildout scenario.
- **Chapter 6 – Hydraulic Model Development.** This chapter describes the development and calibration of the City's sewer collection system hydraulic model. The City's hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth.
- **Chapter 7 – Evaluation and Proposed Improvements.** This section presents a summary of the sewer collection system capacity evaluation during peak dry weather flows and peak wet weather flows for the existing and buildout flows. The recommended sewer collection system improvements needed to mitigate capacity deficiencies are also discussed in this chapter.
- **Chapter 8 – Condition and Risk Assessment** This section documents the condition and risk assessment of the existing sanitary sewer pipelines within the South San Francisco service area. This risk assessment included the following elements:

- Review available system data
- Define risk criteria
- Perform a risk analysis for existing pipelines
- Recommended improvements

The following sections include discussion of the data reviewed to perform the analysis, the condition and risk assessment criteria used to evaluate the risk of each pipeline, the results of the condition and risk assessment, and recommended improvements.

Chapter 9 – Capital Improvement Program. This chapter provides a summary of the recommended Capital Improvement Program (CIP) for the City of South San Francisco sewer collection system. The program is based on the evaluation of the City's sewer collection system and on the recommended projects described in the previous chapters. The CIP has been prepared to assist the City in planning and constructing the collection system improvements through the ultimate buildout scenario. This chapter also presents the cost criteria and methodologies for developing the capacity improvement costs.

1.6 ACKNOWLEDGEMENTS

Obtaining the necessary information to successfully complete the analysis presented in this report, and developing the long-term strategy for mitigating the existing system deficiencies and for accommodating future growth, was accomplished with the strong commitment and very active input from dedicated team members including:

- Jason Hallare, Senior Engineer.
- Billy Gross, Senior Planner.
- Adena Friedman, Planning Manager.
- Nicholas Talbot, Water Quality Control Plant Assistant Superintendent.
- Arran Gordon, Water Quality Control Plant Maintenance Supervisor.

1.7 UNIT CONVERSIONS AND ABBREVIATIONS

Engineering units were used in reporting flow rates and volumes pertaining to the design and operation of various components of the sewer system. In some cases, different sets of units were used to describe the same parameter where it was necessary to report values in smaller or larger quantities. Values reported in one set of units can be converted to another set of units by applying a multiplication factor. A list of multiplication factors for units used in this report are shown on **Table 1.1.**

Various abbreviations and acronyms were also used in this report to represent relevant sewer system terminologies and engineering units. A list of abbreviations and acronyms is included in **Table 1.2.**

Table 1.1 Unit Conversions
City-Wide Sewer System Master Plan
City of South San Francisco

Volume Unit Calculations		
To Convert From:	**To:**	**Multiply by:**
acre feet	gallons	325,857
acre feet	cubic feet	43,560
acre feet	million gallons	0.3259
cubic feet	gallons	7.481
cubic feet	acre feet	2.296×10^{-5}
cubic feet	million gallons	7.481×10^{-6}
gallons	cubic feet	0.1337
gallons	acre feet	3.069×10^{-6}
gallons	million gallons	1×10^{-6}
million gallons	gallons	1,000,000
million gallons	cubic feet	133,672
million gallons	acre feet	3.069

Flow Rate Calculations		
To Convert From:	**To:**	**Multiply By:**
ac-ft/yr	mgd	8.93×10^{-4}
ac-ft/yr	cfs	1.381×10^{-3}
ac-ft/yr	gpm	0.621
ac-ft/yr	gpd	892.7
cfs	mgd	0.646
cfs	gpm	448.8
cfs	ac-ft/yr	724
cfs	gpd	646300
gpd	mgd	1×10^{-6}
gpd	cfs	1.547×10^{-6}
gpd	gpm	6.944×10^{-4}
gpd	ac-ft/yr	1.12×10^{-3}
gpm	mgd	1.44×10^{-3}
gpm	cfs	2.228×10^{-3}
gpm	ac-ft/yr	1.61
gpm	gpd	1,440
mgd	cfs	1.547
mgd	gpm	694.4
mgd	ac-ft/yr	1,120
mgd	gpd	1,000,000

Table 1.2 Abbreviations and Acronyms

City-Wide Sewer System Master Plan
City of South San Francisco

Abbreviation	Expansion	Abbreviation	Expansion
10yr-24hr	10-Year 24-Hour	Highway	HWY
ADWF	Average Dry Weather Flow	HGL	Hydraulic Grade Line
AAF	Annual Average Flow	in/hr	Inch per Hour
ADWF	Average Dry Weather Flow	I&I	Infiltration and Inflow
Akel	Akel Engineering Group, Inc.	LF	Linear Feet
AWWF	Average Wet Weather Flow	MDDWF	Maximum Day Dry Weather Flow
CCI	Construct Cost Index	MDWWF	Maximum Day Wet Weather Flow
CIP	Capital Improvement Program	MGD	Million Gallons per Day
City	City of South San Francisco	MMDWF	Maximum Month Dry Weather Flow
DDF	Depth Duration Frequency	MMWWF	Maximum Month Wet Weather Flow
d/D	depth of flow to pipe diameter	NOAA	National Oceanic and Atmospheric Administration
ENR	Engineering News Record	PDWF	Peak Dry Weather Flow
ft	Feet	PS	Pump Station
fps	Feet per Second	PWWF	Peak Wet Weather Flow
GIS	Geographic Information Systems	ROW	Right of Way
gpd	Gallons per Day	WQCP	Water Quality Control Plant
gpm	Gallons per Minute		

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1.8 GEOGRAPHIC INFORMATION SYSTEMS

This master planning effort made extensive use of Geographic Information Systems (GIS) technology, for efficiently completing the following tasks:

- Developing the physical characteristics of the hydraulic model (gravity mains, force mains, and pump stations).
- Allocating existing sewer loads, as calculated using the developed sewer unit factors.
- Calculating and allocating future sewer loads, based on the future developments land use.
- Extracting ground elevations along the gravity and force mains from available contour maps.
- Generating maps and exhibits used in this master plan

CHAPTER 2 – PLANNING AREA CHARACTERISTICS

This chapter presents a discussion of the planning area characteristics and includes a study area description, defines the land use classification, and documents the population for the City's service area.

2.1 STUDY AREA DESCRIPTION

The City of South San Francisco is generally bisected by Highway 101 in a north-south direction. The west portion of the City is primarily comprised of residential dwelling units and commercial development, while the east portion of the City is primarily composed of industrial, commercial office, commercial research and development, and manufacturing land uses types. The study area for this master plan is located within the City's boundaries and is generally bound by Interstate 280 to the west, the San Francisco Bay to the east, the San Bruno mountain to the north, and the San Bruno canal to the south (**Figure 2.1**).

2.2 SEWER SERVICE AREAS

The City's sewer system services residential and non-residential lands within the City limits as well as portions of San Bruno to the south, Daly City to the northwest, and the Town of Colma to the north. The City's service area can generally be divided into two regions: west of Highway 101 and east of Highway 101. The boundaries and planning area characteristics of these two regions are briefly described in the following sections.

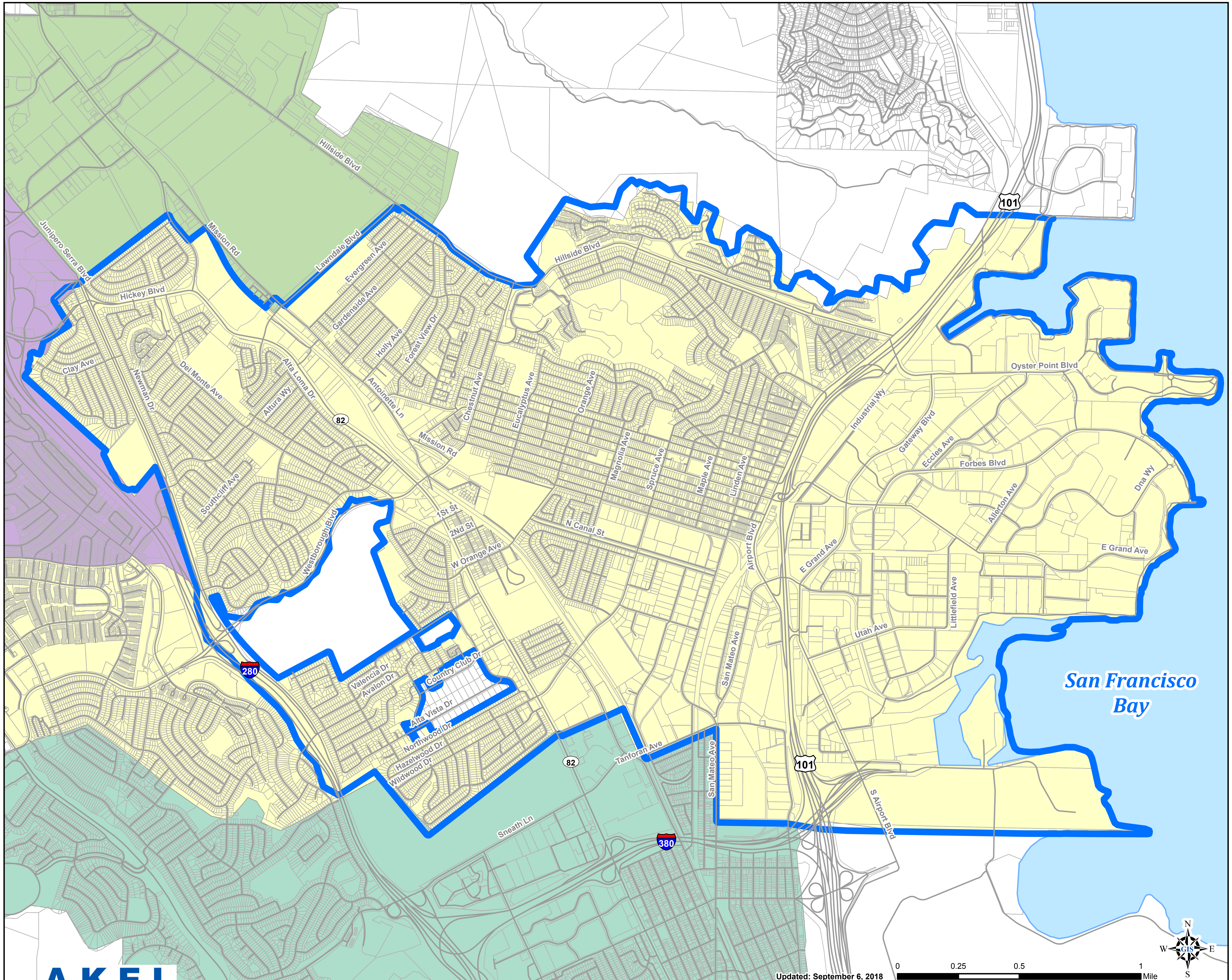
2.2.1 West of Highway 101

The west of Highway 101 service area collects sewer flows from existing residential and non-residential users east of Newman Drive and west of Highway 101, with Hillside Boulevard and Tanforan Avenue generally serving as the north and south boundaries respectively. This service area also collects flows from the municipalities shown below. Further discussion of sewer flows and cost allocation for construction projects is included in Chapter 5 and Chapter 9.

- **Town of Colma:** The Town of Colma discharges a portion of their sewer flows into an 18-inch pipeline at the intersection of Mission Road and Lawndale Boulevard.

- **Daly City:** Daly City discharges a portion of their sewer flows into an 8-inch pipeline at the intersection of Clay Avenue and Dundee Drive.

- **City of San Bruno:** The City of San Bruno discharges a portion of their sewer flow to two sewer mains. Approximately 60 percent of flow into a 24-inch pipeline along Tanforan



Legend

- Sewer Service Area
- Municipality
  - Colma
  - Daly City
  - San Bruno
  - South San Francisco
- Street Centerlines
- Parcels

Figure 2.1
Planning Area
City-Wide Sewer System
Master Plan
City of South San Francisco

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Avenue at Maple Avenue and approximately 40 percent into a 24-inch pipeline along Shaw Road east of San Mateo Avenue.

The west of Highway 101 service area does not include the Westborough area of the City. This area is generally defined as adjacent to Westborough Boulevard, within the City limits west of Interstate 280; the Westborough Water District provides sewer service for this area.

Additionally, there are three unincorporated areas in the City's existing service area (**Figure 2.1**). The California Golf Club of San Francisco, Ponderosa Elementary School, and Low Density Residential homes along Alta Vista Drive do not contribute sanitary sewer flows the City's existing sewer collection system. It should be noted that the City plans to eventually annex these areas and integrate them into the current collection system. Therefore, sewer loads and connection points for the unincorporated areas were established and are documented in Chapter 4 and Chapter 5 of this master plan.

2.2.2 East of Highway 101

The east of Highway 101 service area collects sewer flows from non-residential users east of Highway 101, south and west of the San Francisco Bay, and the access road to San Francisco International Airport to the south.

2.3 EXISTING AND FUTURE LAND USE INFORMATION

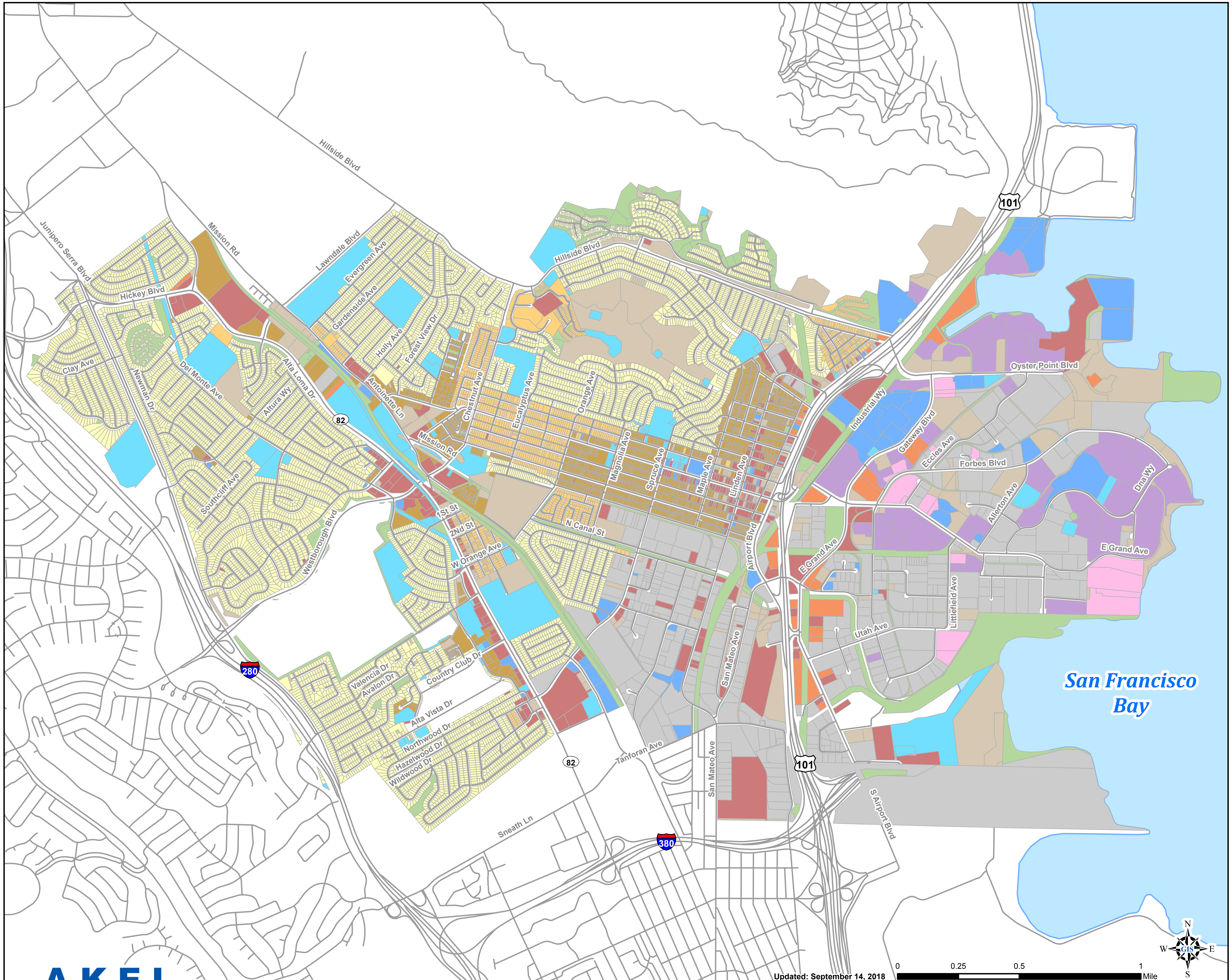
The existing and future land use for the City's service area is based on a combination of planning documents provided by City staff, which included General Plan Land Use information as well as traffic analysis zone (TAZ) land use data. It should be noted that the City is currently in the process of updating the General Plan Land Use, and it is recommended that the master plan be updated with the new General Plan to preserve its integrity. The existing and future land use conditions are graphically summarized on **Figure 2.2** and **Figure 2.3** and described in more detail in the following sections.

2.3.1 West of Highway 101

The existing and future land use for the service area west of Highway 101 is based on General Plan Land Use information provided by City staff. The General Plan Land Use consists of residential, commercial, hotel, industrial, and various mixed use development types. These land use types, and the associated planning assumptions as extracted from the City's General Plan, are briefly summarized as follows:

2.3.1.1 *Residential*

The City's General Plan includes multiple residential development types. The development intensities of the residential uses range from less than 8 units/acre up to 80 units/acre. The General Plan also includes incentives and bonuses that allow the maximum development density to increase with a total intensity of up to 125 units per acre.



Legend

Existing Land Use

- Low Density Residential
- Medium Density Residential
- High Density Residential
- Hotel
- Commercial
- Office Commercial
- Biotech
- Business and Technology Park
- Public
- Mixed Industrial
- Open Space
- Vacant
- Street Centerlines

Figure 2.2
Existing Land Use
City-Wide Sewer System
Master Plan
City of South San Francisco

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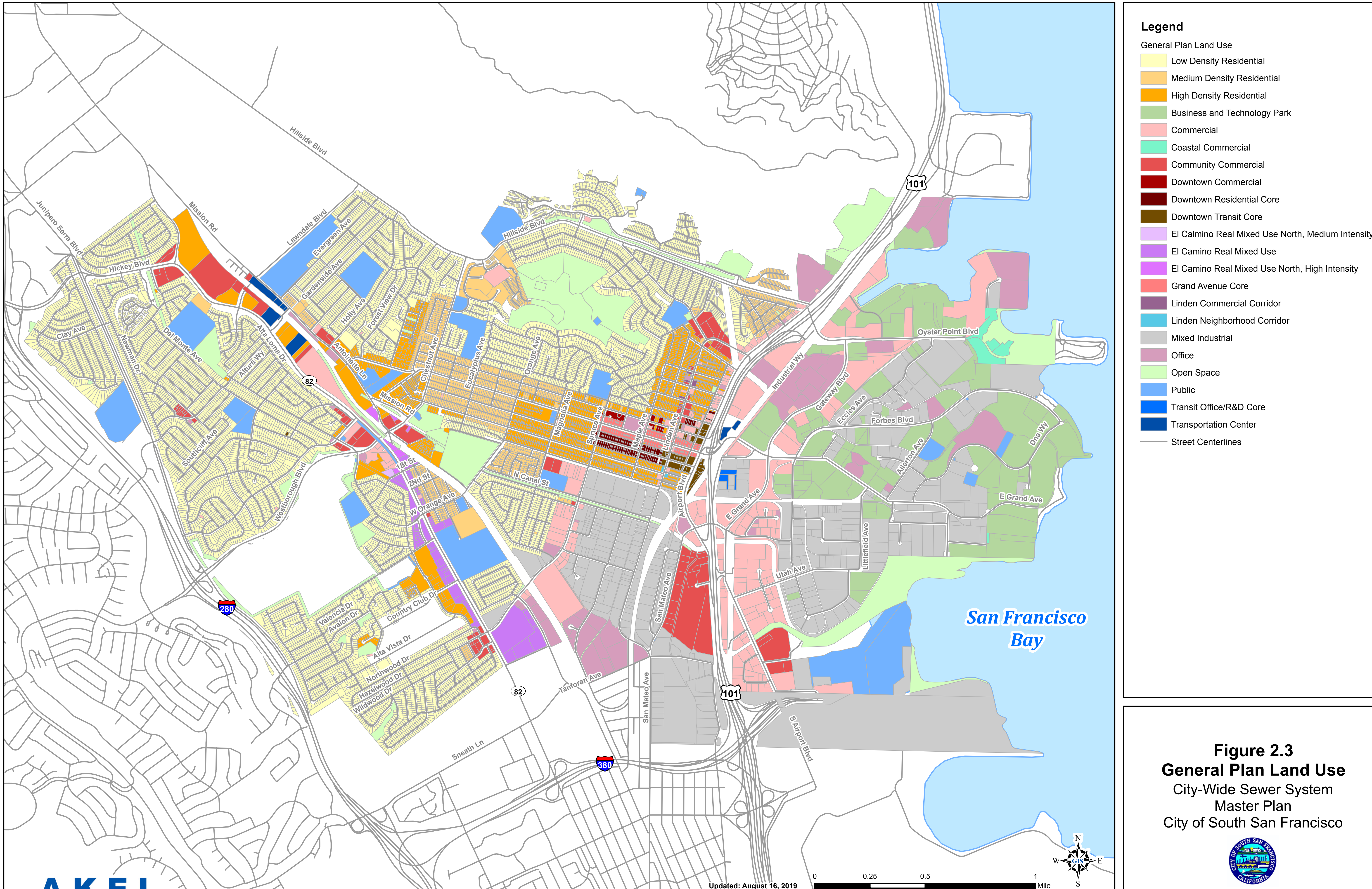

Figure 2.3
General Plan Land Use
City-Wide Sewer System
Master Plan
City of South San Francisco

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2.3.1.2 *Mixed Use*

The City's General Plan includes multiple mixed use development types, with varying residential intensities and commercial floor area ratios (FAR). The maximum possible residential development intensities with permitted incentives and bonuses range between 60 units per acre to 180 units per acre. The maximum possible commercial FAR values with permitted incentives and bonuses range between 3.0 and 8.0. The mixed use land use types include Downtown Transit Core, Grand Avenue Core, Linden Neighborhood Corridor, and El Camino Real Mixed Use.

2.3.1.3 *Other Non-Residential*

The City's General Plan includes other non-residential development types, with varying FAR and density values, such as commercial, office space, hotel, mixed industrial, and public facility with varying FAR and density values. These varying land use types are generally summarized below:

- Office/Coastal/Business Commercial: These non-residential categories reflect neighborhood district commercial development, visitor servicing commercial, and major commercial districts. These designations have FAR's between 0.5 and 1.0, with incentive-based FAR values up to 1.6.
- Office/Mixed Industrial: These non-residential categories reflect professional office developments and a variety of processing and industrial developments. These designations have FAR's between 0.4 and 1.0, with incentive-based FAR's up to 2.5.
- Hotel: This non-residential category reflects new hotel developments and has a maximum FAR of 1.6, with an incentive-based maximum value of 2.2.
- Public Facility: This non-residential category includes parks, open space, schools, government offices, transit sites, and airport facilities.

2.3.2 East of Highway 101

The existing and future land use for the service area east of Highway 101 is based on parcel land use information developed from a traffic analysis zone (TAZ) study provided by City staff. Depending on the type of land use the TAZ study quantified existing and future development in terms of either dwelling units, thousands of square feet, or hotel rooms depending on the land use type. Typically, these unit types are estimated from future acreage and assumed density (units per acre) or FAR values. However, as specific values for each type were provided in the TAZ study density and FAR ranges were not incorporated. The following sections briefly summarize the various types of development planned within the east of Highway 101 service area.

2.3.2.1 *Residential*

The City is not planning any new residential development under the most recent General Plan. City staff have indicated that the upcoming General Plan revisions will include residential developments closer to the Caltrain Station Area. Once the City adopts the new General Plan, it is recommended that the Master Plan be updated to reflect impacts to land use changes.

2.3.2.2 *Commercial*

The existing and future commercial development generally consist of business, retail, and other professional services. These designations have a maximum allowable FAR value of 0.60. Additional floor area shall be subject to an approved conditional use permit and an environmental review analyzing the additional adverse impacts resulting from the increased Floor Area Ratio above 0.60.

2.3.2.3 *Hotel*

The hotel land use classification is intended for developments offering visitor services such as hotels, motels, resorts or others. These designations have a maximum allowable FAR value of 1.60.

2.3.2.4 *Office/ Research and Development*

The office/research and development (R&D) land use designation is intended for administrative, business, professional, medical and other research and development uses. These designations have a maximum allowable FAR value of 0.55.

2.4 EXISTING AND FUTURE LAND USE ANALYSIS

The following sections document the land use analysis performed for the west and east of Highway 101 sewer service areas. The total amount of existing and future development is based on a combination of planning documents provided by City staff, which included General Plan Land Use information as well as water meter consumption and existing land use data. The results of the land use analysis for the west of Highway 101 and east of Highway 101 service areas respectively, are documented on **Table 2.1** and **Table 2.2,** are briefly summarized in the following sections.

2.4.1 West of Highway 101

Including open space and vacant parcels there are approximately 4,278 acres of land within the west of Highway 101 service area. The land use types for the west of Highway 101 service area are broken down into the following classifications.

- **Existing Development:** This classification represents existing developed lands
- **Existing Lands – Redeveloped:** This classification represents existing developed lands expected to redevelop into other land use types under the buildout development condition.
- **Existing Development – Unchanged:** This classification represents the total existing development expected to maintain the same land use type under the buildout development

Table 2.1 Existing and Future Land Use (West of 101)
City-Wide Sewer System Master Plan
City of South San Francisco

Land Use Classification	Existing Development			Future Development			Total Development
	Existing Development (acre)	Existing Lands - Redeveloped (acre)	Subtotal Existing Development - Unchanged (acre)	New Lands - Redevelopment (acre)	New Development (acre)	Subtotal Future Development (acre)	(acre)
1	2	3	3	4	5		6
Residential							
Low Density	1,135.1	-	1,135.1	18.4	8.0	26.4	1,161.5
Medium Density	149.3	-1.0	148.3	3.7	10.3	14.1	162.4
High Density	211.8	-15.0	196.8	20.8	3.1	24.0	220.8
Downtown Residential Core	-	-	-	10.4	1.0	11.4	11.4
Subtotal Residential	1,496.2	-16.0	1,480.2	53.3	22.5	75.8	1,556.1
Mixed Use							
Downtown Transit Core	-	-	-	6.1	3.1	9.2	9.2
El Camino Real Mixed Use	-	-	-	41.5	6.0	47.4	47.4
El Camino Real Mixed Use North[1]	-	-	-	4.8	-	4.8	4.8
Other Mixed Use[2]	-	-	-	17.5	9.3	26.8	26.8
	-	-	-	69.9	18.3	88.2	88.2
Other Non-Residential							
Commercial[3]	203.5	-95.0	108.5	110.2	32.5	142.6	251.2
Office Commercial	48.7	-10.0	38.6	36.8	-	36.8	75.4
Hotel	17.6	-	17.6	-	-	-	17.6
Mixed Industrial	320.6	-124.7	195.9	54.1	13.0	67.2	263.1
Public Facility	279.9	-63.9	216.0	1.6	70.6	72.2	288.2
Right of way	35.2	-16.2	19.1	-	-	-	19.1
Non-flow	153.4	-	153.4	-	-	-	153.4
Open Space	1,408.6	-	1,408.6	-	157.7	157.7	1,566.3
Vacant	314.6	-314.6	-	-	-	-	-
Subtotal Non-Residential	2,782.2	-624.5	2,157.7	202.6	273.8	476.5	2,634.2
Total							
	4,278.4	**-640.5**	**3,637.9**	**325.8**	**314.6**	**640.5**	**4,278.4**

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Notes:
1. Includes the following land use types: El Camino Real Mixed Use North, High Intensity and El Camino Real Mixed Use North, Medium Intensity
2. Includes the following land use types: Grand Avenue Core, Transportation Center, Downtown Commercial, Linden Neighborhood Corridor, and Linden Commercial Corridor
3. Includes the following land use types: Business Commercial, Coastal Commercial, Community Commercial

Table 2.2 Existing and Future Land Use (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Land Use Classification	Land Use Unit	Existing Development[1]	Future Development[2,3]	Future Service Area
Flow Generating				
Hotel-Commercial	No. Hotel Room	3,299	926	4,225
Commercial	1,000 sq. ft.	587	1,109	1,696
Industrial	1,000 sq. ft.	7,635	24	7,659
Office/ Research and Development	1,000 sq. ft.	7,293	12,610	19,903
Genentech[4]	1,000 sq. ft.	3,942	2,991	6,933
Non-Flow Generating				
Open Space	1,000 sq. ft.	1,130	0	1,130
Parking	1,000 sq. ft.	143	0	143
Public	1,000 sq. ft.	157	0	157
Totals				
Total - Hotel Rooms		**3,299**	**926**	**4,225**
Total - 1,000 sq. ft.		**20,886**	**16,734**	**37,620**

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Notes:

1. Source: Land Use database received from City staff March 1, 2017
2. Source: Land Use database received from City staff April 11, 2017.
3. Future development for Oyster Point based on "Kilroy Oyster Point Sanitary Sewer Pump Station #1 Study" received from City staff February 12, 2019.
4. Existing and Future development for Genentech provided by the City's Economic & Community Development Department via email from City staff March 1, 2017.

condition.

- **New Lands – Redevelopment:** This classification represents the amount of development expected to occur from the redevelopment of lands currently occupied by a different and use

- **New Development:** This classification represents the amount of development expected to occur from the development of currently vacant lands.

At the buildout of the service area there are approximately 641 acres of future development planned to occur, which includes the redevelopment existing developed lands as well as the development of vacant parcels.

2.4.2 East of Highway 101

There are nearly 3,300 hotel rooms and 20,900 thousand square feet of development within the east of Highway 101 service area. The buildout development condition increases the total amount of development to 4,225 hotel rooms and approximately 37,600 thousand square feet of other non-residential land use. Due to the lack of vacant parcels within the east of Highway 101 service area the planned future development consists of redevelopment only.

The east of Highway 101 service area includes several specific areas that are planned to experience future redevelopment. These areas are documented on **Figure 2.4** and described below.

- **The Oyster Point Community.** The Oyster Point Community is located in the northeastern side of the east of Highway 101 service area, west of the San Francisco Bay. The Oyster Point Community incorporates many different land uses such as residential developments, retail developments, office and research developments, and hotels. It should be noted that the redevelopment plans for this area have been updated following the completion of the 2017 E101SSMP. The planning assumptions included in this 2022 CWSSMP reflect the most recent planning information provided by City staff, which is dated February 2019.

- **Genentech Campus.** This area is located on the eastern side of the east of Highway 101 service area, bordered to the west by Allerton Avenue and to the east by the San Francisco Bay. Genentech's campus includes several land uses, including office and research, commercial and industrial developments.

- **The Gateway Area.** This area is located along Gateway Boulevard, south of Oyster Point Boulevard, east of highway 101, and west of Eccles Avenue. It includes hotels, office, research, and industrial development types.

- **Bay West Cove.** This area is located on the northern side of Oyster Point Boulevard, from

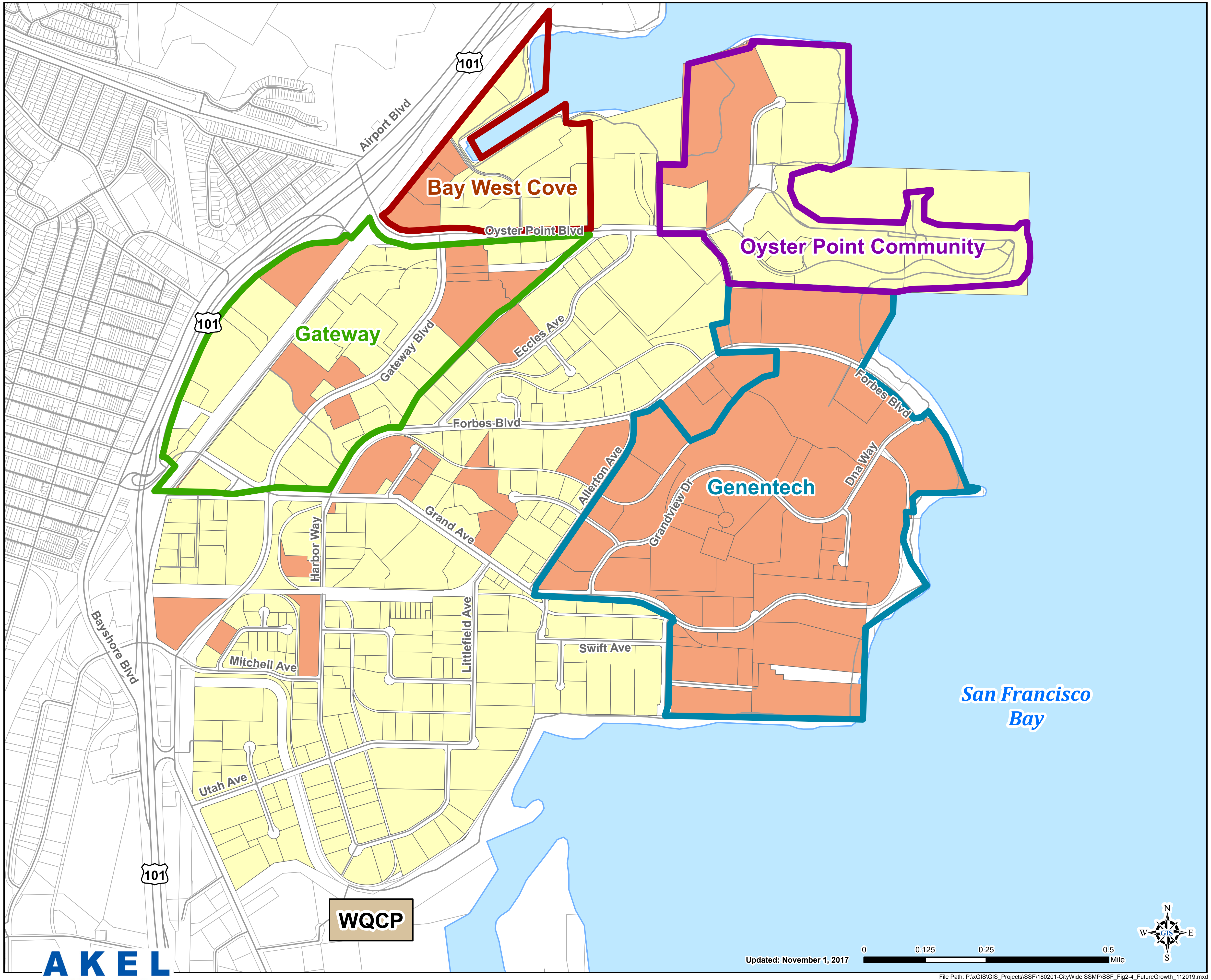

Figure 2.4
East of 101
Areas of Future Growth
City-Wide Sewer System
Master Plan
City of South San Francisco

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Veterans Boulevard to Highway 101. It includes hotels, office, and research.

2.5 HISTORICAL AND FUTURE GROWTH

According to California Department of Finance (DOF) population estimates, the 2020 City population is approximately 67,879. This population only includes lands within the City limits and does not account for the population associated with the flows delivered from the Town of Colma, Daly City, and the City of San Bruno. For planning purposes an annual population growth rate of 0.72 percent, consistent with the City's 2015 Urban Water Management Plan, was used for population projections. The existing and future population estimates are provided on **Table 2.3**.

In addition to the City-wide population estimates **Table 2.3** includes estimated populations for the City's sewer service area, which does not include the portion of the City serviced by the Westborough Water District. The service area population estimates reflect the removal of existing and projected populations for the Westborough area as extracted from the Westborough Water District 2015 UWMP.

Table 2.3 Historical and Projected Population

City-Wide Sewer System Master Plan
City of South San Francisco

Year	Population[1] City-Wide[1,2]	Population[1] Sewer Service Area	Percent Growth (%)
Historical[1]			
2000	60,552	49,253	-
2001	60,528	49,233	0.0%
2002	60,132	48,911	-0.7%
2003	59,913	48,733	-0.4%
2004	59,917	48,736	0.0%
2005	60,172	48,944	0.4%
2006	60,211	48,975	0.1%
2007	60,491	49,203	0.5%
2008	61,701	50,187	2.0%
2009	62,999	51,243	2.1%
2010	63,632	51,758	1.0%
2011	64,201	52,221	0.9%
2012	64,935	52,818	1.1%
2013	66,107	53,771	1.8%
2014	66,442	54,043	0.5%
2015	66,884	54,403	0.7%
2016	67,220	54,676	0.5%
2017	67,232	54,686	0.0%
2018	67,268	55,080	0.1%
2019	67,221	55,476	-0.1%
2020	67,879	55,876	1.0%
Projected[2]			
2021	68,368	56,278	0.7%
2022	68,860	56,683	0.7%
2023	69,356	57,091	0.7%
2024	69,855	57,502	0.7%
2025	70,358	57,917	0.7%
2026	70,865	58,334	0.7%
2027	71,375	58,754	0.7%
2028	71,889	59,177	0.7%
2029	72,406	59,603	0.7%
2030	72,928	60,032	0.7%
2031	73,453	60,464	0.7%
2032	73,982	60,899	0.7%
2033	74,514	61,338	0.7%
2034	75,051	61,779	0.7%
2035	75,591	62,224	0.7%
2036	76,135	62,672	0.7%
2037	76,684	63,123	0.7%
2038	77,236	63,578	0.7%
2039	77,792	64,036	0.7%
2040	79,293	64,497	1.9%

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Note:

1. Historical population extracted from California Department of Finance Population Estimates
2. Projected population based on annual growth rate of 0.70%, consistent with City of South San Francisco 2015 Urban Water Management Plan
3. Service area population excludes portion of City serviced by Westborough Water District.
4. Historical and projected Westborough Water District population extracted from District 2015 UWMP.

CHAPTER 3 – SYSTEM PERFORMANCE AND DESIGN CRITERIA

This chapter presents the City's performance and design criteria that were used in this master plan for evaluating the adequacy of capacity for the existing sewer collection system and for sizing improvements required to mitigate deficiencies and to accommodate future growth. The design criteria include: capacity requirements for the sewer facilities, flow peaking factors, and minimum slope requirements.

3.1 HYDRAULIC CAPACITY CRITERIA

In addition to applying the City design standards for evaluating hydraulic capacities this master plan included dynamic hydraulic modeling. The dynamic modeling was a critical and essential element in identifying surcharge conditions resulting from downstream bottlenecks in the gravity sewers.

3.1.1 Gravity Sewers

Gravity sewer capacities depend on several factors including: material and roughness of the pipe, the limiting velocity and slope, and the maximum allowable depth of flow. The hydraulic modeling software used for evaluating the capacity adequacy of the City's sewer collection system, InfoSWMM by Innovyze Inc., utilizes the fully dynamic St. Venant's equation which has a more accurate engine for simulating backwater and surcharge, in addition to manifolded force mains. The software also incorporates the use of the Manning Equation in other calculations including upstream pipe flow conditions.

Manning's Equation for Pipe Capacity

The Continuity equation and the Manning equation for steady-state flow are used for calculating pipe capacities in open channel flow. Open channel flow can consist of either open conduits or, in the case of gravity sewers, partially full closed conduits. Gravity full flow occurs when the conduit is flowing full but has not reached a pressure condition.

- Continuity Equation: $Q = V A$

  Where:
  Q = peak flow, in cubic feet per second (cfs)
  V = velocity, in feet per second (fps)
  A = cross-sectional area of pipe, in square feet (sq. ft.)

- Manning Equation: $V = (1.486\, R^{2/3}\, S^{1/2})/n$

  Where:
  V = velocity, fps
  n = Manning's roughness coefficient

R = hydraulic radius (area divided by wetted perimeter), ft
S = slope of pipe, in feet per foot

St. Venant Equations for Pipe Capacity

Dynamic modeling facilitates the analysis of unsteady and non-uniform flows (dynamic flows) within a sewer system. Some hydraulic modeling programs have the ability to analyze these types of flows using the St. Venant equation, which take into account unsteady and non-uniform conditions that occur over changes in time and cross-section within system pipes.

The St. Venant equations are a set of two equations, a continuity equation and a dynamic equation, that are used to analyze dynamic flows within a system. The first equation, the continuity equation, relates the continuity of flow mass within the system pipes in terms of: (A) the change in the cross-sectional area of flow at a point over time and (B) The change of flow over the distance of piping in the system. The continuity equation is provided as follows:

- Continuity Equation: $\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = 0$

  (A) (B)

Where:
t = time
x = distance along the longitudinal direction of the channel
Q = discharge flow
A = flow cross-sectional area perpendicular to the x directional axis

The second equation, the dynamic equation, relates changes in flow to fluid momentum in the system using: (A) Changes in acceleration at a point over time, (B) Changes in convective flow acceleration, (C) Changes in momentum due to fluid pressure at a given point, (D) Changes in momentum from the friction slope of the pipe and (E) Fluid momentum provided by gravitational forces. The dynamic equation is provided as follows:

- Dynamic Equation: $\frac{\partial Q}{\partial t} + \frac{\partial}{\partial t}\left(\beta \frac{Q^2}{A}\right) + gA\frac{\partial y}{\partial x} + gAS_f - gAS_o = 0$

  (A) (B) (C) (D) (E)

Where:
t = time
x = distance along the longitudinal direction of the channel
Q = discharge flow
A = flow cross-sectional area perpendicular to the x directional axis
y = flow depth measured from the channel bottom and normal to the x directional axis
S_f = friction slope
S_o = channel slope
β = momentum
g = gravitational acceleration

Use of this method of analysis provides a more accurate and precise analysis of flow conditions within the system compared to steady state flow analysis methods. It must be noted that two assumptions are made for use of St. Venant equations in the modeling software. First, flow is one dimensional. This means it is only necessary to consider velocities in the downstream direction and not in the transverse or vertical directions. Second, the flow is gradually varied. This means the vertical pressure distribution increases linearly with depth within the pipe.

Manning's Roughness Coefficient (n)

The Manning roughness coefficient 'n' is a friction coefficient that is used in the Manning formula for flow calculation in open channel flow. In sewer systems, the coefficient can vary between 0.009 and 0.017 depending on pipe material, size of pipe, depth of flow, root intrusion, smoothness of joints, and other factors.

For the purpose of this evaluation an "n" value of 0.013 was used for both existing and proposed gravity sewer pipes unless directed otherwise by City staff based on pipe structural condition. This "n" value is an acceptable practice in planning studies.

Partial Flow Criteria (d/D)

Partial flow in gravity sewers is expressed as a depth of flow to pipe diameter ratio (d/D). For circular gravity conduits, the highest capacity is generally reached at 92 percent of the full height of the pipe (d/D ratio of 0.92). This is due to the additional wetted perimeter and increased friction of a gravity pipe.

When designing sewer pipelines, it is common practice to use variable flow depth criteria that allow higher safety factors in larger sizes. Thus, design d/D ratios may range between 0.5 and 0.92, with the lower values used for smaller pipes. The smaller pipes may experience flow peaks greater than planned or may experience blockages from debris.

The City's design standards pertaining to the d/D criteria are summarized in **Table 3.1**.

During peak dry weather flows (PDWF), the maximum allowable d/D ratio for proposed pipes of all sizes is 0.75. The maximum allowable d/D ratio for all existing pipes (all diameters) is 0.90. The criterion for existing pipes is relaxed in order to maximize the use of the existing pipes before costly pipe improvements are required.

During peak wet weather flows (PWWF), to avoid premature or unnecessary trunk line replacements, the capacity analysis allowed the d/D ratio to exceed the dry weather flow criteria and surcharge. This condition is evaluated using the dynamic hydraulic model and the criteria listed on **Table 3.1**, which stipulates that the hydraulic grade line (HGL), even during a surcharged condition, should be at least one foot below the manhole rim elevation. It should be noted that this 2022 CWSSMP is consistent with the City's previous PWWF criteria, which allowed surcharging within one foot below the manhole rim elevation.

Table 3.1 Sewer System Performance and Design Criteria

City-Wide Sewer System Master Plan

City of South San Francisco

Dry Weather Flow Criteria	
Sewer Trunk	**d/D**
Existing System	0.90
Future System	0.75
Wet Weather Flow Criteria[2]	
HGL must be at least 1 foot below manhole rim elevation	
Pipe Slope Criteria	
Pipe Size	**Minimum Slope (ft/ft)**
8"	0.0026
10"	0.0019
12"	0.0015
15"	0.0011
18"	0.0009
21" and Up[1]	0.0008
Pipe Velocity Criteria	
Pipe Type	**Minimum / Maximum Velocity (fps)**
Gravity Sewer	Minimum 2 / Maximum 10
Force Main	Desired 2 to 6.5 / Maximum 10

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5/17/2021

Notes:
1. Source: 2002 East of 101 Sewer System Master Plan
2. Wet Weather Flow Criteria reduced from 3 feet to 1 foot below manhole rim elevation per City instruction on April 5, 2021.

Minimum Pipe Sizes and Design Velocities

In order to minimize the settlement of sewage solids, it is standard practice in the design of gravity sewers to specify that a minimum velocity of 2 feet per second (fps) be maintained when the pipeline is half-full. At this velocity, the sewer flow will typically result with self-cleaning of the pipe.

Due to the hydraulics of a circular conduit, velocity of half-full flows approaches the velocity of nearly full flows. **Table 3.1** lists the minimum slopes, varying by pipe size, in accordance with the City's design standards. The design standards also specify minimum pipe sizes, depending on the peak dry weather flows, as shown on **Table 3.1**.

Changes in Pipe Size

When a smaller gravity sewer pipe joins a larger pipe, the invert of the larger pipe is generally to maintain the same energy gradient. One of the methods used to approximate this condition includes placing the 80 percent depth point (d/D at 0.8) from both sewers at the same elevation. For master planning purposes, and in the absence of known field data, sewer crowns were matched at the manholes.

3.1.2 Force Mains and Pump Stations

The Hazen-Williams formula is commonly used for the design of force mains as follows:

- Hazen Williams Velocity Equation: $V = 1.32\, C\, R^{0.63}\, S^{0.54}$

  Where:
  V = mean velocity, fps
  C = roughness coefficient
  R = hydraulic radius, ft
  S = slope of the energy grade line, ft/ft

The value of the Hazen-Williams 'C' varies and depends on the pipe material and is also influenced by the type of construction and pipe age. A 'C' value of 110 was used in this analysis.

The minimum recommended velocity in force mains is at 2 feet per second. The economical pumping velocity in force mains ranges between 3 and 5 fps. A maximum desired velocity is typically around 7 fps and a maximum not-to-exceed velocity is at 10 fps.

The capacities of pump stations are evaluated and designed to meet the peak wet weather flows with one standby pump having a capacity equal to the largest operating unit. The standby pump provides a safety factor in case the duty pump malfunctions during operations and allows for maintenance.

3.2 DRY WEATHER FLOW CRITERIA

Sewer unit flow factors are coefficients commonly used in planning level analysis to estimate future average daily sewer flows for areas with predetermined land uses. The unit factors are multiplied by the number of dwelling units or acreages for residential categories, and by the number of square-feet or acreages for non-residential categories, to yield the average daily sewer flow projects.

3.2.1 Unit Flow Factors Methodology

Sewer unit factors are developed by using water consumption records and applying a return to sewer ratio for each land use to estimate sewer flow coefficients. There are several methods for developing the unit factors. The sewer unit flow factors developed as a part of this Master plan relied on the City's water billing records and flows recorded at the water quality control plant.

3.2.2 Average Daily Sewer Unit Flow Factors

Sewer flow factors were based on the City's water consumption records and the existing land use data provided by City staff. A return to sewer ratio was applied to each unadjusted water demand factor for individual land uses, and sewer flows were balanced to match recorded flows at the WQCP. Generally, non-residential land uses return the majority of the water consumed back to the sewer collection system. As minimal water consumption for non-residential land uses is related to irrigation, it was assumed that 95 percent of water consumption returns to the sewer system. Lastly, unit factors were adjusted to 100 percent occupancy, and rounded.

The developed unit factors can be applied to estimate the ADWF for future growth areas and development projects. Separate unit factor analyses were performed for the east and west of Highway 101 service areas, which are summarized in the following sections.

3.2.2.1 *West of Highway 101*

The sewer unit factor analysis for the development west of Highway 101, summarized on **Table 3.2**, was based on 2017 water billing records and WQCP flows. It should be noted that some land use types were consolidated for planning purposes.

It should be noted that mixed use development, including in those outlined in the General Plan, are not generally defined within existing land use classifications. Accordingly, and in order to estimate a sewer unit factor for these land use classifications, the General Plan development intensity assumptions were combined with residential and commercial sewer unit factors to estimate a planning factor. These mixed use flow factor assumptions are summarized on **Table 3.3**. The recommended average dry weather flow unit factors for the development west of Highway 101 are summarized on **Table 3.4**.

3.2.2.2 *East of Highway 101*

The sewer unit factor analysis for the development east of Highway 101, summarized on **Table 3.5**, was completed as part of the 2017 E101SSMP and used 2016 water billing records and WQCP flows. Genentech's campus was itemized separately due to the size of the campus and the planning assumptions for future growth. **Table 3.6** documents the recommended average dry weather flow unit factors used for estimating flows from future developments.

Table 3.2 Sewer Flow Unit Factor Analysis (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Land Use Classification	Existing Development	2017 Average Daily Water Demand Unit Factors 2017 Water Consumption[1] Annual Consumption (gpd)	Unadjusted Water Unit Factors (gpd/acre)	2017 Average Dry Weather Sewer Flow Unit Factors Return to Sewer Ratio	Dry Weather Sewer Flows Unadjusted Sewer Unit Factor (gpd/acre)	Balance using Recommended Unit Factor (gpd)	Sewer Flows at 100% Occupancy Vacancy Rate[2,3] (gpd/acre)	Projected Flows at 100% Occupancy (gpd/acre)	(gpd)	Sewer Unit Factor Recommended ADWF Factor (gpd/acre)	Balance Using Recommended Factor (gpd)
Residential											
Low Density	1,135	1,432,832	1,262	0.85	1,073	1,217,907	4.5%	1,121	1,272,713	1,130	1,282,612
Medium Density	149	259,693	1,739	0.85	1,478	220,739	4.5%	1,545	230,673	1,550	231,472
High Density	212	686,496	3,241	0.9	2,917	617,846	4.5%	3,048	645,649	3,050	646,055
Subtotal Residential	1,496	2,379,021				2,056,493			2,149,035		2,160,139
Non-Residential											
Commercial	204	314,002	1,543	0.95	1,466	298,302	6.9%	1,567	318,885	1,570	319,511
Office Commercial	49	51,610	1,061	0.95	1,008	49,029	6.9%	1,077	52,412	1,080	52,549
Hotel	18	91,051	5,178	0.95	4,919	86,499	0.0%	4,919	86,499	4,920	86,509
Mixed Industrial	321	530,643	1,655	0.95	1,572	504,111	1.5%	1,596	511,673	1,600	513,009
Public Facility	280	121,360	434	0.95	412	115,292	0.0%	412	115,292	420	117,560
Subtotal Non-Residential	870	1,108,667				1,053,234			1,084,761		1,089,138
Totals				**2017 Average Dry Weather Flows**							
	2,366	3,487,688			Estimated Sewer Flows	3,109,727			3,233,796		3,249,277
					Measured WWTP Flows[4,5]	**3,044,000**					

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Notes:

1. Water consumption extracted from water billing data received from City staff April 4, 2018.
2. Residential vacancy rate extracted from California Department of Finance E-5 Population estimates.
3. Office Commercial and Industrial vacancy rates extracted from "San Mateo County Economic & Industry Overview June 2018". For planning purposes, Business Commercial vacancy rate assumed equal to Office Commercial.
4. Measured WWTP flows extracted from WWTP inflow data provided by City staff March 29, 2018.
5. Measured WWTP Average Dry Weather flows as shown exclude the following flows contributed to the sewer system from outside of the existing service area:
    a) City of Colma: 0.20 mgd (Town of Colma Wastewater Collection System Master Plan, 2019)
    b) City of San Bruno: 2.26 mgd (Assumes 80% of Pump Station #9 Flow)
    c) City of Daly City: 0.12 mgd (3,500 people x 35 gpcd) 3,500 people per 2011 WQCP Report

Table 3.3 Mixed Use Flow Factor Assumptions (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Flow Factor	Maximum Development Intensity[1,2]		Development Assumptions		Development Intensity Assumptions	
			Percent Residential	Percent Commercial	Residential[3]	Commercial[4]
	DU/Acre	FAR			DU/Acre	FAR
Downtown Transit Core	180	8	70%	30%	160	5.0
Grand Avenue Core	100	4	50%	50%	83	2.8
Linden Neighborhood Corridor	80	3	50%	50%	72	2.5
Downtown Residential Core	125	3.25	100%	0%	108	-
El Camino Real Mixed Use	80	3.5	70%	30%	64	2.1
El Camino Real Mixed Use Neighborhood, High Intensity	110	3	70%	30%	88	1.8
El Camino Real Mixed Use Neighborhood, Medium Intensity	60	2.5	70%	30%	48	1.6

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Notes:

1. Source: City of South San Francisco 1999 General Plan, Table 2.2-1
2. For conservative planning purposes maximum development intensities shown reflect maximum permitted with incentives and bonuses.
3. Residential development intensities assumed equal to 80% of the intensity range documented in the General Plan.
4. Commercial development intensities assumed equal to 50% of the intensity range documented in the General Plan.

Table 3.4 Recommended ADWF Unit Factors (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Land Use Classification	Assumed Development Intensity		Recommended Sewer Unit Factor Basis Acreage (gpd/acre)	Basis Dwelling Unit or Thousand Sq. Feet	
Residential[1]					
Low Density	8	DU/acre	1,130	141	gpd/DU
Medium Density	12	DU/acre	1,550	129	gpd/DU
High Density	24	DU/acre	3,050	127	gpd/DU
Downtown Residential Core	108	DU/acre	8,760	81	gpd/DU
Mixed Use[2]					
Downtown Transit Core	160	DU/acre	13,480	81	gpd/DU
	5.0	FAR		72	gpd/TSF
El Camino Real Mixed Use	64	DU/acre	5,440	81	gpd/DU
	2.1	FAR		72	gpd/TSF
El Camino Real Mixed Use North	88	DU/acre	6,125	81	gpd/DU
	1.8	FAR		72	gpd/TSF
Other Mixed Use[3]	-	-	7,375	81	gpd/DU
	-	-		72	gpd/TSF
Other Non-Residential					
Commercial[4]	0.5	FAR	1,570	72	gpd/TSF
Office Commercial	1.3	FAR	1,080	20	gpd/TSF
Hotel	1.0	FAR	4,920	113	gpd/TSF
Mixed Industrial	0.6	FAR	1,600	61	gpd/TSF
Public Facility	-	-	420	-	-

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Notes:

1. Residential intensities assumed equal to 80% of density range maximum documented in 1999 General Plan Table 2.2-1.
2. Residential and commercial intensities consistent with Mixed Land Use assumptions documented in in-progress Sewer System Master Plan.
3. Includes the following land use types: Grand Avenue Core, Transportation Center, Downtown Commercial, Linden Neighborhood Corridor, and Linden Commercial Corridor
4. Includes the following land use types: Business Commercial, Coastal Commercial, and Community Commercial.

Table 3.5 Sewer Flow Unit Factor Analysis (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Land Use Classification[1]	Land Use Unit	Existing Service Area	2016 Average Daily Water Demand Unit Factors			2016 Average Dry Weather Sewer Unit Flow Factors									
			2016 Water Consumption			Return-to-Sewer Ratio	2016 Average Annual Wastewater Flows		2016 Average Dry Weather Wastewater Flows		2016 Wastewater Flows at 100% Occupancy			Recommended Wastewater Unit Factor	
		Developed (unit)	Water Demands[2] (gpd)	Unadjusted Unit Factor (gpd/unit)	Balance to 2016 Consumption (gpd)		Unadjusted Wastewater Unit Factor (gpd/unit)	Balance to 2016 Wastewater Flows	Average Dry Weather Wastewater Unit Factor (gpd/unit)	Average Dry Weather Wastewater Flows (gpd)	Vacancy	Unit Factor at 100% Occupancy (gpd/unit)	Wastewater Flow at 100% Occupancy (gpd)	Recommended Unit Factor (gpd/unit)	Balance Using Recommended Unit Factor (gpd)
Flow Generating															
Hotel	Hotel Room	3,299	169,780	51	169,780	0.95	49	161,291	46	152,245	15.0%	53	175,081	60	197,940
Industrial	1,000 sf	7,635	214,529	28	214,529	0.95	27	203,802	25	192,372	2.5%	26	197,181	30	229,051
Commercial	1,000 sf	587	107,609	183	107,609	0.95	174	102,229	164	96,495	2.5%	169	98,907	170	99,745
Office/Research and Development	1,000 sf	7,293	372,945	51	372,945	0.95	49	354,298	46	334,427	2.5%	47	342,788	50	364,669
Genentech	1,000 sf	3,942	792,497	201	792,497	0.95	191	752,872	180	710,647	2.5%	185	728,414	190	748,908
Subtotal-Hotel Room		3,299	169,780		169,780					152,245			175,081		
Subtotal-1000 sf		19,457	1,487,580		1,487,580					1,333,941			1,542,371		
Grand Total		-	**1,657,359**		**1,657,359**					**1,486,186**			**1,717,453**		
Other (Non-flow generating)															
ROW	1,000 sf	0	0	0	0										
Open Space	1,000 sf	1,129,932	0	0	0										
Parking	1,000 sf	142,974	0	0	0										
Public	1,000 sf	156,545	0	0	0										
Subtotal		1,272,906	0		0					0			0		
Total Wastewater Flows															
Grand Total			**1,657,359**		**1,657,359**		**Total Dry Weather Flow Using Unadjusted Unit Factors**			1,486,186	**Total ADWF Using Recommended Unit Factors (gpd)**				1,640,313
							Average Dry Weather WWTP Flow (gpd)			1,426,806					
							Total Annual Flow Using Unadjusted Unit Factors (gpd)			1,574,491					
							Average Annual WWTP Flow[7] (gpd)			1,511,583					

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Notes:

1. Source: Existing Land Use extracted from "2016 South San Francisco East and West Land Use Data v1 - Planning Edits 1.26.17" received from City's Planning staff March 01, 2017.
2. Water consumption extracted from water billing data received from City staff March 14, 2017.
3. Average daily demand based only May to September period to mitigate impacts of infiltration.

Table 3.6 Recommended ADWF Unit Factors (East of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Land Use Type	Unit	Sewer Flow Coefficient
Residential [1]	Dwelling Unit	200
Hotel-Commercial	No. Hotel Rooms	60
Commercial	gpd / 1,000 sf	170
Industrial	gpd / 1,000 sf	30
Office/ R&D	gpd / 1,000 sf	50
Genentech	gpd / 1,000 sf	190

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4/5/2022

Notes:

1. Residential factors extracted from 2015 CalWater UWMP (103 gallon per day per capita) assuming 3 person per dwelling unit, and a return to sewer ratio equal to 0.65.

3.2.3 Peaking Factors

The sewer system is evaluated based on its ability to convey peak sewer flows. Peaking factors represent the increase in sewer flows experienced above the average dry weather flows (ADWF). The various peaking conditions are numerical values obtained from a review of historical data and, at times, tempered by engineering judgment. The peaking conditions that are significant to hydraulic analysis of the sewer collection system include peak dry weather flows and peak wet weather flows.

As part of the preparation of this master plan, a 24-hour diurnal pattern and peaking factors for dry weather flows for the sewer collection system; the diurnals for the West of 101 system are shown on **Figure 3.1, Figure 3.2,** and **Figure 3.3**, while the diurnals for the East of 101 system are shown on **Figure 3.4, Figure 3.5,** and **Figure 3.6**.

Diurnal patterns can help the City project hourly flows for single development projects. However, it should be noted that these diurnal patterns account for travel time from when flow enters the system to when it reaches the WQCP. This travel time, also known as flow attenuation, results in peaks at the WQCP that may be several hours after the flow actually enters the system. Due to varying travel times in the system, peak flows are often higher in the upper reaches of the sewer collection system than at the WQCP. For purposes of estimating flows on a development level, an upstream basin with a majority land use similar to the future development can be applied to estimate projected sewer flows.

3.3 WET WEATHER FLOW CRITERIA

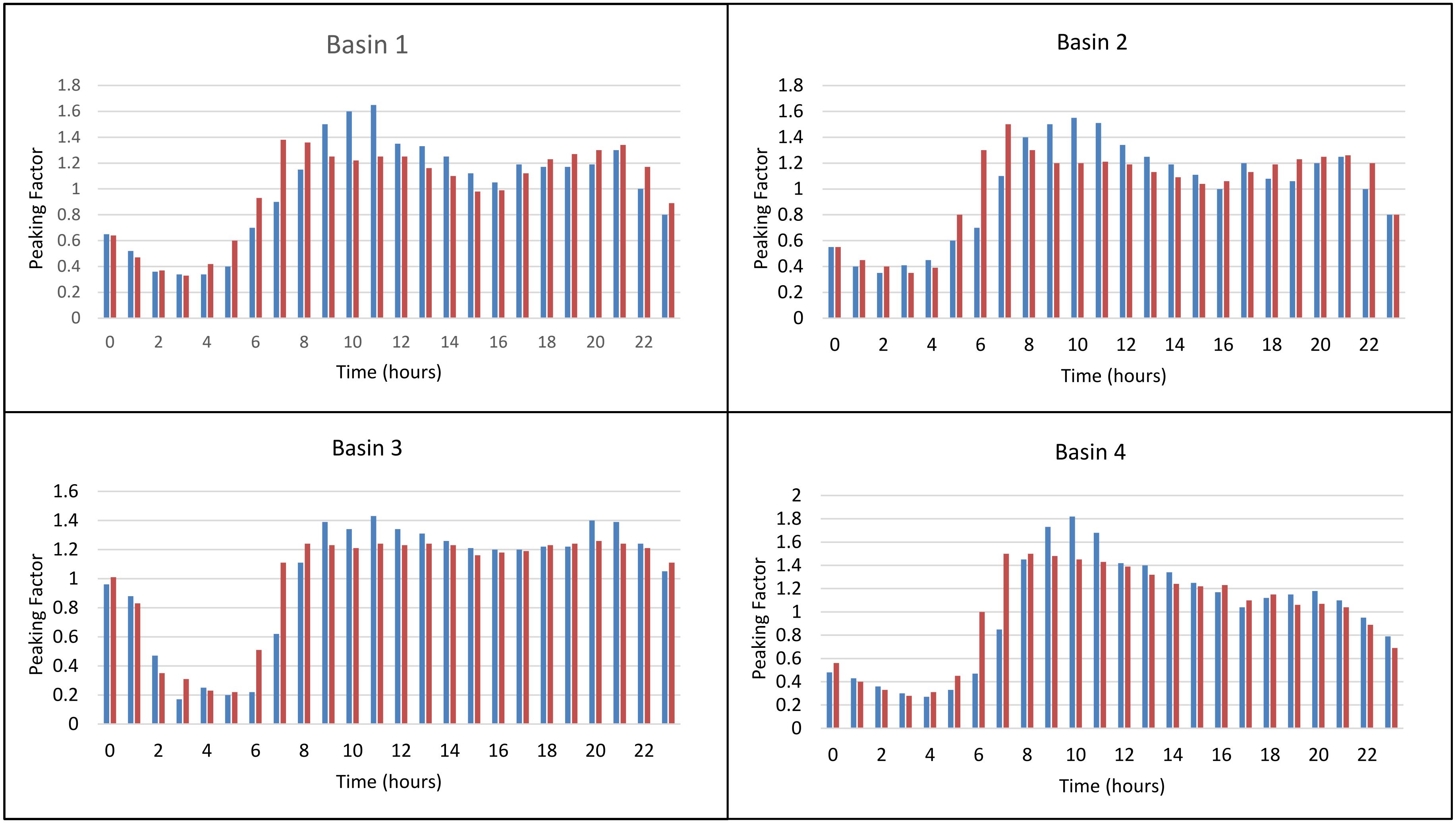
The wet weather flow criteria accounts for the infiltration and inflows (I&I) that seep into the City's sewer collection system during storm events.

3.3.1 Infiltration and Inflow

Groundwater infiltration and inflow is associated with extraneous water entering the sewer through defects in pipelines and manholes. Infiltration occurs when groundwater rises or the soil is saturated due to seasonal factors such as a storm event which causes an increase in flows in the sewer collection system. The groundwater will enter the sewer collection system through cracks in the pipes or deteriorating manholes. Inflow occurs when surface water enters the wastewater collection system from storm drain cross connections, manhole covers, or roof/footing drains. **Figure 3.7** was developed by King County, Washington and was included in this chapter to illustrate the typical causes of infiltration and inflow.

There are several accepted methodologies for estimating infiltration and inflows (I&I). These include:

- **Methodology 1.** Based on Acreages. In this methodology, factors that may range between 400 and 1,500 gallons per day (gpd) or more are applied to acreages for estimating the I&I



LEGEND

Weekend Peaking Factor

Weekday Peaking Factor

February 26, 2020

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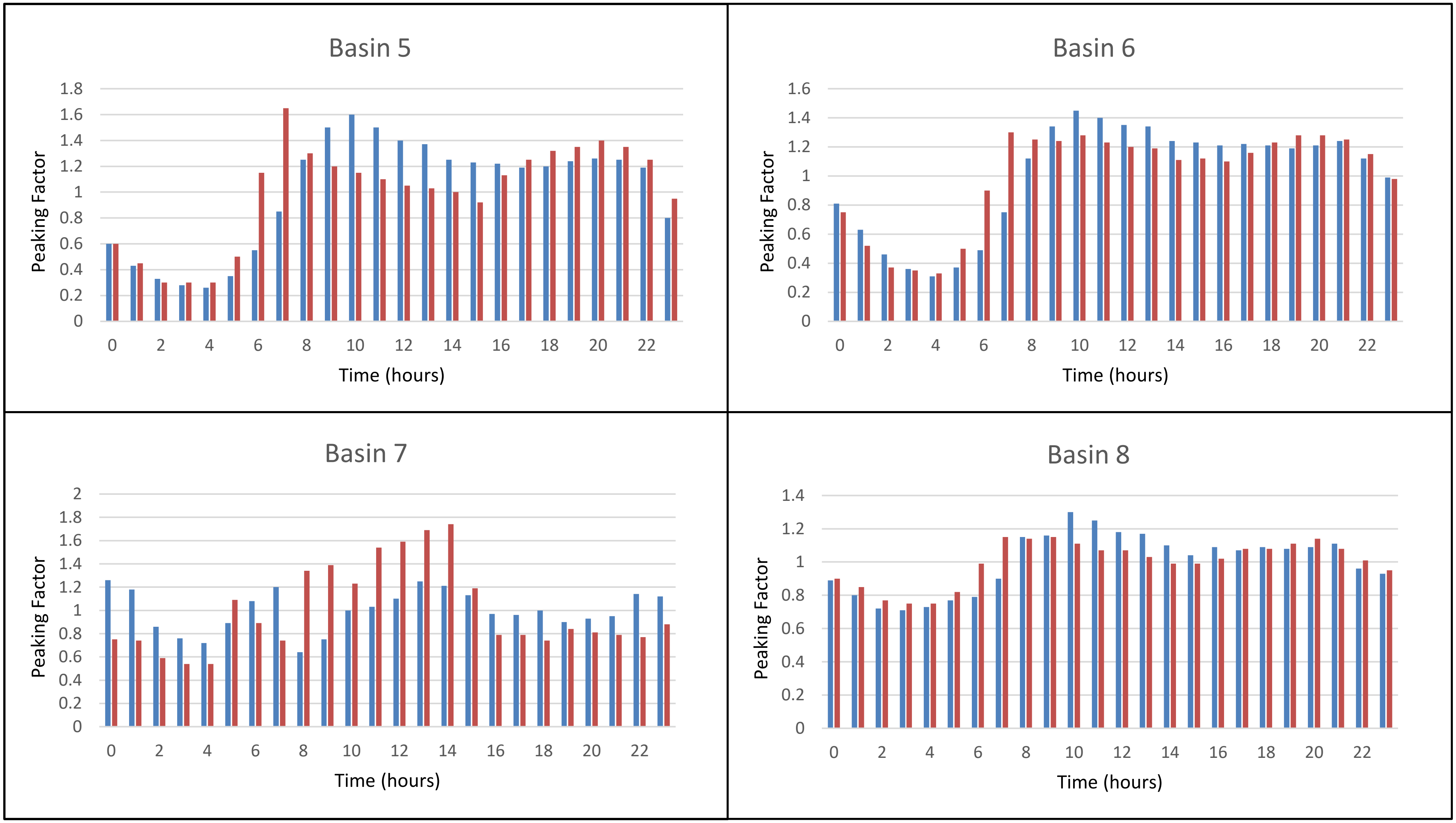
Figure 3.1

W/101 Hydraulic Model Diurnals

City-Wide Sewer System Master Plan

City of South San Francisco



LEGEND

Weekend Peaking Factor

Weekday Peaking Factor

February 26, 2020

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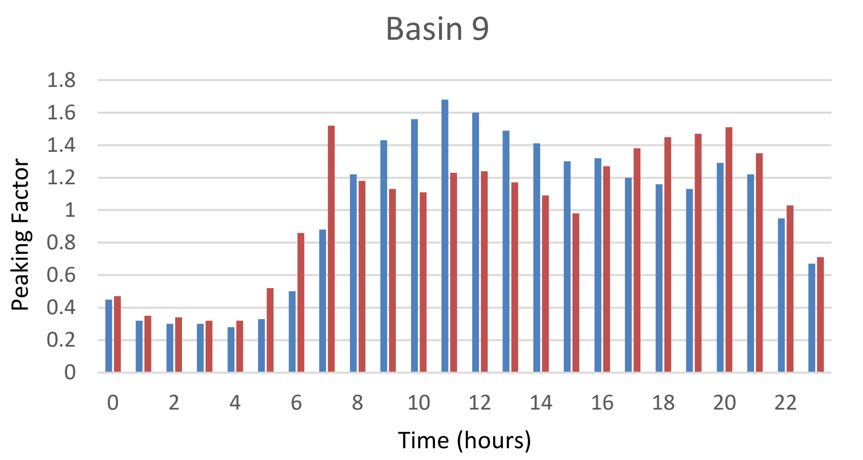
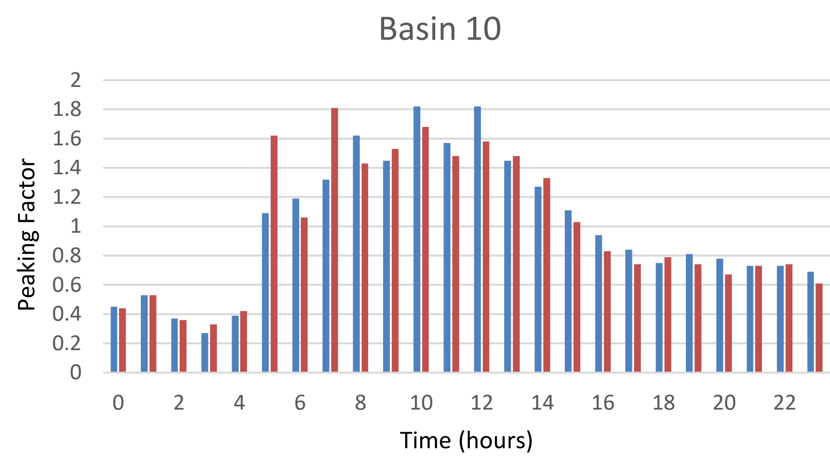
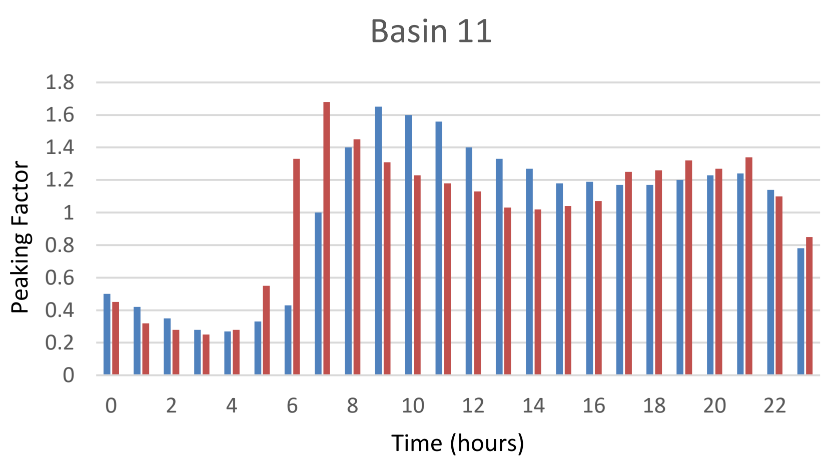
Figure 3.2
W/101 Hydraulic Model Diurnals
City-Wide Sewer System Master Plan
City of South San Francisco







LEGEND

Weekend Peaking Factor

Weekday Peaking Factor

February 26, 2020

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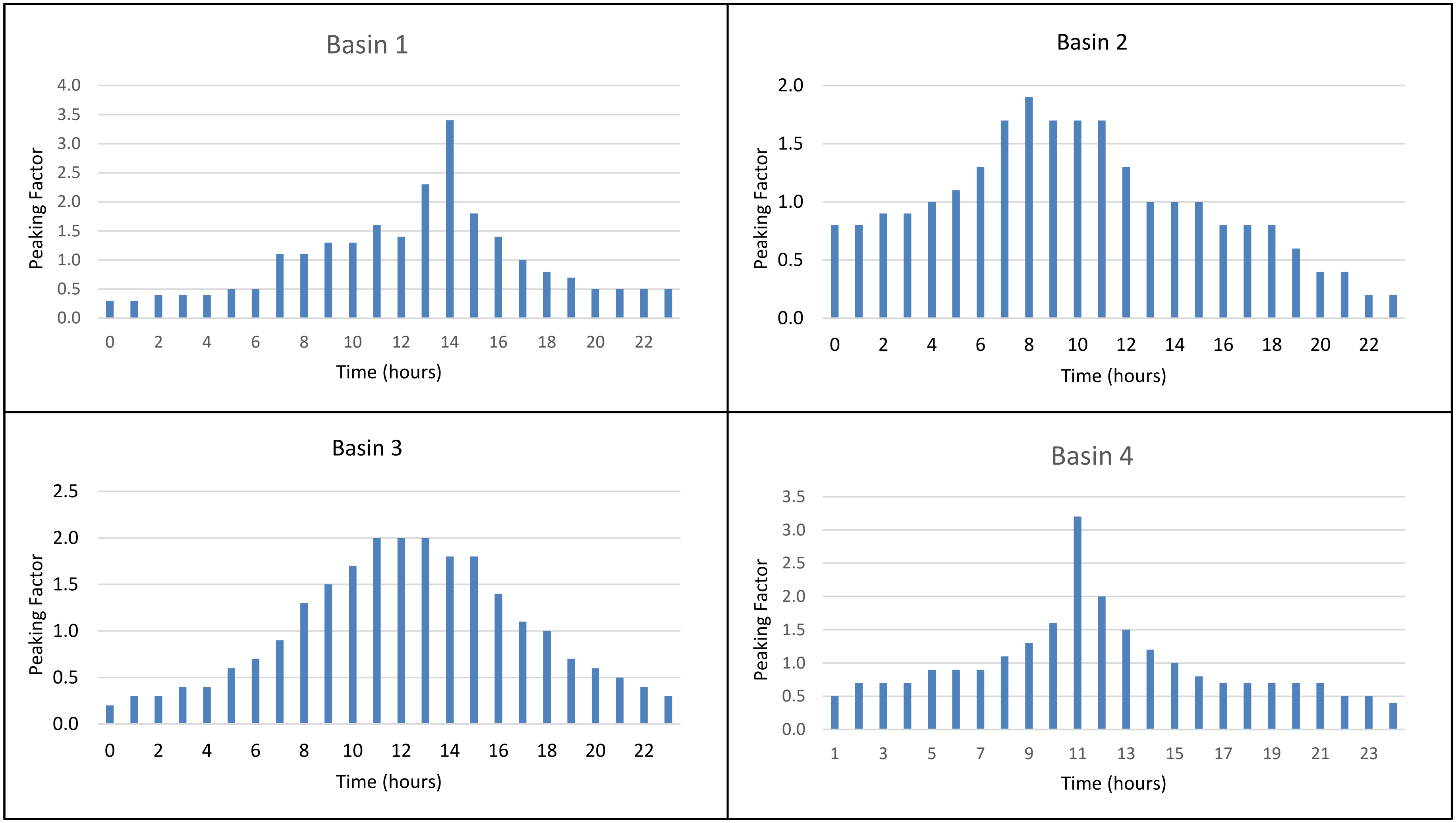
Figure 3.3

W/101 Hydraulic Model Diurnals

City-Wide Sewer System Master Plan

City of South San Francisco



LEGEND

Peaking Factor

February 26, 2020

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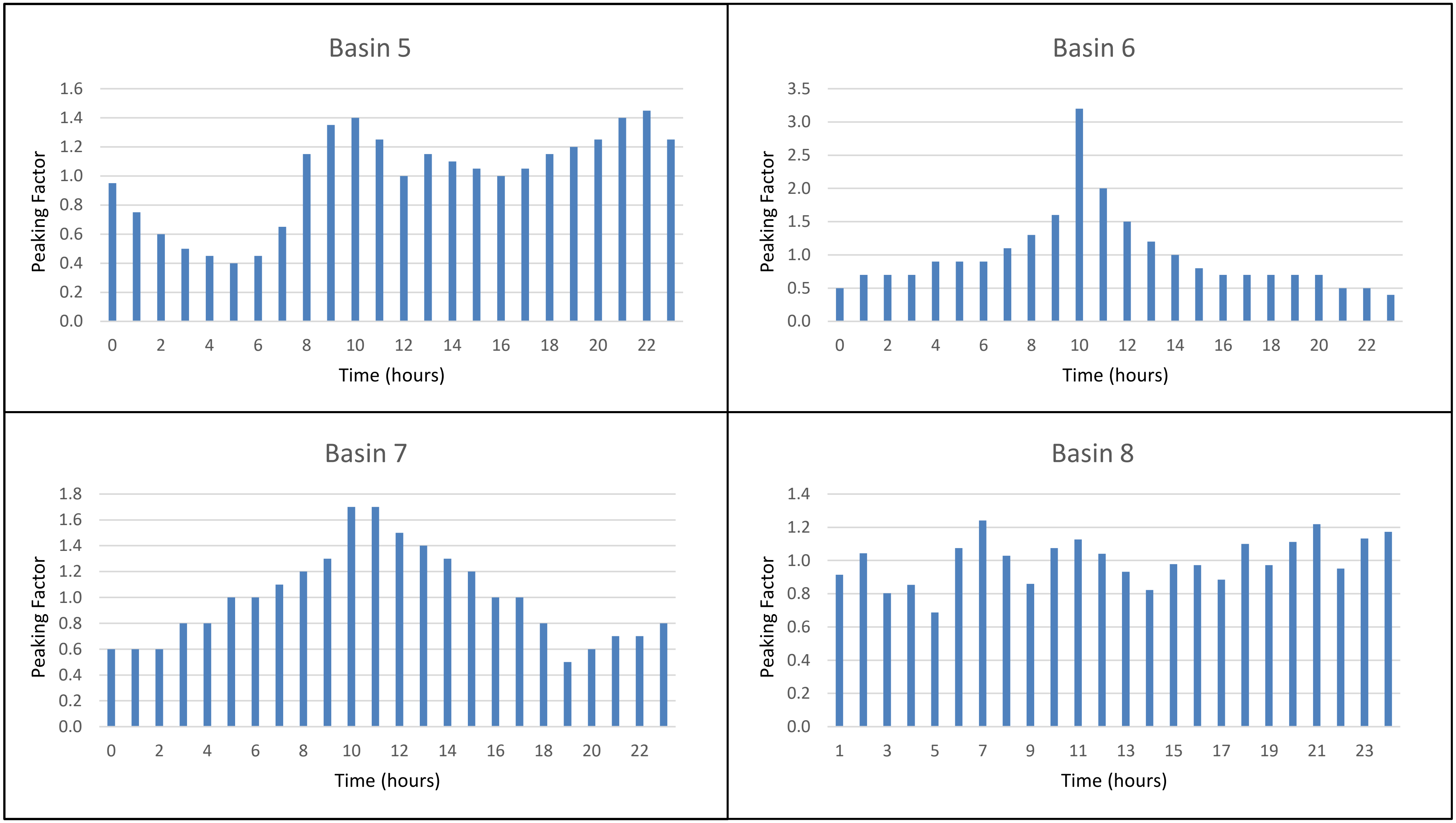
Figure 3.4

E/101 Hydraulic Model Diurnals

City-Wide Sewer System
Master Plan
City of South San Francisco



LEGEND

Peaking Factor

February 26, 2020

Figure 3.5
E/101 Hydraulic Model Diurnals
City-Wide Sewer System Master Plan
City of South San Francisco

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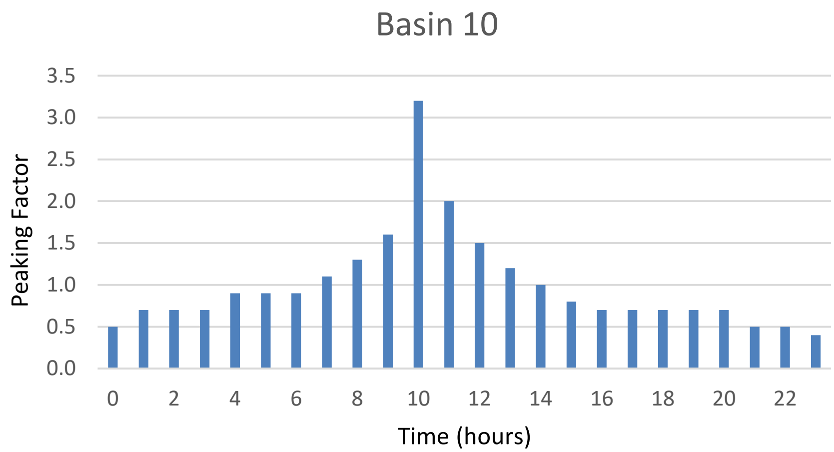

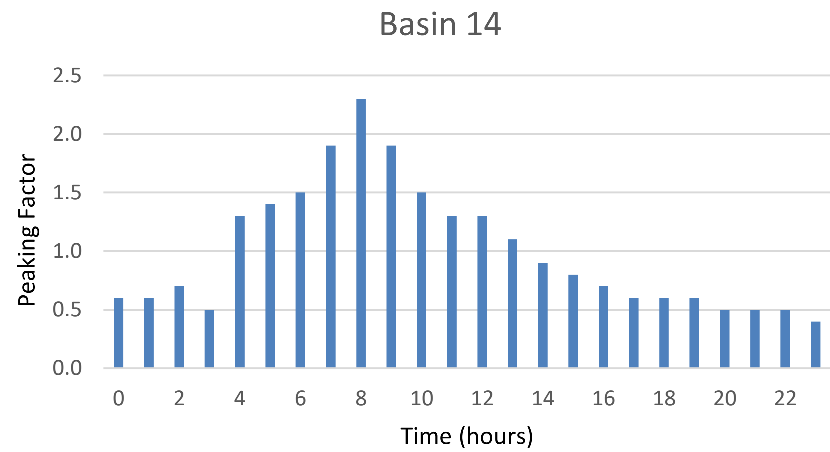

LEGEND

Peaking Factor

February 26, 2020

Figure 3.6
E/101 Hydraulic Model Diurnals

City-Wide Sewer System
Master Plan
City of South San Francisco

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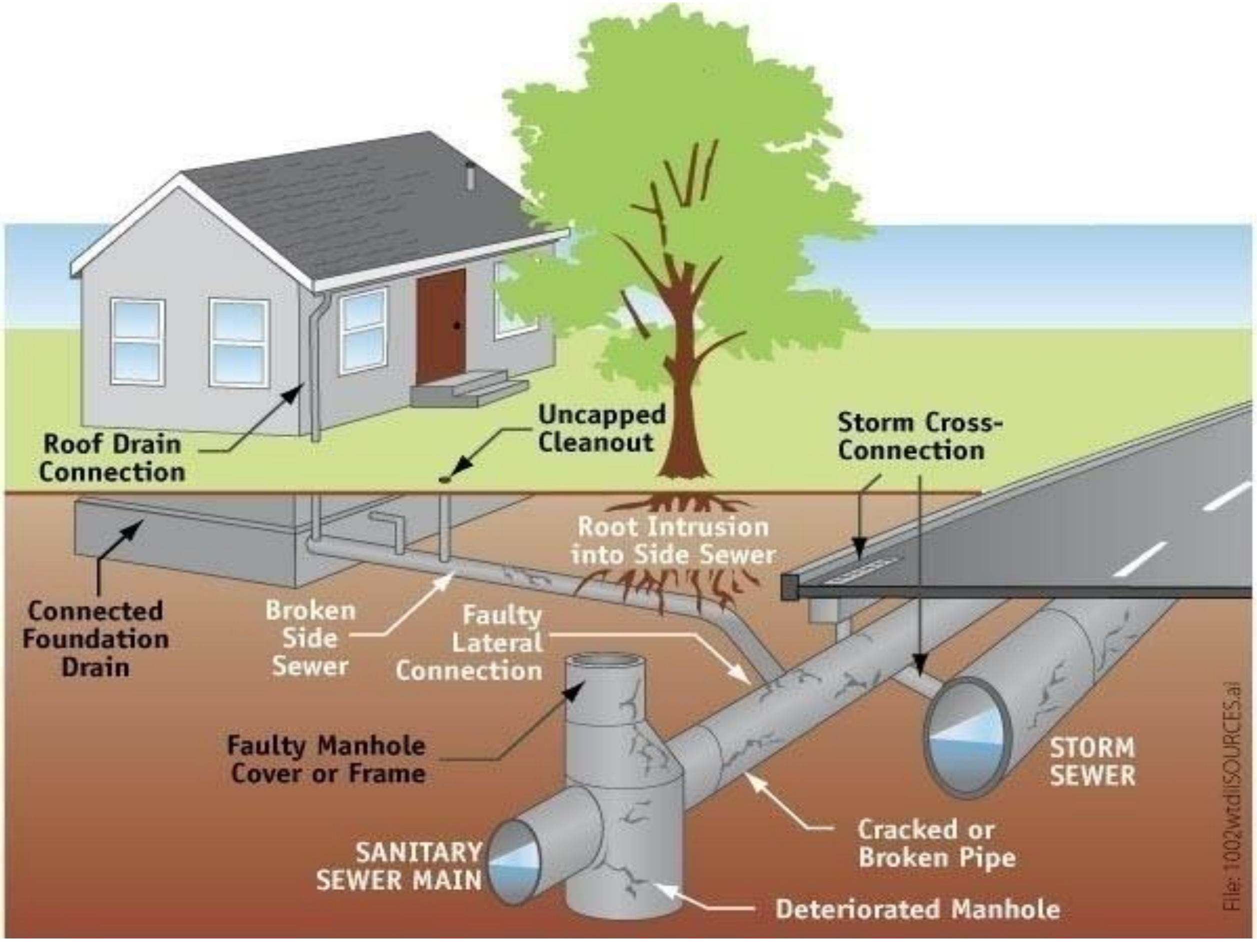

Source: King County, WA
http://www.kingcounty.gov/environment/wastewater/II/What.aspx?print=1

LEGEND

Inflow Sources (Black Text)

Infiltration Sources (White Text)

Figure 3.7

Infiltration and Inflow Sources

City-Wide Sewer System Master Plan

City of South San Francisco

September 4, 2018

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component.

- Methodology 2. Based on Linear Feet of Pipe. In this methodology, factors that may range between 12 and 30 or more gallons per day per inch diameter per 100 linear feet (gpd/inch diameter/100LF) are applied to linear feet of gravity sewers

- **Methodology 3**. Based on a percentage of Average Dry Weather Flows. In this methodology, infiltration and inflows are calculated based on a percentage of the average dry weather flow.

- **Methodology 4**. Based on flow monitoring data. In this methodology, infiltration and inflows are determined by analyzing flow monitoring data of current and past flow monitoring efforts. This methodology is used in this master plan.

This capacity analysis and master plan based the infiltration and inflow on specific flow monitoring data from the Villalobos and Associates (V&A) 2018 Flow Monitoring Program (**Appendix A**).

3.3.2 10-Year 24-Hour Design Storm

A synthetic design storm is typically used to evaluate the sewer collection system's response during wet weather flow conditions. The design storm information was extracted from Depth-Duration-Frequency rainfall data available from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (**Table 3.7** and **Table 3.8**).

- **10-Year Frequency.** Industry standards include design storms that range between 5-year and 20-year events. The City's 1999 I&I Study evaluated the existing system based on a 5-year design storm. However, based on current industry trends, and comparing against other local agencies (San Bruno, Daly City, and Pacifica) a 10-year storm event was chosen for the City to evaluate the capacity adequacy of the sewer collection system.
- **24-Hour Duration.** Peak flows from a storm event are usually caused by brief intense rains, that can happen as part of an individual event or as a portion of a larger storm. The 24-hour storm duration is longer than needed to determine peak flow but aids in identifying infiltration and inflows a sewer system may experience during a storm event.
- **Balanced Rainfall Centered Distribution.** The National Resources Conservation Service, previously known as the Soil Conservation Service, has developed rainfall distributions for wide geographic regions based on traditional DDF rainfall data. In this methodology, the highest rainfall intensity is placed at the center of the storm. Incrementally lower intensities are placed on alternating sides of the peak.

Thus, the NOAA Atlas 14 DDF, 10-year 24-hour (10yr-24hr) design storm, with a balanced rainfall distribution, was used to evaluate the capacity adequacy of the City's sewer collection system during wet weather flow conditions.

Table 3.7 Precipitation Depth-Duration-Frequency (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Duration	1-Year		2-Year		5-Year		10-Year		25-Year		100-Year	
	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)
5-min	0.13	1.52	0.16	1.86	0.19	2.30	0.22	2.68	0.27	3.20	0.34	4.08
10-min	0.18	1.10	0.22	1.33	0.28	1.65	0.32	1.92	0.38	2.30	0.49	2.92
15-min	0.22	0.88	0.27	1.07	0.33	1.33	0.39	1.55	0.46	1.85	0.59	2.36
30-min	0.30	0.60	0.37	0.73	0.46	0.91	0.53	1.06	0.63	1.27	0.81	1.61
1-hr	0.43	0.43	0.52	0.52	0.65	0.65	0.75	0.75	0.90	0.90	1.14	1.14
2-hr	0.62	0.31	0.75	0.38	0.93	0.47	1.08	0.54	1.29	0.65	1.64	0.82
3-hr	0.77	0.26	0.94	0.31	1.16	0.39	1.34	0.45	1.60	0.53	2.03	0.68
6-hr	1.08	0.18	1.31	0.22	1.63	0.27	1.89	0.32	2.27	0.38	2.88	0.48
12-hr	1.39	0.12	1.72	0.14	2.16	0.18	2.54	0.21	3.06	0.26	3.91	0.33
24-hr	1.80	0.08	2.26	0.09	2.89	0.12	**3.41**	0.14	4.13	0.17	5.31	0.22

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9/4/2018

Note:

1. Source: NOAA Atlas 14 Volume 6 version 2 for station South San Francisco

Table 3.8 Precipitation Depth-Duration-Frequency (East of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Duration	1-Year		2-Year		5-Year		10-Year		25-Year		100-Year	
	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)	(in)	(in/hr)
5-min	0.14	1.68	0.17	2.00	0.20	2.45	0.24	2.83	0.28	3.36	0.35	4.21
10-min	0.20	1.20	0.24	1.44	0.29	1.76	0.34	2.03	0.40	2.41	0.50	3.02
15-min	0.24	0.97	0.29	1.16	0.35	1.42	0.41	1.63	0.49	1.94	0.61	2.43
30-min	0.33	0.66	0.40	0.80	0.49	0.97	0.56	1.12	0.67	1.33	0.84	1.67
1-hr	0.47	0.47	0.56	0.56	0.69	0.69	0.79	0.79	0.94	0.94	1.18	1.18
2-hr	0.69	0.34	0.82	0.41	0.99	0.50	1.14	0.57	1.34	0.67	1.67	0.84
3-hr	0.86	0.29	1.02	0.34	1.23	0.41	1.41	0.47	1.67	0.56	2.07	0.69
6-hr	1.20	0.20	1.44	0.24	1.76	0.29	2.03	0.34	2.40	0.40	2.99	0.50
12-hr	1.53	0.13	1.90	0.16	2.39	0.20	2.80	0.23	3.36	0.28	4.26	0.36
24-hr	1.97	0.08	2.52	0.11	3.25	0.14	**3.85**	0.16	4.67	0.19	5.97	0.25

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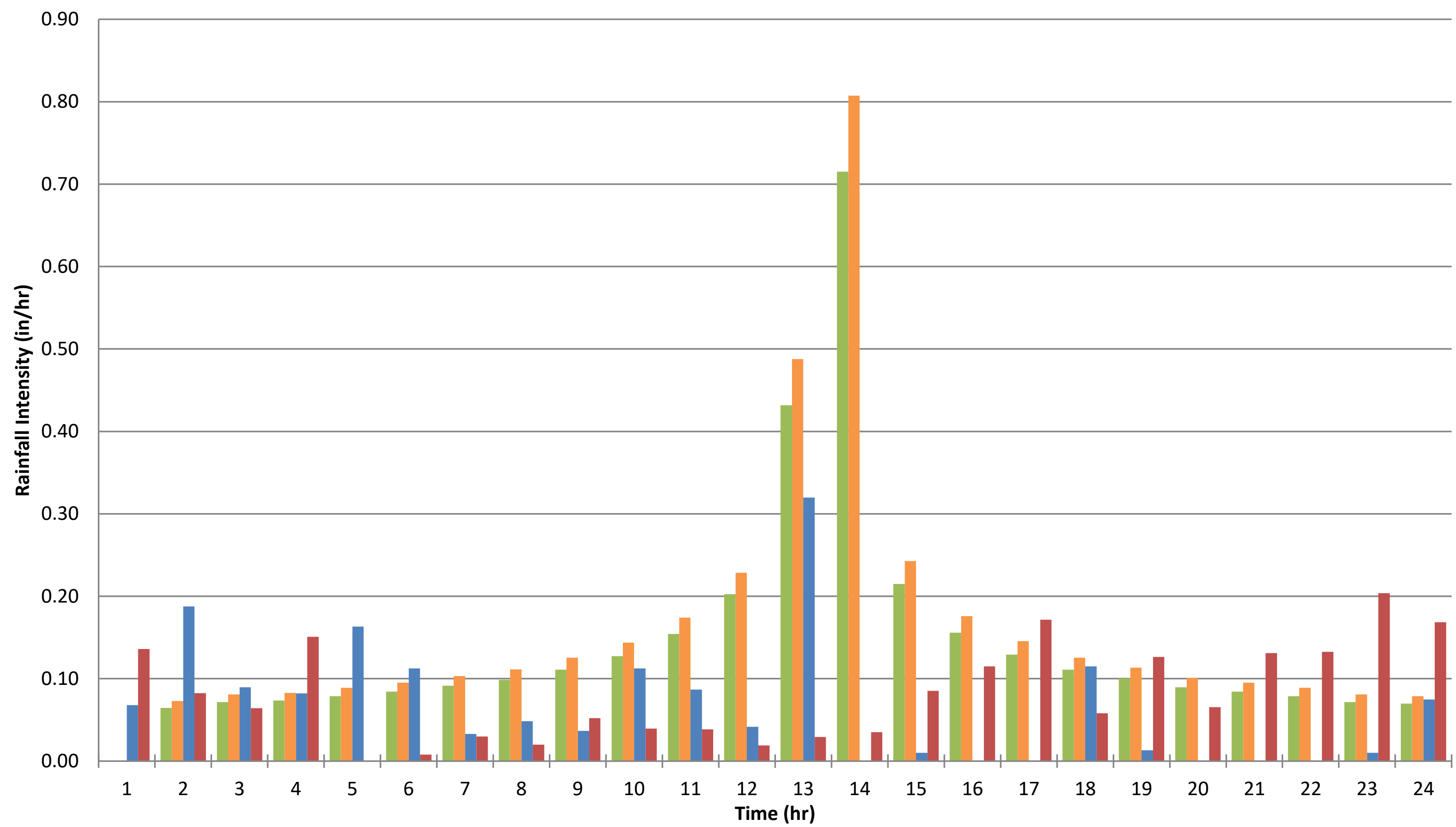
9/4/2018

Note:

1. Source: NOAA Atlas 14 Volume 6 version 2 for station South San Francisco



LEGEND

- Design Storm W/101: 10 Year - 24 Hour (3.41 in)
- Design Storm E/101: 10 Year - 24 Hour (3.85 in)
- Event 1: April 6, 2018 (1.96 in)
- Event 2: March 1, 2018 (1.61 in)

Notes:
1. Design storm rainfall amount based on NOAA Atlas 14 precipitation information for San Francisco International Airport.
2. Event precipitation volumes based on rainfall data collected during 2018 Flow Monitoring Program

March 30, 2022

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Figure 3.8

10-Year 24-Hour Storm

(Design Storm vs Historical Storms)

City-Wide System Master Plan

City of South San Francisco

Table 3.9 Storm Events Analysis

City-Wide Sewer System Master Plan
City of South San Francisco

Storm Event	Estimated Return Interval	Single Event Volume and Intensity	
		Volume (in)	Peak Intensity (in/ hour)
February 28 - March 3, 2018	1.5 Year 12-Hour	1.92	0.65
March 12 - March 25, 2018	1.5 Year 2-Day	2.76	0.33
April 5 - April 7, 2018	2-Year 45-Day	2.36	0.42
Design Storm - West of 101	10-Year 24-Hour	3.41	0.71
Design Storm - East of 101	10-Year 24-Hour	3.85	0.81

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3/30/2022

The selected 10-year 24-hour design storm was further compared to historical storm events, between February 2018 and April 2018, as shown on **Figure 3.8** and summarized on **Table 3.9**. **Table 3.9** lists the total rainfall volume and peak hour intensity for each respective storm. Historical rainfall data for the February 2018 and April 2018 storm events was compiled from information publicly available for the San Francisco International Airport.

Figure 3.8 is intended to show the diurnal comparison between the design storms and the two major storm events experienced during the Flow Monitoring period (February 2018 to April 2018). Major storm events were ranked and selected in order of greatest rainfall volume within a 24-hour period. The comparison indicates that, based on the balanced centered hyetograph, the West of 101 and East of 101 design storm's peak hour value is at 0.71 inch per hour (in/hr) and 0.81 in/hr respectively, while the March 2018 and April 2018 storms peak values are 0.32 in/ hr and 0.20 in/hr respectively. This comparison illustrates the more conservative nature of the design storm and the smaller peak values of the storm events experienced 2018.

CHAPTER 4 – EXISTING SEWER SYSTEM FACILITIES

This chapter provides a description of the City's existing sewer system facilities including gravity trunks, force mains, pump stations, and sewer collection basins. The chapter also includes a brief description of the Water Quality Control Plant (WQCP).

4.1 SEWER COLLECTION SYSTEM OVERVIEW

The City provides sewer collection services to approximately 13,100 residential, commercial, industrial, and institutional accounts. The City's collection system consists of gravity mains and force mains, with pipe sizes up to 42-inches, that convey flows towards the WQCP, south of the San Bruno Canal. The system relies on its trunk sewers, generally 15-inches in diameter or larger, designed to convey flows to the various pump stations that discharge flow to the WQCP. Pump Station 9 and Pump Station 11 convey flows from the west of Highway 101 service area to the WQCP. Flows east of Highway 101 are conveyed to various intermediate pump stations before Pump Station 4 and Pump Station 7 ultimately convey the collected flows to the WQCP. **Figure 4.1** provides an overview of the existing sewer system.

The west of Highway 101 and east of Highway 101 pipe inventory, listing the total length by pipe diameter, is documented on **Table 4.1** and **Table 4.2.** This table is based on GIS information provided by City staff. The 6-inch and 8-inch diameter pipes account for more than 78 percent of the total gravity main pipe lengths.

4.2 SEWER COLLECTION BASINS AND TRUNKS

The west of Highway 101 and east of Highway 101 sewer collection service areas are divided into multiple dendritic sewer collection basins as shown on **Figure 4.2**. The sewer collection basins for the west of Highway 101 sewer service area are defined by the areas tributary to the flow monitors installed in 2017 as discussed in a separate chapter. The sewer collection basins for the east of Highway 101 sewer service area are defined by the areas tributary to the intermediate pump stations that convey flow to Pump Station 4 and Pump Station 7.

The City's existing pump stations are shown on **Figure 4.3.** .A schematic diagram intended to simplify the connectivity between the basins and trunks is shown on **Figure 4.4**. The basins were further divided into collection system subbasins, and the basins are documented in the following sections.

4.2.1 East of Highway 101

The following sections summarize the sewer tributary areas in the east of Highway 101 service area.

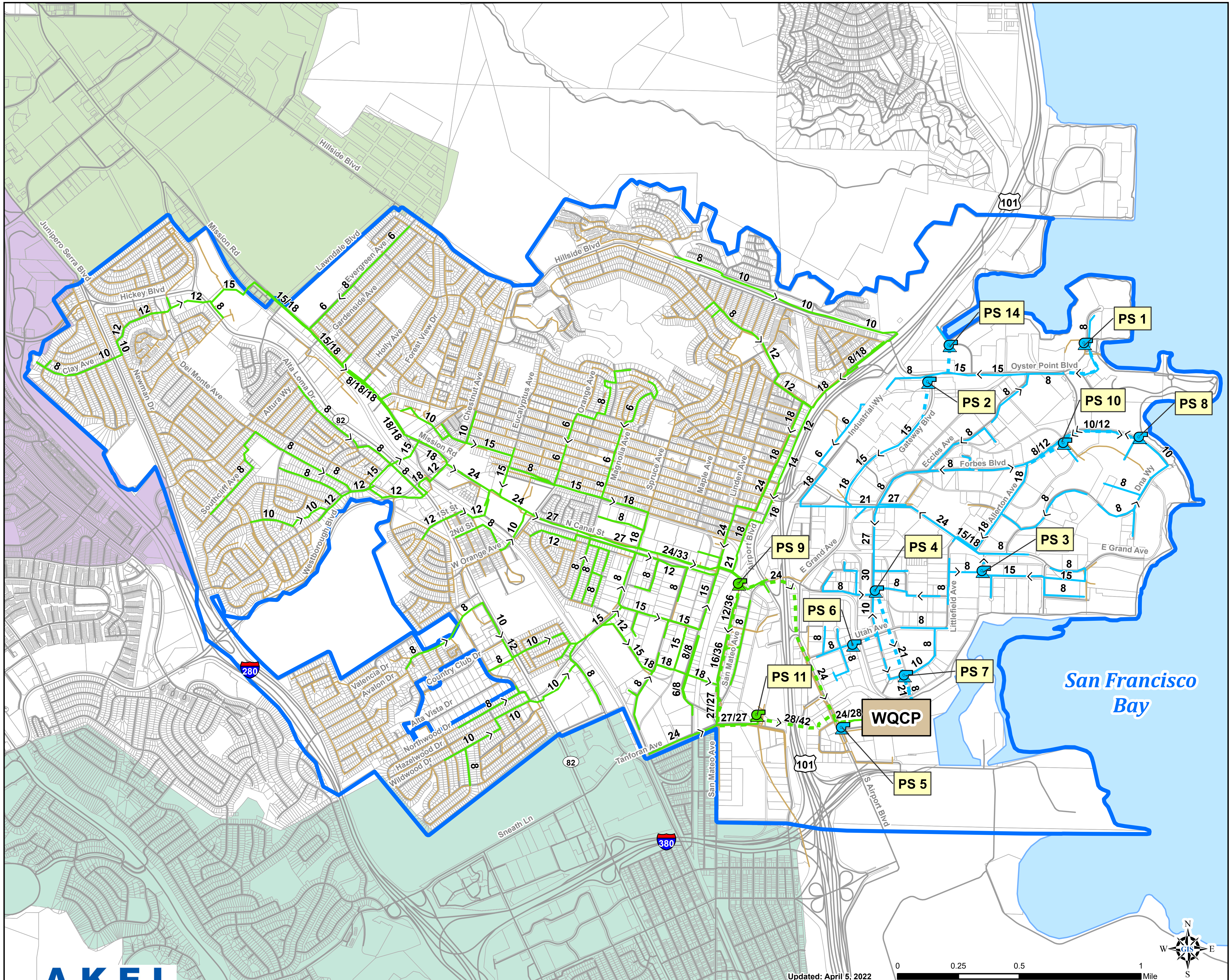

Figure 4.1
Existing Sanitary Sewer System
City-Wide Sewer System
Master Plan
City of South San Francisco

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File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\SSF_Fig4-1_ExistingSystem_040522.mxd

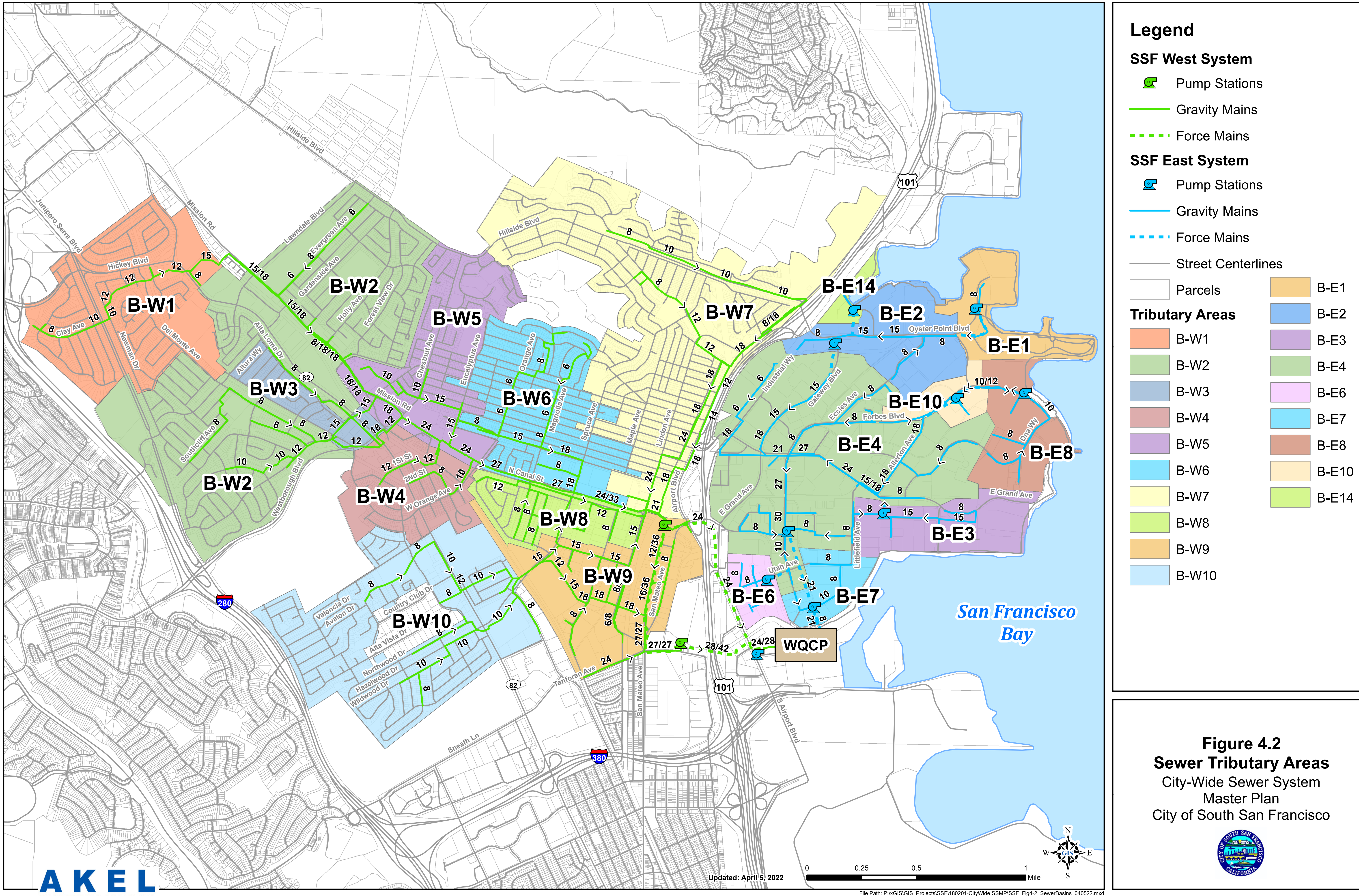


Figure 4.2
Sewer Tributary Areas
City-Wide Sewer System
Master Plan
City of South San Francisco

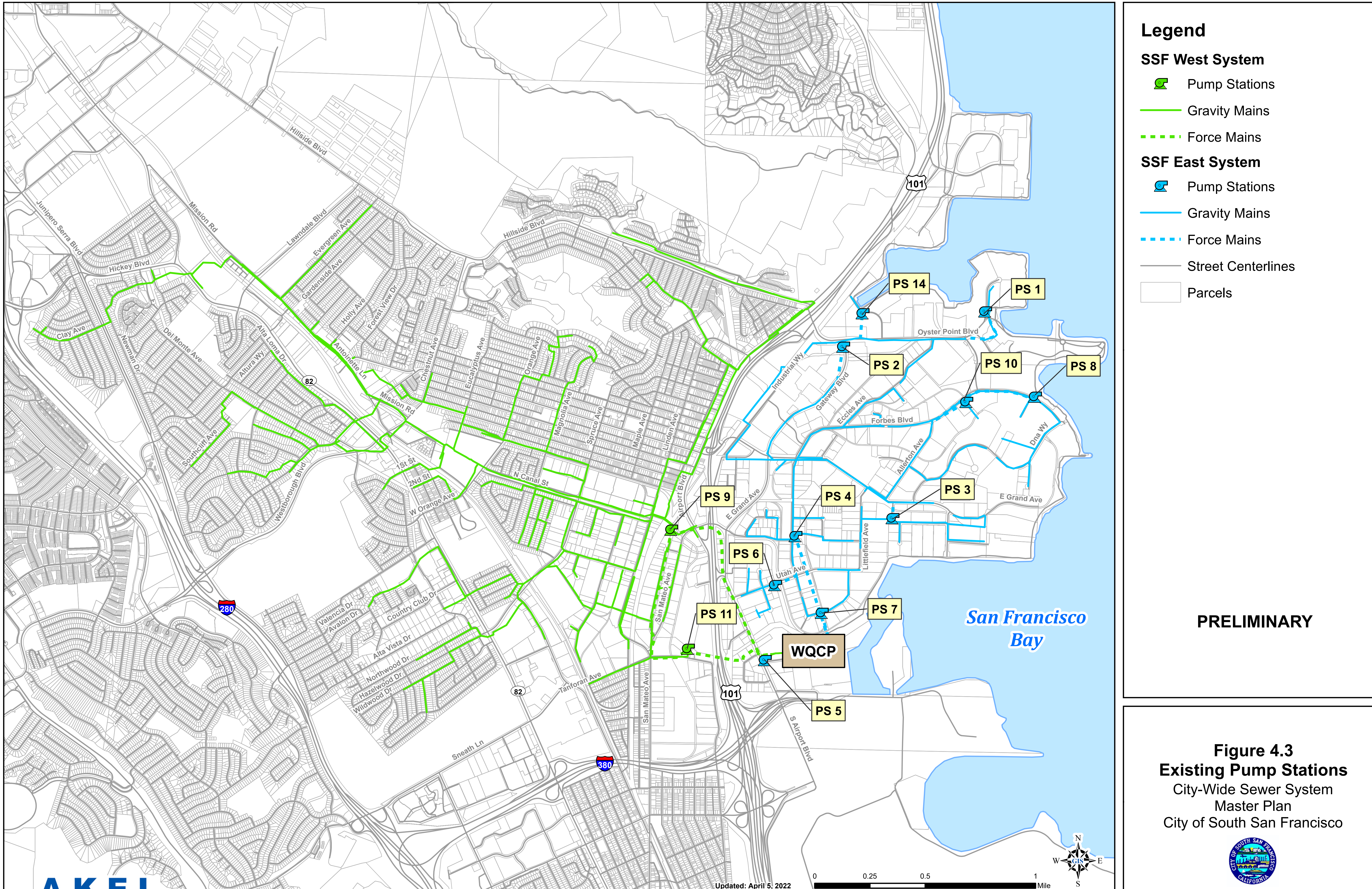
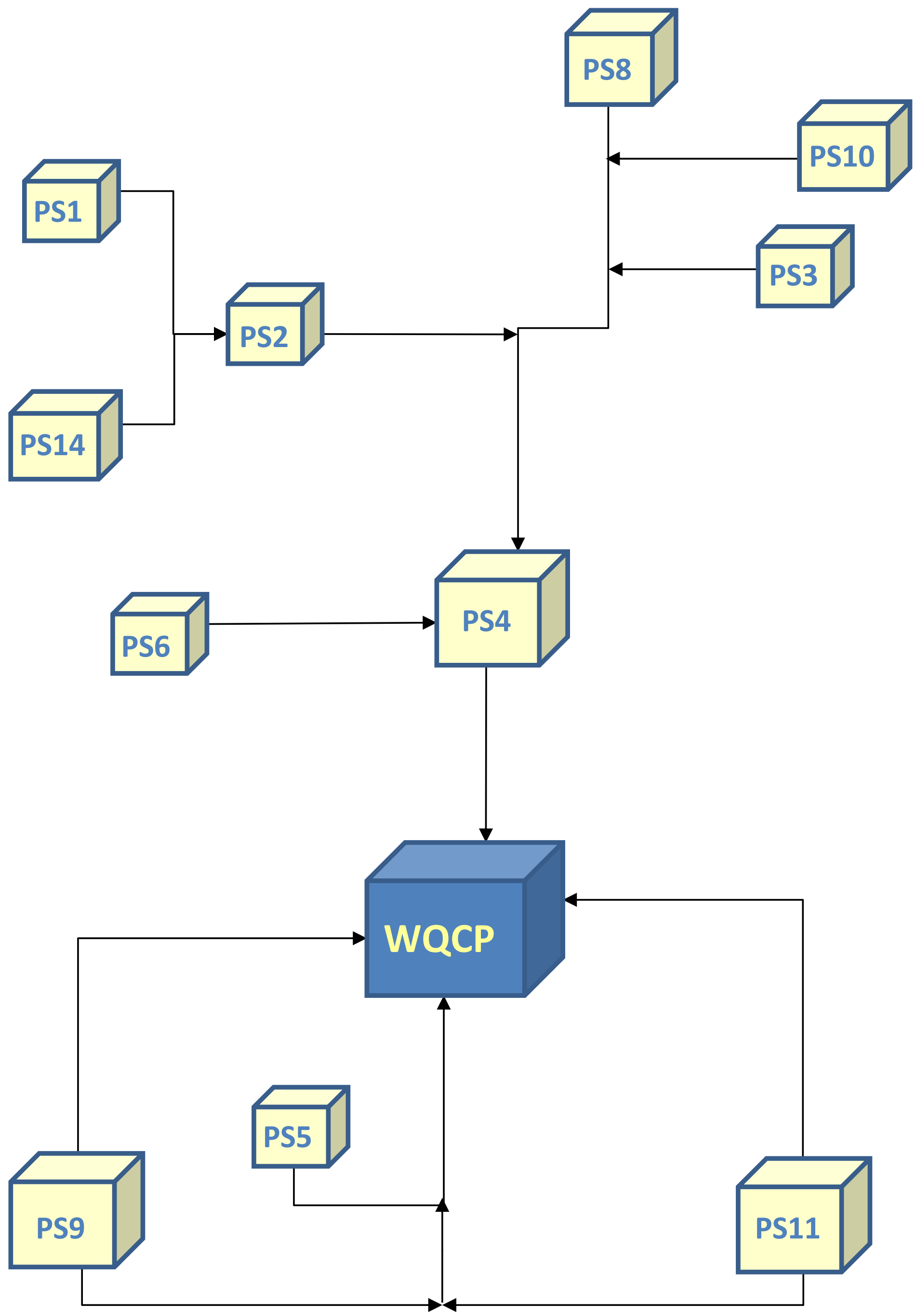


Figure 4.3
Existing Pump Stations
City-Wide Sewer System
Master Plan
City of South San Francisco



LEGEND

Sewer Pump Stations

Sewer Mains

Water Quality Control Plant

February 26, 2020

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Figure 4.4

Pump Station Schematic

City-Wide Sewer System
Master Plan
City of South San Francisco

Table 4.1 Existing GIS Pipe Inventory (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
4	492	0.1
6	371,728	70.4
8	63,335	12.0
10	18,603	3.5
12	13,824	2.6
14	1,084	0.2
15	16,852	3.2
16	1,177	0.2
18	18,453	3.5
21	2,928	0.6
24	10,173	1.9
27	6,267	1.2
30	96	0.0
33	2,606	0.5
36	3,270	0.6
Unknown	7,453	1.4
SubTotal	538,340	102.0
Force Mains		
24	4,674	0.9
27	1,869	0.4
28	2,281	0.4
36	2,219	0.4
SubTotal	11,044	2.1
Total East of Highway 101 Pipe Length		
Total	**549,384**	**104.1**

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2/26/2020

Note:

1. Information extracted from GIS shapefiles provided by City Staff on 03/13/2018.

Table 4.2 Existing GIS Pipeline Inventory (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
6	5,150	1.0
8	39,240	7.4
10	5,949	1.1
12	3,161	0.6
15	10,603	2.0
18	2,275	0.4
20	0	0.0
21	793	0.2
24	924	0.2
27	2,045	0.4
30	315	0.1
Unknown	801	0.2
Subtotal	71,256	13.5
Force Mains		
6	595	0.1
8	2,493	0.5
10	2,000	0.4
12	2,746	0.5
21	2,649	0.5
SubTotal	10,484	2.0
Total East of Highway 101 Pipe Length		
Total	**81,740**	**15.5**

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4.2.1.1 *Basin E1*

Basin E1 encompasses 73 acres in the northeastern portion of the service area. It is bound by Oyster Point Boulevard to the west and the San Francisco Bay to north and east. The boundaries of Basin E1 are approximately the same as the boundaries of the Oyster Point community. The flows are collected through a succession of 8-inch gravity mains as sewer flows approach Pump Station 1. Flows are then discharged to Basin E2 through a 8-inch force main located along Oyster Point Boulevard.

4.2.1.2 *Basin E2*

Basin E2 encompasses 194 acres in the northern portion of the service area. It is bound by the Oyster Point Channel to the north, Rozzie Place to the south, and Highway 101 to the west. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 15-inch as sewer flows approach Pump Station 2. Flows are then discharged into Basin E4 through a 10-inch force main located along Gateway Boulevard.

4.2.1.3 *Basin E3*

Basin E3 encompasses 123 acres in the southeastern portion of the service area. It is bound by Littlefield Avenue to the west, East Grand Avenue to the north, and the San Francisco Bay to the east and south. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 15-inch as sewer flows approach Pump Station 3. Flows are then discharged into Basin E4 through a 10-inch force main located along Kimball Way.

4.2.1.4 *Basin E4*

Basin E4 encompasses 439 acres in the central portion of the East of Highway 101 service area. It is the largest basin in the system and is bound to the west by Highway 101. It collects the flows of pump stations 1, 2, 3, 6, 8, 10, and 14. The flows are collected through a succession of gravity mains ranging from 8-inch to 30-inch as sewer flows approach Pump Station 4. Flows are then discharged to the WQCP through a 21-inch force main.

4.2.1.5 *Basin E6*

Basin E6 encompasses 47 acres in the southwestern portion of the service area. It is bound by Wondercolor Lane to the north, Harbor Way to the east, and Highway 101 to the west. The flows are collected through a succession of 8-inch gravity mains as sewer flows approach Pump Station 6. Flows are then discharged into Basin E4 through a 6-inch force main located along Utah Avenue.

4.2.1.6 *Basin E7*

Basin E7 encompasses 60 acres in the southern portion of the service area. It is bound by Utah Avenue to the north, Harbor Way to the west, and the San Francisco Bay to the east. The flows are collected through a succession of gravity mains ranging from 8-inch to 10-inch as sewer flows approach Pump Station 7. Basin E7 is not connected to any other basins in the sewer system and discharges directly to the WQCP through an 8-inch force main.

4.2.1.7 *Basin E8*

Basin E8 encompasses 123 acres in the eastern portion of the service area. It is bound by Forbes Avenue to the north, East Grand Avenue to the south, and the San Francisco Bay to the east. The flows are collected through a succession of gravity mains ranging from 8-inch to 10-inch as sewer flows approach Pump Station 8. Flows are then discharged into Basin E4 through a 12-inch force main located along Forbes Boulevard.

4.2.1.8 *Basin E10*

Basin E10 encompasses 42 acres in the central eastern portion of the service area. It is bound by Carlton Court to the west and Gull Drive to the east. It primarily collects flows from development located along Forbes Boulevard. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 10-inch as sewer flows approach Pump Station 10. Flows are then discharged into Basin E4 through a 10-inch force main located along Forbes Boulevard.

4.2.1.9 *Basin E14*

Basin E14 encompasses 8 acres in the northwestern portion of the service area. It is bound by Veterans Boulevard to the north and Oyster Point Boulevard to the south. The flows are collected through a succession of 8-inch gravity mains as sewer flows approach Pump Station 14. Flows are then discharged into Basin E2 through an 8-inch force main.

4.2.2 West of Highway 101

The following sections summarize the sewer tributary areas in the west of Highway 101 service area.

4.2.2.1 *Basin W1*

Basin W1 encompasses 297 acres in the northwestern portion of the service area. It is bound by Mission Road to the north, Dundee Drive to the south, Arlington Drive to the west and Romney Way to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 15-inch as sewer flows approach Basin W2. Flows are then conveyed into Basin W2 through a 15-inch gravity main located along Mission Road. Basin W1 collects a portion of the sewer flows from Daly City and conveys the flow to the WQCP.

4.2.2.2 *Basin W2*

Basin W2 encompasses 820 acres in the western portion of the service area. It is bound by Hillside Boulevard to the north, Interstate 280 to the south, Lawndale Boulevard and Romney Way to the west, and Westborough Boulevard and Willow Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 6-inch to 18-inch as sewer flows approach Basin W5. Flows are then conveyed into Basin W5 through 15-inch and 18-inch gravity mains located along Arroyo Drive and Mission Road respectively. Basin W2 collects a portion of the sewer flows from the City of Colma via an 18-inch gravity main near the intersection of Mission Road and Lawndale Boulevard and conveys the flow to the WQCP.

It should be noted that the southern half of Basin W2 (south of Basin W3) was originally included as a part of Basin W3. During the Master Plan process, the City completed a manhole survey program which verified the presence of an active 15-inch gravity main along Arroyo Drive between Camaritas Avenue and Mission Road. The decrease in Basin area is a result of the 15-inch gravity main altering the divergence of flows specifically at the intersection of Arroyo Drive and Camaritas Avenue. This divergence of flows was later verified in the flow monitoring data.

4.2.2.3 *Basin W3*

Basin W3 encompasses 65 acres in the central western portion of the service area. It is bound by El Camino Real to the north, Camaritas Avenue to the south, San Felipe Avenue to the west, and Westborough Boulevard to the east. The flows are collected through a succession of gravity main ranging in size from 8-inch to 18-inch as sewer flows approach Basin W5. Flows are then conveyed into Basin W5 through a 12-inch gravity main located along Westborough Boulevard. For the future planning horizon, and to account for the City's planned annexation of unincorporated areas, Basin W3 will collect sewer flows from the California Golf Club at San Francisco.

4.2.2.4 *Basin W4*

Basin W4 encompasses 141 acres in the central portion of the service area. It is bound by Colma Creek to the north, Lassen Street to the south, Westborough Boulevard to the west, and Centennial Way Trail to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 12-inch as sewer flows approach Basin W5. Flows are then conveyed into Basin W5 through 12-inch gravity mains located along Orange Avenue and Memorial Drive.

4.2.2.5 *Basin W5*

Basin W5 encompasses 272 acres in the northern portion of the service area. It is bound by Hillside Boulevard to the north, Colma Creek to the south, Willow Avenue to the west, and Eucalyptus Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 24-inch as sewer flows approach Basin W6. Flows are then conveyed into Basin W6 through a 24-inch gravity main located along North Canal Street.

4.2.2.6 *Basin W6*

Basin W6 encompasses 259 acres in the northern portion of the service area. It is bound by Rocca Avenue to the north, North Canal Street to the south, Eucalyptus Avenue to the west, and Maple Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 6-inch to 18-inch as sewer flows approach Basin W7. Flows are then conveyed into Basin W7 through a 33-inch gravity main located along North Canal Street.

4.2.2.7 *Basin W7*

Basin W7 encompasses 672 acres in the northeaster portion of the of the service area. It is the largest basin in the system. It is bound the San Bruno Mountain State & County Park to the north, North Canal Street to the south, Hillside Boulevard to the west, and Highway 101 to the east. The flows are collected through a succession of gravity mains ranging in size from 6-inch to 24-inch as sewer flows approach Basin W9. Flows are then conveyed into Basin W9 through 21-inch and 24-inch gravity mains located along Cypress Avenue and Linden Avenue respectively.

4.2.2.8 *Basin W8*

Basin W8 encompasses 125 acres in the central eastern portion of the service area. It is bound by North Canal Street to the north, Centennial Way Trail to the south, Orange Avenue to the west, and Linden Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 15-inch as sewer flows approach Basin W9. Flows are then conveyed into Basin W9 through a 15-inch gravity main located along Linden Avenue.

4.2.2.9 *Basin W9*

Basin W9 encompasses 216 acres in the southwestern portion of the service area. It is bound by North Canal Street to the north, Tanforan Avenue to the south, Spruce Avenue to the west, and San Mateo Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 33-inch as sewer flows approach Pump Station 9 and Pump Station 11. Flows are conveyed to Pump Station 9 and Pump Station 11 through 33-inch and 27-inch gravity mains located along North Canal Street and Shaw Road respectively. Flows are then discharged to the WQCP through a 24-inch force main from Pump Station 9 and a parallel 28-inch and 42-inch force main from Pump Station 11.

4.2.2.10 *Basin W10*

Basin W10 encompasses 459 acres in the southern portion of the service area. It is bound by Centennial Way Trail to the North, Interstate 280 to the south, Ponderosa Road to the west, and Noor Avenue to the east. The flows are collected through a succession of gravity mains ranging in size from 8-inch to 10-inch as sewer flows approach Basin W9. Flows are then conveyed into Basin W9 through a 15-inch gravity main located along Spruce Avenue. For the future planning horizon, and to account for the City's planned annexation of unincorporated areas, Basin W10 will collect sewer flows from the Ponderosa Elementary School and Low-Density Residential homes along Alta Vista Drive.

4.3 PUMP STATIONS

When routing flows by gravity is not possible due to adverse grades, pump stations are used to pump flows. The City currently maintains twelve pump stations in the sewer collection system, as summarized on **Table 4.3** and shown on **Figure 4.4**.

Table 4.3 lists each pump station with relevant information obtained from the City's records including: location, wet well capacity, number of pumps, pump capacity, and controls, if data was available. The pump stations are operated to turn "on" or "off" based on the levels in their wet wells.

Eleven of the twelve pump stations were included in the hydraulic model and a brief description of the pump stations is provided below:

- **Pump Station 1.** This pump station is located in the northeastern part of the east of Highway 101 sewer system service area. Flows from the Oyster Point Community are conveyed to this pump station and then routed to an 8-inch sewer main along Oyster Point Boulevard. The pump station is located north of the intersection of Oyster Point Road and Marina Boulevard, at 383 Oyster Point Road. The pump station includes two duty pumps and one standby pump. The pump station has a firm capacity of 2.01 mgd and a total capacity of 4.02 mgd. The pump discharges into a force main following the alignment of Oyster Point Road.

- **Pump Station 2.** This pump station services the area located north of Oyster Point Boulevard, east of Bayshore Boulevard and west of the Oyster Point Channel. It collects the sewer flows from Pump Station 1 and Pump Station 14, as well as the flows tributary directly to this pump station. This pump station is located at 955 Gateway Boulevard. The pump station includes one duty pump and one standby pump. The pump station has a firm capacity is 1.44 mgd and a total capacity of 2.88 mgd. The pump discharges into a 10-inch force main along Gateway Boulevard.

- **Pump Station 3.** This pump station services the southeast portion of the east of Highway 101 sewer system service area of the City. It services the developments bound to the west by Littlefield Avenue, to the north by Grand Avenue and the east by the San Francisco Bay. This pump station is located at 195 Kimball Way. The pump station includes two duty pumps and one standby pump. The pump station has a firm capacity of 2.3 mgd and a total capacity of 3.46 mgd. The pumps discharge into a 10-inch fore main along Kimball way and discharges flows into Swift Avenue.

- **Pump Station 4.** This pump station services a large portion of the east of Highway 101 sewer system service area and collects flows from developed areas encompassed to the east by Bayshore Boulevard and to the south by Utah Avenue. The pump station is located at 249 Harbor Way and includes three duty pumps and one standby pump. The pump station has a firm capacity of approximately 12.96 mgd and a total capacity of 17.28 mgd. The pump station discharges flow directly into the WQCP through a 21-inch force main.

- **Pump Station 6.** This pump station is located in the southwestern portion of the east of Highway 101 sewer system service area and collects flows from the area bordered by Highway 101 to the east and Mitchell Avenue to the west along Utah Avenue. This pump

Table 4.3 Pump Station Inventory
City-Wide Sewer System Master Plan
City of South San Francisco

Pump Station Information		Wet Well Capacity[1]	Pumps			Pump Controls							
No.	Location	Total (gal)	Quantity	Capacity (mgd)	Capacity (gpm)	High Level (ft)	Low Level (ft)	Lead On (ft)	Lead Off (ft)	Lag 1 On (ft)	Lag 1 Off (ft)	Lag 2 On (ft)	Lag 2 Off (ft)
Marina Pump Station	Oyster Point Marina	1,688	2	2 @ 0.61	2 @ 425	6.0	1.5	4.5	2.0	5.0	2.5		
PS1[2]	383 Oyster Point Rd	8,000	2	2 @ 2.01	2 @ 1,400	6.1	1.6	5.5	3.5	6.0	4.0	6.5	4.5
PS2	955 Gateway Blvd	19,000	2	2 @ 1.44	2 @ 1,000	7.4	2.0	5.5	3.0	6.0	3.0		
PS3	195 Kimball Way	22,000	3	3 @ 1.15	3 @ 800	9.6	1.7	7.5	4.0	8.5	4.5	9.0	5.0
PS4	249 Harbor Way	80,000	4	4 @ 4.32	4 @ 3,000	6.5	2.0	4.9	4.0				
PS5	477 South Airport Blvd	15,000	2	2 @ 1.08	2 @ 750	6.3	2.0	5.5	3.3	6.0	3.5		
PS6	160 Utah Ave	7,000	2	2 @ 0.86	2 @ 600	7.0	2.0	5.5	3.5	6.5	3.5		
PS7	220 Littlefield Ave	7,000	2	1 @ 0.61 1 @ 0.86	1 @ 425 1 @ 600	6.0	2.5	5.0	3.0	5.5	3.5		
PS8	701 Forbes Blvd	40,000	3	3 @ 2.02	3 @ 1,400			5.0	4.0	5.8	4.5		
PS9	1479 San Mateo Ave	100,000	4	2 @ 6.05 2 @ 12.05	2 @ 4,200 2 @ 8,400	6.5	3.0	5.7	3.8				
PS10	572 Forbes Blvd	4,800	2	2 @ 1.58	2 @ 1,097			5.0	3.3	5.4	3.8		
PS11	235 Shaw Rd		6	3 @ 4.18 3 @ 8.35	3 @ 2,900 3 @ 5,800			8.5	6.5				
PS14	1191 Veterans Blvd	14,069	2	2 @ 2.88	2 @ 2,000	6.3	2.5	4.2	3.3	5.0	3.3		

Notes:
1. Source: City of San Francisco Pump Station Standard Operating Procedures
2. Source: City Staff provided confirmation that the Oyster Point Pump Station improvement from the East of 101 SSMP had been constructed. Pump controls are unavailable until the City updates the Sewage and Storm Water Pump Stations Standard Operating Procedures document.

station is located at 160 Utah Avenue and includes one duty pump and one standby pump. The pump station firm capacity is 0.86 mgd and the total capacity is 1.72 mgd. The pump station discharges flow directly into a 6-inch force main.

- **Pump Station 7.** This pump station services the southernmost portion of the east of Highway 101 sewer system service area and collects flows from developments encompassed by Utah Avenue, Littlefield Avenue and Colma Creek. This pump station is located at 220 Littlefield Avenue and includes one duty pump and one standby pump. The pump station firm capacity is 0.61 mgd and the total capacity is 1.47 mgd. The pump station discharges flow directly into the WQCP through an 8-inch force main.

- **Pump Station 8.** This pump station services the eastern portion of the east of Highway 101 sewer system service area and collects flows from developments located along DNA Way. It is located at 701 Forbes Boulevard and includes two duty pumps and one standby pump. The pump station has a firm capacity of 4.04 mgd and a total capacity of 6.06 mgd. It discharges flows into a 12-inch force main along Forbes Boulevard.

- **Pump Station 9.** This pump station services a majority of the west of Highway 101 sewer system service area and is located at 1479 San Mateo Avenue. This pump station includes a dry weather wet well, equipped with two 4,200 gpm pumps, and a wet weather wet well equipped with two 8,400 gpm pumps. Under typical flow conditions the dry weather pumps convey flows through a 24-inch force main to the WQCP. During high flow events the wet weather wet well will receive additional flows and the pumps will discharge to a 36-inch force main that conveys flows to Pump Station 11. The pump station has a firm capacity of 24.2 mgd and a total capacity of 36.3 mgd.

- **Pump Station 10.** This pump station services developments within the east of Highway 101 sewer system service area located along Forbes Boulevard west of Gull Drive. It is located at 572 Forbes Boulevard and includes one duty pump and one standby pump. The pump station has a firm capacity of 1.58 mgd and a total capacity of 3.16 mgd. The pump station discharges flow into a 10-inch force main connecting to a gravity main on Allerton Avenue.

- **Pump Station 11.** This pump station, located at 235 Shaw Road, services the southern portion of the west of Highway 101 sewer system service area and collects flows from developments located south of Canal Street and east of Orange Avenue. Additionally, a 24-inch pipeline along Tanforan Avenue collects flows from the City of San Bruno that are conveyed to Pump Station 11. This pump station includes a dry weather wet well, equipped with three 2,900 gpm pumps, and a wet weather wet well equipped with three 5,900 gpm pumps. Under typical flow conditions the flows are conveyed to the WQCP through the 28-inch dry weather dry force main. During high flow events the 42-inch wet weather force main may be use to convey additional flows to Bar Screen 4 facility at the WQCP, which then coveys flows to the WQCP inflow. The pump station has a firm capacity of 29.2 mgd and a total capacity of 37.6 mgd.

- **Pump Station 14.** This pump station is located north of Oyster Point Boulevard and collects flows along Veterans Boulevard within the east of Highway 101 sewer system service area. It is located at 1191 Veterans Boulevard and includes one duty pump and one standby pump. The pump station has a firm capacity of 2.88 mgd and a total capacity of 5.76 mgd. It discharges flow into an 8-inch force main connecting to a gravity main on Oyster Point Boulevard.

4.4 WATER QUALITY CONTROL PLANT

The Water Quality Control Plant (WQCP) is an advanced wastewater treatment plant located on south side of the San Bruno Canal with a street address of 195 Belle Air Road. The plant provides wastewater treatment to several municipalities, including the City of San Bruno, Daly City, and the Town of Colma. According to information provided by City Staff the average dry weather flow experienced by the plant ranges daily between 4.2 mgd and 6.1 mgd. When strong wet weather events occur, creating an increase in peak wet weather flows, the WQCP can experience Peak Day Wet Weather flows up to 28.4 mgd.

CHAPTER 5 – SEWER FLOWS

This chapter summarizes historical sewer flows experienced at the Water Quality Control Plant and defines flow terminologies relevant to this evaluation. This chapter discusses the sewer flow distribution within the nine defined basins, and identifies the design flows used in the hydraulic modeling effort and capacity evaluation. The design flows include the existing condition (existing customers) and the projected ultimate buildout scenario.

5.1 FLOWS AT THE WATER QUALITY CONTROL PLANT

The sewer flows collected and treated at the Water Quality Control Plant vary monthly, daily, and hourly. While the dry weather flows are influenced by customer uses, the wet weather flows are influenced by the severity and length of storm events and the condition of the system. **Figure 5.1** shows the monthly flows versus rainfall at the WQCP for the year 2018, where January was the maximum month during 2018.

Influent flow data at the WQCP was obtained from City operations staff. The flow data covered a period from 2008 to 2018. The average monthly, average daily, and peak daily flows, estimated for the west and east of Highway 101 sewer systems. The system-wide, west of Highway 101, and east of Highway 101 flows are respectively summarized on **Table 5.1**, **Table 5.2**, and **Table 5.3.**

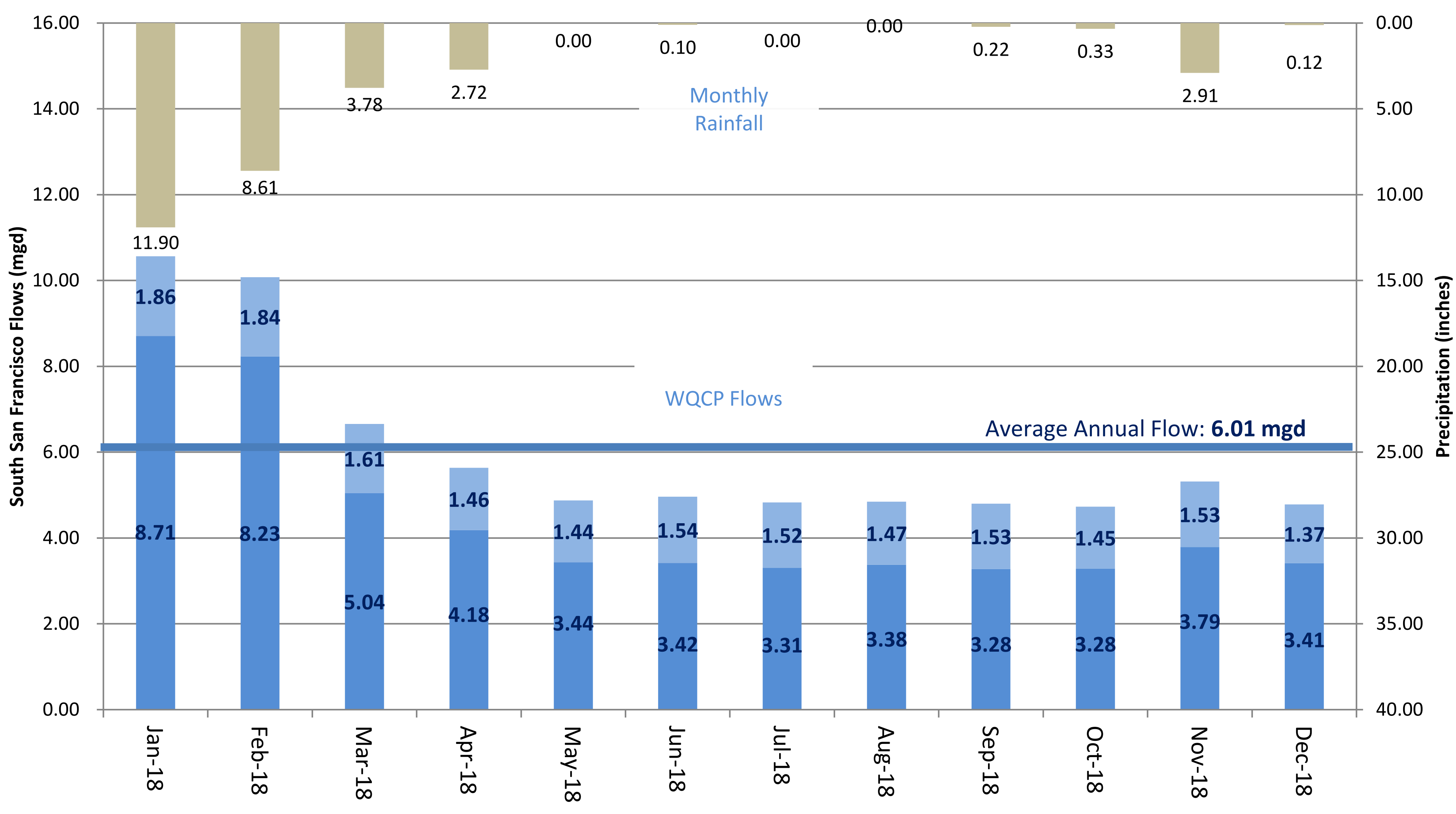
The following definitions are intended to document relevant terminologies shown on **Table 5.1**, **Table 5.2**, and **Table 5.3**.

- **Average Annual Flow (AAF).** The average annual flow is the total annual flow, or average monthly flow, for a given year, expressed in daily or other time units. This flow includes the combined average of the average dry weather flow (ADWF) and average wet weather flow (AWWF).

- **Average Dry Weather Flow (ADWF).** The average dry weather flow occurs on a daily basis during the dry weather season, with no evident reaction to rainfall. The ADWF also includes the Base Wastewater Flow (BWF). The base wastewater flow is the average flow that is generated by residential, commercial, and industrial users. The flow pattern from these users varies depending on land use types.

- **Average Wet Weather Flow (AWWF).** This average wet weather flow occurs on a daily basis during the wet weather season. In addition to the flow components in the ADWF, the AWWF includes infiltration and inflow from storm rainfall events.

- **Maximum Month Dry Weather Flow (MMDWF).** This maximum month flow occurs during the dry weather season.



LEGEND

- West of 101 Monthly Flows
- East of 101 Monthly Flows
- Monthly Rainfall
- 2018 Average Flow

Note: Monthly flows shown exclude San Bruno

August 2, 2019

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Figure 5.1

2018 WQCP Flows

City-Wide Sewer System Master Plan

City of South San Francisco

Table 5.1 Historical Flow Statistics (System-Wide)

City-Wide Sewer System Master Plan

City of South San Francisco

Year	Average Annual (mgd)	Seasonal Average		Monthly Average		Maximum Day	
		ADWF (mgd)	AWWF (mgd)	PMDWF (mgd)	PMWWF (mgd)	MDDWF (mgd)	MDWWF (mgd)
Historical Flows							
2012	6.11	5.47	6.56	5.53	8.59	7.06	21.82
2013	5.49	5.42	5.55	5.57	5.97	7.54	7.82
2014	5.94	5.45	6.29	5.50	9.45	7.04	28.42
2015	5.30	4.99	5.52	5.08	6.04	6.18	14.75
2016	5.70	4.97	6.23	5.08	7.73	6.03	17.34
2017	5.98	4.86	6.79	4.96	10.56	6.33	27.50
2018	5.23	4.84	5.52	4.94	6.06	6.09	21.69
Historical Peaking Factors (Applied to ADWF)							
2012	1.12	1.00	1.20	1.01	1.57	1.29	3.99
2013	1.01	1.00	1.02	1.03	1.10	1.39	1.44
2014	1.09	1.00	1.15	1.01	1.73	1.29	5.21
2015	1.06	1.00	1.11	1.02	1.21	1.24	2.95
2016	1.15	1.00	1.25	1.02	1.56	1.21	3.49
2017	1.23	1.00	1.40	1.02	2.17	1.30	5.66
2018	1.08	1.00	1.14	1.02	1.25	1.26	4.48
Recommended Evaluation Peaking Factor							

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Notes:

1. Historical flows extracted from WQCP data received from City staff June 19, 2019.
2. Dry weather months include months from May to September.
3. Wet weather months include months from October to April.
4. Flows for the City of San Bruno are not included in the historical flows and were estimated based on Pump Station 11 inflows and flows recorded at Flow Monitor 7. An analysis of these flows indicated approximatley 80% of the flows at Pump Station 11 are contributed by the City of San Bruno.

Table 5.2 Historical Flow Statistics (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Year	Average Annual (mgd)	Seasonal Average ADWF (mgd)	Seasonal Average AWWF (mgd)	Monthly Average PMDWF (mgd)	Monthly Average PMWWF (mgd)	Maximum Day MDDWF (mgd)	Maximum Day MDWWF (mgd)
Historical Flows							
2012	4.48	3.91	4.89	3.95	6.71	5.30	18.92
2013	3.88	3.81	3.94	3.91	4.31	5.76	6.56
2014	4.31	3.88	4.63	3.95	7.51	5.38	25.25
2015	3.73	3.43	3.95	3.47	4.41	4.57	12.57
2016	4.19	3.54	4.65	3.62	5.99	4.43	15.17
2017	4.43	3.36	5.20	3.44	8.71	4.70	24.52
2018	3.89	3.57	4.12	3.67	4.60	4.76	19.21
Historical Peaking Factors (Applied to ADWF)							
2012	1.15	1.00	1.25	1.01	1.72	1.36	4.84
2013	1.02	1.00	1.03	1.03	1.13	1.51	1.72
2014	1.112	1.00	1.19	1.02	1.94	1.39	6.51
2015	1.088	1.00	1.15	1.01	1.29	1.33	3.66
2016	1.183	1.00	1.31	1.02	1.69	1.25	4.29
2017	1.318	1.00	1.55	1.02	2.59	1.40	7.29
2018	1.089	1.00	1.15	1.03	1.29	1.33	5.38
Recommended Evaluation Peaking Factor							
			1.30	1.03	2.00	1.40	6.50

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Notes:

1. Historical flows extracted from WQCP data received from City staff June 19, 2019.
2. Dry weather months include months from May to September.
3. Wet weather months include months from October to April.
4. Flows for the City of San Bruno are not included in the historical flows and were estimated based on Pump Station 11 inflows and flows recorded at Flow Monitor 7. An analysis of these flows indicated approximatley 80% of the flows at Pump Station 11 are contributed by the City of San Bruno.

Table 5.3 Historical Flow Statistics (East of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Year	Average Annual (mgd)	Seasonal Average ADWF (mgd)	Seasonal Average AWWF (mgd)	Monthly Average PMDWF (mgd)	Monthly Average PMWWF (mgd)	Maximum Day MDDWF (mgd)	Maximum Day MDWWF (mgd)
Historical Flows							
2012	1.63	1.56	1.67	1.60	1.88	1.96	3.16
2013	1.61	1.62	1.61	1.67	1.66	1.96	1.97
2014	1.63	1.58	1.67	1.61	1.94	1.89	3.17
2015	1.57	1.56	1.57	1.62	1.64	1.91	2.18
2016	1.52	1.43	1.58	1.45	1.74	1.70	2.37
2017	1.55	1.50	1.59	1.54	1.86	1.82	2.99
2018	1.34	1.27	1.40	1.31	1.53	1.53	2.48
Historical Peaking Factors (Applied to ADWF)							
2012	1.04	1.00	1.07	1.02	1.20	1.25	2.02
2013	1.00	1.00	1.00	1.03	1.03	1.22	1.22
2014	1.03	1.00	1.06	1.02	1.23	1.20	2.01
2015	1.00	1.00	1.00	1.04	1.05	1.22	1.39
2016	1.06	1.00	1.10	1.02	1.22	1.19	1.66
2017	1.03	1.00	1.06	1.03	1.24	1.22	1.99
2018	1.06	1.00	1.10	1.03	1.20	1.20	1.95
Recommended Evaluation Peaking Factor							
			1.10	1.04	1.25	1.25	2.00

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Notes:

1. Historical flows extracted from WQCP data received from City staff June 19, 2019.
2. Dry weather months include months from May to September.
3. Wet weather months include months from October to April.

- **Maximum Month Wet Weather Flow (MMWWF).** This maximum month flow occurs during the wet weather season.
- **Maximum Day Dry Weather Flow (MDDWF).** This is the highest measured daily flow that occurs during a dry weather season.
- **Maximum Day Wet Weather Flow (MDWWF).** This is the highest measured daily flow that occurs during a wet weather season.

A summary of the historical flow statistics and related peaking factors are summarized below:

- **System-Wide:** As shown on **Table 5.1** the average dry weather flows experienced at the WQCP have varied between 4.84 mgd in 2018 to 5.47 mgd in 2012. The historical MDDWF peaking factors vary between 1.21 and 1.39, while the historical MDWWF peaking factors vary between 1.44 and 5.66.
- **West of Highway 101:** As shown on **Table 5.2** the average dry weather flows experienced at the WQCP have varied between 3.36 mgd in 2017 to 3.91 mgd in 2012. The historical MDDWF peaking factors vary between 1.25 and 1.51, while the historical MDWWF peaking factors vary between 1.72 and 7.29. For existing and future sewer flows estimates, the recommended MDDWF and MDWWF season peaking factors for the West of 101 system are 1.4 and 6.5 respectively.
- **East of Highway 101:** As shown on **Table 5.3** the average dry weather flows experienced at the WQCP have varied between 1.27 mgd in 2018 to 1.62 mgd in 2013. The historical MDDWF peaking factors vary between 1.19 and 1.25, while the historical MDWWF peaking factors vary between 1.22 and 2.02. For existing and future sewer flows estimates, the recommended MDDWF and MDWWF season peaking factors for the East of 101 system are 1.25 and 2.0 respectively.

5.2 FUTURE SEWER FLOWS

Future sewer flows were projected using unit factors for residential and non-residential land uses and included the developments within the Future Service Area, as identified in Chapter 2. These flows were used in sizing future infrastructure facilities, include gravity and force mains as well as pump stations. Flows were also used for allocating and reserving capacities in the existing or proposed facilities.

5.2.1 West of Highway 101

Table 5.4 documents the total acreages for the various residential and non-residential land use types west of Highway 101. The existing and future lands were multiplied by the corresponding unit flow factor to estimate the future sewer flows, which results in a future average dry weather sewer flow of approximately 4.05 mgd.

Table 5.4 Future Average Dry Weather Sewer Flows (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Land Use Type	Existing Development			Future Development within Study Area					Total Development at Buildout of Study Area	Total Average Dry Weather Flow
	Existing Lands, No Redevelopment (acre)	Sewer Unit Factor (gpd/acre)	Average Daily Flow (gpd)	Lands Planned for Redevelopment (acre)	New Development (acre)	Subtotal Future Development (acre)	Sewer Unit Factor (gpd/acre)	Average Dry Weather Flow (gpd)	(acre)	(gpd)
1	2	3	4	5	6	7	8	9	10	11
Residential										
Low Density	1,135.1	1,130	1,282,612	18.4	8.0	26.4	1,130	29,850	1,161.5	1,312,462
Medium Density	148.3	1,550	229,921	3.7	10.3	14.1	1,550	21,815	162.4	251,736
High Density	196.8	3,050	600,341	20.8	3.1	24.0	3,050	73,081	220.8	673,423
Downtown Residential Core	0.0	8,760	0	10.4	1.0	11.4	8,760	99,698	11.4	99,698
Subtotal Residential	1,480.2		2,112,874	53.3	22.5	75.8		224,444	1,556.1	2,337,319
Mixed Use										
Downtown Transit Core	0.0	13,480	0	6.1	3.1	9.2	13,480	123,539	9.2	123,539
El Camino Real Mixed Use	0.0	5,440	0	41.5	6.0	47.4	5,440	257,995	47.4	257,995
El Camino Real Mixed Use North[1]	0.0	6,125	0	4.8	0.0	4.8	6,125	29,164	4.8	29,164
Other Mixed Use[2]	0.0	7,375	0	17.5	9.3	26.8	7,375	197,801	26.8	197,801
Subtotal - Mixed Use	0.0		0	69.9	18.3	88.2		608,499	88.2	608,499
Other Non-Residential										
Commercial[3]	108.5	1,570	170,374	110.2	32.5	142.6	1,570	223,950	251.2	394,324
Office Commercial	38.6	1,080	41,698	36.8	0.0	36.8	1,080	39,710	75.4	81,408
Hotel	17.6	4,920	86,509	0.0	0.0	0.0	4,920	0	17.6	86,509
Mixed Industrial	195.9	1,600	313,413	54.1	13.0	67.2	1,600	107,471	263.1	420,884
Public Facility	216.0	420	90,715	1.6	70.6	72.2	420	30,331	288.2	121,045
Subtotal Non-Residential	576.6		702,708.8	202.6	116.1	318.8		401,461.5	895.4	1,104,170
Total[4]										
	2,056.8		2,815,583	325.8	157.0	482.8		1,234,405	**2,539.6**	**4,049,988**

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Notes:

1. Includes the following land use types: El Camino Real Mixed Use North, High Intensity and El Camino Real Mixed Use North, Medium Intensity
2. Includes the following land use types: Grand Avenue Core, Transportation Center, Downtown Commercial, Linden Neighborhood Corridor, and Linden Commercial Corridor
3. Includes the following land use types: Business Commercial, Coastal Commercial, Community Commercial
4. Existing and Future flows do not account for San Bruno, Daly City, or the Town of Colma.

5.2.1 East of Highway 101

Table 5.5 documents the total acreages for the various non-residential land use types east of Highway 101. The existing and undeveloped lands were multiplied by the corresponding unit flow factor to estimate the future sewer flows, which results in a future average dry weather sewer flow of approximately 3.08 mgd.

5.3 NON-SERVICE AREA FLOWS

The City's west of Highway 101 sewer system collects and conveys sewer flows from three neighboring service areas. These sewer flows and assumptions relevant to the hydraulic analysis are documented below:

- **Daly City:** The City serves a small portion of Daly City, generally north of Hickey Boulevard between Interstate 280 and Junipero Serra Boulevard. The average annual flows were estimated at 0.14 mgd and the average dry weather flows were estimated at 0.12 mgd, based on the 2011 Water Quality Control Plant report. These flows were validated in the model calibration process. Daly City flows discharge into the City's sewer collection system via 8-inch gravity main along Clay Avenue west of Dundee Drive

- **Town of Colma:** The City serves a portion of the Town of Colma, generally northwest of the intersection of Mission Road and Lawndale Boulevard. The existing and future average dry weather flows are based on the 2019 Town of Colma Wastewater Collection System Master Plan. The existing average dry weather flows are estimated at 0.20 mgd, and the buildout flows are estimated at 0.25 mgd. The existing peak dry and peak wet weather flows are equal to 0.31 mgd and 1.08 mgd respectively. Future peak dry and peak wet weather flows are equal to 0.40 mgd and 1.15 mgd respectively. Town of Colma flows discharge into the City's sewer collection system via 18-inch gravity main along Mission Road north west of Lawndale Boulevard.

- **City of San Bruno:** Portions of the City of San Bruno, generally west of the intersection of Tanforan Avenue and Huntington Avenue, discharge flows into Pump Station 11, where they comprise of a majority of the stations influent flows. An analysis was previously completed using flow monitoring data and available City pump station pumping records to determine the City of San Bruno's percentage of flows contributed to Pump Station 11. The results of this analysis indicated that 80 percent of the average annual flow influent to Pump Station 11 are from the City of San Bruno. This percentage may change during peak wet weather flow events.

  The existing and future average dry weather flows are based on the City of San Bruno 2014 Sewer Master Plan. The existing average dry weather flows are estimated at 2.26 mgd, and the buildout flows are estimated at 3.34 mgd. The existing peak dry and peak wet weather flows are equal to 5.29 mgd 20.50 mgd respectively. Future peak dry and peak wet weather flows are equal to 6.42 mgd and 21.41 mgd respectively.

Table 5.5 Future Average Dry Weather Sewer Flows (East of 101)
City-Wide Sewer System Master Plan
City of South San Francisco

Land Use Classification	Land Use Unit	Existing Development			Future Development			Totals at Buildout	
		Development (unit)	Sewer Unit Factor (gpd/ unit)	Existing Average Daily Flow (gpd)	Development[1] (unit)	Future Sewer Unit Factor (gpd/ unit)	Future Development Average Daily Flow (gpd)	Development (unit)	Average Daily Flow (gpd)
Flow Generating									
Hotel-Commercial	No. Hotel Room	3,299	60	197,940	926	60	55,560	4,225	253,500
Commercial	1,000 sqft	587	170	99,745	1,109	170	188,535	1,696	288,281
Industrial	1,000 sqft	7,635	30	229,051	24	30	720	7,659	229,771
Office/ Research and Development	1,000 sqft	7,293	50	364,669	12,610	50	630,505	19,903	995,174
Genentech	1,000 sqft	3,942	190	748,908	2,991	190	568,279	6,933	1,317,188
Subtotal				1,640,313			1,443,599		3,083,913
Non-Flow Generating									
Open Space	1,000 sqft	1,130	0	0	0	0	0	1,130	0
Parking	1,000 sqft	143	0	0	0	0	0	143	0
Public	1,000 sqft	157	0	0	0	0	0	157	0
Subtotal				0			0		0
Totals									
Total - Hotel Commercial	No. Hotel Room	3,299		**197,940**	926		55,560	4,225	**253,500**
Total - Other Development[2]	1,000 sqft	20,886		**1,442,373**	16,734		1,388,039	37,620	**2,830,413**
Grand Total				**1,640,313**			**1,443,599**		**3,083,913**

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Notes:
1. Future Service Area includes Oyster Point Redevelopment.
2. Includes flows for Commerical, Industrial, Office R&D, and Genentech.

5.4 SEWER DESIGN FLOWS

The future system flow analysis incorporated buildout land use and sewer flow unit factors, both of which are documented in a previous chapter. The future system flows for the west of Highway 101 and east of Highway 101 sewer systems are respectively summarized on **Table 5.6** and **Table 5.7**. It should be noted that these flows are extracted from the sewer system hydraulic model and reflect diurnal flow variation, flow attenuation, and non-service area flows from neighboring service areas.

5.4.1 West of Highway 101

The following documents flows for the areas west of Highway 101. These values include flows for San Bruno, Daly City, and the Town of Colma:

- **Average Dry Weather Flow (ADWF).** The ADWF is the baseline flowrate for the sewer collection system and represents a typical daily flow during the dry weather season. The existing ADWF for the West of 101 system is quantified at 5.8 mgd, while the buildout ADWF is quantified as 7.8 mgd.

- **Peak Dry Weather Flow (PDWF).** The PDWF is used for evaluating the capacity adequacy of the sewer collection system, and represents the highest hourly peak flow during the dry weather season. The existing PDWF is estimated at 12.5 mgd, while the buildout PDWF is estimated at 14.6 mgd.

- **Peak Wet Weather Flow (PWWF).** The PWWF is used for designing the capacity of the collection system, as well as the pump stations, and represents the highest hourly flow during the wet weather season. The existing PWWF is quantified at 64.5 mgd, while the buildout PWWF is quantified at 61.1 mgd. Future PWWF assumes a 20 percent reduction in Infiltration and Inflow, consistent with the City's planned implementation of an I&I reduction program, which was initiated in December 2020.

5.4.2 East of Highway 101

The following documents flows for the areas east of Highway 101:

- **Average Dry Weather Flow (ADWF).** The ADWF is the baseline flowrate for the sewer collection system and represents a typical daily flow during the dry weather season. The existing ADWF for the East of 101 system is quantified at 1.6 mgd, while the buildout ADWF is quantified as 3.1 mgd.

- **Peak Dry Weather Flow (PDWF).** The PDWF is used for evaluating the capacity adequacy of the sewer collection system, and represents the highest hourly peak flow during the dry weather season. The existing PDWF is estimated at 3.9 mgd, while the buildout PDWF is estimated at 8.8 mgd.

Table 5.6 Design Flows (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Description	Average Dry Weather Flow[1,2] (mgd)	Dry Weather Flow		Wet Weather Flow	
		Max Day[2] (mgd)	Peak Hour[3] (mgd)	Max Day[2] (mgd)	Peak Hour[3] (mgd)
Existing[4]	5.8	8.2	12.5	37.9	64.5
Future[4,5]	7.8	10.9	14.6	40.3	61.1

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Notes:

1. Existing and Future ADWFs extracted from "Table 3.2 Unit Factor Analysis" and "Table 5.4 Future ADWFs" respectively.
2. MDDWF and MDWWF reflect seasonal peaking factors extracted from "Table 5.2 Historical Flow Statistics (West of 101)".
3. Peak Hour Flows are extracted from the sewer system hydraulic model and reflect diurnal flow variations, flow attenuation, and a 10-year 24-hour storm event.
4. Existing and Future values include flows for San Bruno, Daly City, and Town of Colma.
5. Future Wet Weather Flow assumes a 20% reduction in Rainfall Dependent Infiltration and Inflow (RDII).

Table 5.7 Design Flows (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Description	Average Dry Weather Flow[1,2] (mgd)	Dry Weather Flow: Max Day[2] (mgd)	Dry Weather Flow: Peak Hour[3] (mgd)	Wet Weather Flow: Max Day[2] (mgd)	Wet Weather Flow: Peak Hour[3] (mgd)
Existing	1.6	2.1	3.9	3.3	5.5
Future	3.1	3.9	8.8	6.2	10.0

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Notes:

1. Existing and Future ADWFs extracted from "Table 3.5 Unit Factor Analysis" and "Table 5.5 Future ADWFs" respectively.
2. MDDWF and MDWWF reflect seasonal peaking factors extracted from "Table 5.3 Historical Flow Statistics (East of 101)".
3. Peak Hour Flows are extracted from the sewer system hydraulic model and reflect diurnal flow variations, flow attenuation, and a 10-year 24-hour storm event.

- **Peak Wet Weather Flow (PWWF).** The PWWF is used for designing the capacity of the collection system, as well as the pump stations, and represents the highest hourly flow during the wet weather season. The existing PWWF is quantified at 5.5 mgd, while the buildout PWWF is quantified at 10.0 mgd. Future PWWF for the East of Highway 101 system does not assume any percentage reduction in Infiltration and Inflow. The City's planned I&I reduction program focuses on the West of Highway 101 collection system.

CHAPTER 6 – HYDRAULIC MODEL DEVELOPMENT

This chapter describes the development and calibration of the City's sewer collection system hydraulic model. The City's hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated future growth.

6.1 OVERVIEW

Hydraulic modeling analysis has become an effectively powerful tool in many aspects of sewer collection planning, design, operation, management, emergency response planning, and system reliability analysis and evaluation. The City's hydraulic model was used to evaluate the capacity adequacy of the existing system and to plan its expansion to service anticipated growth.

6.2 HYDRAULIC MODEL SOFTWARE SELECTION

The City's hydraulic model combines information on the physical characteristics of the sewer collection system (pipelines, pump stations) and operational characteristics (how they operate). The hydraulic model then performs calculations and solves series of equations to simulate flows in pipes, including backwater calculations for surcharged conditions.

There are several network analysis software products released by different manufacturers that can equally perform the hydraulic analysis satisfactorily. The selection of a particular software depends on user preferences, the wastewater collection system's unique requirements, and the costs for purchasing and maintaining the software.

The hydraulic modeling software used for evaluating the capacity adequacy of the City sewer collection system, InfoSWMM by Innovyze Inc., utilizes the fully dynamic St. Venant's equation which has a more accurate engine for simulating backwater and surcharge conditions, in addition to having the capability for simulating manifolded force mains. The software also incorporates the use of the Manning Equation in other calculations including upstream pipe flow conditions. The St Venant's and Manning's equations are discussed in the System Performance and Design Criteria chapter.

6.3 HYDRAULIC MODEL DEVELOPMENT

Computer modeling requires the compilation of large numerical databases that enable data input into the model. Detailed physical aspects, such as pipe size, ground elevation, invert elevations, and pipe lengths contribute to the accuracy of the model.

Pipes and manholes represent the physical aspect of the system within the model. A manhole is a computer representation of a place where wastewater flows may be allocated into the hydraulic system, while a pipe represents the conveyance aspect of the wastewater flows. In addition, selected pump station capacity and design head settings were also included into the hydraulic model.

Developing the hydraulic model included surveying critical points of the existing system, updating the existing model, system skeletonization, digitizing and quality control, developing pipe and manhole databases, and wastewater loading allocation.

6.3.1 Existing System Survey

Akel Engineering Group coordinated with Towill and Associates to perform a survey of critical manholes through the City's west of 101 sewer system. 96 manholes were selected for survey based on pipeline diameters, diversion locations, missing GIS invert data, as well as other factors critical to the development of the sewer system hydraulic model. This survey included depth to pipes, diameter validation, and connectivity review. The survey was used to validate and update the hydraulic model and to provide a level of accuracy in developing the sewer flow profiles. The manhole survey locations are shown on **Figure 6.1 .**The manhole survey results are included in **Appendix B**.

6.3.2 Existing Model Update

Hydraulic models for the East of Highway 101 and West of Highway 101 sewer systems have been prepared as part of previous master plan studies. The West of Highway 101 sewer system model was prepared as part of the 1999 I&I Study. The East of Highway 101 sewer system model was most recently updated as part of the 2017 E101SSMP. The updates to these separate existing sewer system models are summarized in the following sections.

6.3.2.1 *West of Highway 101 Model*

The West of Highway 101 sewer system model prepared for the 1999 I&I Study was developed in Pizer's "Hydra6". The database files from this model were imported into the InfoSWMM software. The City's most recent sewer system GIS files were used to compare to the 1999 model and updates were made

6.3.2.2 *East of Highway 101 Model*

As part of the 2011 Sewer System Master Plan Update, a hydraulic model of the City's trunk sewer system was developed for analysis and evaluation. This hydraulic model was developed using a computer program developed by Pizer Corporation called "Hydra". For the purposes of this 2017 Sewer System Master Plan, the database from this hydraulic model was imported into InfoSWMM to develop the City's new hydraulic model. Based on information provided by City Staff, updates were made to the sewer collection system to reflect more accurately the existing sewer system and demands in the hydraulic model were updated to reflect actual conditions of the sewer system.

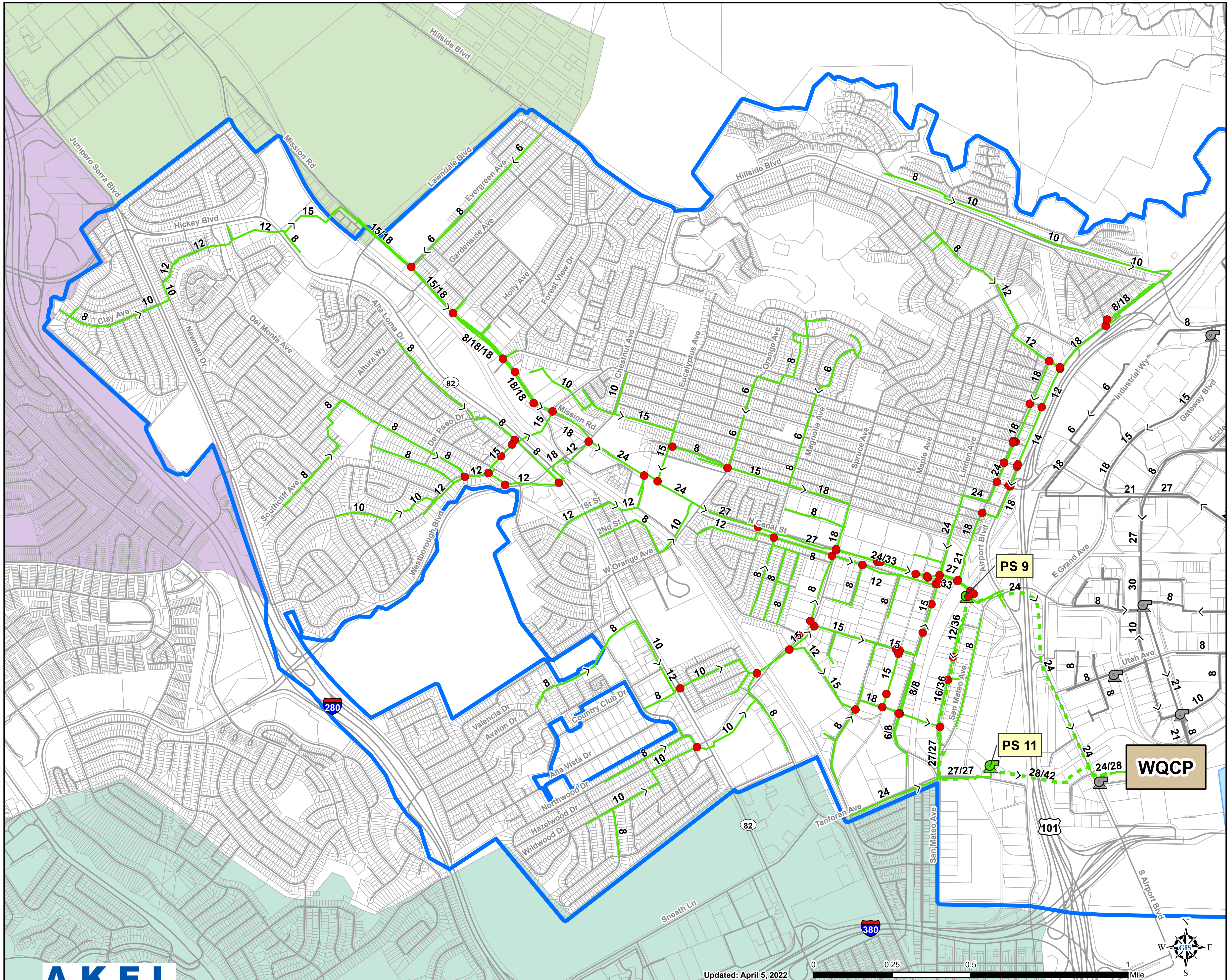

Figure 6.1
Existing West System
Manhole Survey
City-Wide Sewer System
Master Plan
City of South San Francisco

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\SSF_Fig6-1_ManholeSurvey_040522.mxd

6.3.3 Skeletonization

The City's hydraulic model is considered a skeletonized hydraulic model; a skeletonized model does not include pipes considered not essential to the hydraulic analysis of the system. A skeletonized model is useful in creating a system that accurately reflects the hydraulics of the pipes within the system. In addition, skeletonizing the model will reduce complexities of large models, which will also reduce the time of analysis while maintaining accuracy, but will also comply with limitations imposed by the computer program. The modeled pipes generally included pipes 8-inches in diameter and larger, in addition to some critical 6-inch gravity sewer pipes. **Table 6.1** and **Table 6.2** list the total length of modeled sewer system pipes, for the west of Highway 101 and east of Highway 101 sewer systems respectively. The modeled sewer collection system is shown on **Figure 4.1**.

6.3.4 Digitizing and Quality Control

During the development of the hydraulic model, coordination was conducted between City and Akel Engineering staff, implemented a thorough quality control program to resolve discrepancies. The quality control program included the following:

- Sewer System GIS data
- Supplemental field surveys
- Verification figures
- Archived System PLAT Maps

6.3.5 Load Allocation

Load allocation consist of assigning sewer flow to the appropriate manholes (nodes) in the model. The goal is to distribute the loads throughout the model to best represent actual system response.

The existing loading allocation was based off the water billing records. Using GIS, each customer account was geocoded and spatially joined within the existing sewer collection system. Sewer loads were developed by combining the flow factors developed in Chapter 3 with the water billing records for the City. The calculated loads were allocated to the nearest manhole that serves the corresponding customers.

Sewer loads from each anticipated future development, as presented in previous chapters, were also allocated to the model for the purpose of sizing the required future facilities. The loads from the buildout service area were allocated based on proposed land use and the land use acreages. As many of the areas were large in size, the loads were allocated evenly to the loading manholes within each area. Infill areas redevelopment areas, and vacant lands were also included in the future load allocation.

Table 6.1 Modeled Sewer Pipeline Inventory (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
6	9,262	1.8
8	50,012	9.5
10	15,603	3.0
12	16,300	3.1
14	1,042	0.2
15	14,926	2.8
16	1,280	0.2
18	18,680	3.5
21	383	0.1
24	8,427	1.6
27	5,090	1.0
28	0	0.0
30	97	0.0
33	2,696	0.5
36	95	0.0
48	149	0.0
Subtotal	144,041	27.3
Force Mains		
24	4,674	0.9
27	1,869	0.4
28	2,281	0.4
36	2,219	0.4
Subtotal	11,044	2.1
Total West of Highway 101 Pipe Length		
Total	**299,126**	**56.7**

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2/26/2020

Notes:

1. Length per diameter extracted from existing sewer system hydraulic model

Table 6.2 Modeled Sewer Pipeline Inventory (East of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Pipe Diameter	Total Length (ft)	Total Length (mi)
Gravity Pipes		
6	2,635	0.5
8	33,144	6.3
10	5,390	1.0
12	976	0.2
15	7,162	1.4
18	5,281	1.0
20	342	0.1
21	634	0.1
24	1,186	0.2
27	1,724	0.3
30	873	0.2
Subtotal	59,348	11.2
Force Mains		
6	595	0.1
8	2,493	0.5
10	2,000	0.4
12	2,746	0.5
21	2,813	0.5
Subtotal	10,648	2.0
Total East of Highway 101 Pipe Length		
Total	**69,996**	**13.3**

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4/4/2017

6.4 MODEL CALIBRATION

Calibration is intended to instill a level of confidence in the flows that are simulated, and it generally consisted of comparing model predictions to the influent sewer flow recorded at the WQCP, and making necessary adjustments.

6.4.1 Calibration Plan

Calibration can be performed for steady state conditions, which model the peak hour flows, or for dynamic conditions (24 hours or more). Dynamic calibration consists of comparing the model predictions to diurnal operational changes in the wastewater flows. The City's hydraulic model was calibrated for dynamic conditions.

In sewer collection systems, and when using dynamic hydraulic modeling to evaluate the impact of wet weather flows, it is common practice to calibrate the model to the following three conditions:

- Peak dry weather flows on a weekday and weekend.
- Peak wet weather flows from storm rainfall Event No. 1.
- Peak wet weather flows from storm rainfall Event No. 2.

After the model is calibrated to these conditions, it is benchmarked and used for evaluating the capacity adequacy of the sewer collection system, under dry and wet weather conditions.

6.4.2 Dynamic Model Calibration

The calibration process was iterative as it involved calibrating the model for the three calibration conditions: 1) peak dry weather flow, 2) peak wet weather flows from storm rainfall Event No. 1, and 3) peak wet weather flows from storm rainfall Event No. 2.

The model was calibrated under peak dry weather flow conditions using SCADA records made readily available by the City for this purpose. The calibration under peak dry weather flow at each of the existing pump stations yielded acceptable results and diurnal patterns were developed to characterize more accurately the sewer flow during dry weather events; these diurnal patterns are shown in Chapter 3.

The rain events of April 6, 2018 (Event No. 1) and March 1, 2018 (Event No. 2), as listed on **Table 3.9**, were used to calibrate the hydraulic model to the wet weather conditions. The calibration effort continued and the model was calibrated to match the recorded flows at the flow monitoring locations.

The flow monitoring locations and basins are shown on **Figure 6.2**, while the full calibration results are shown in **Appendix C.** Following the completion of the calibration process the hydraulic model was benchmarked and used for further analysis and evaluation.

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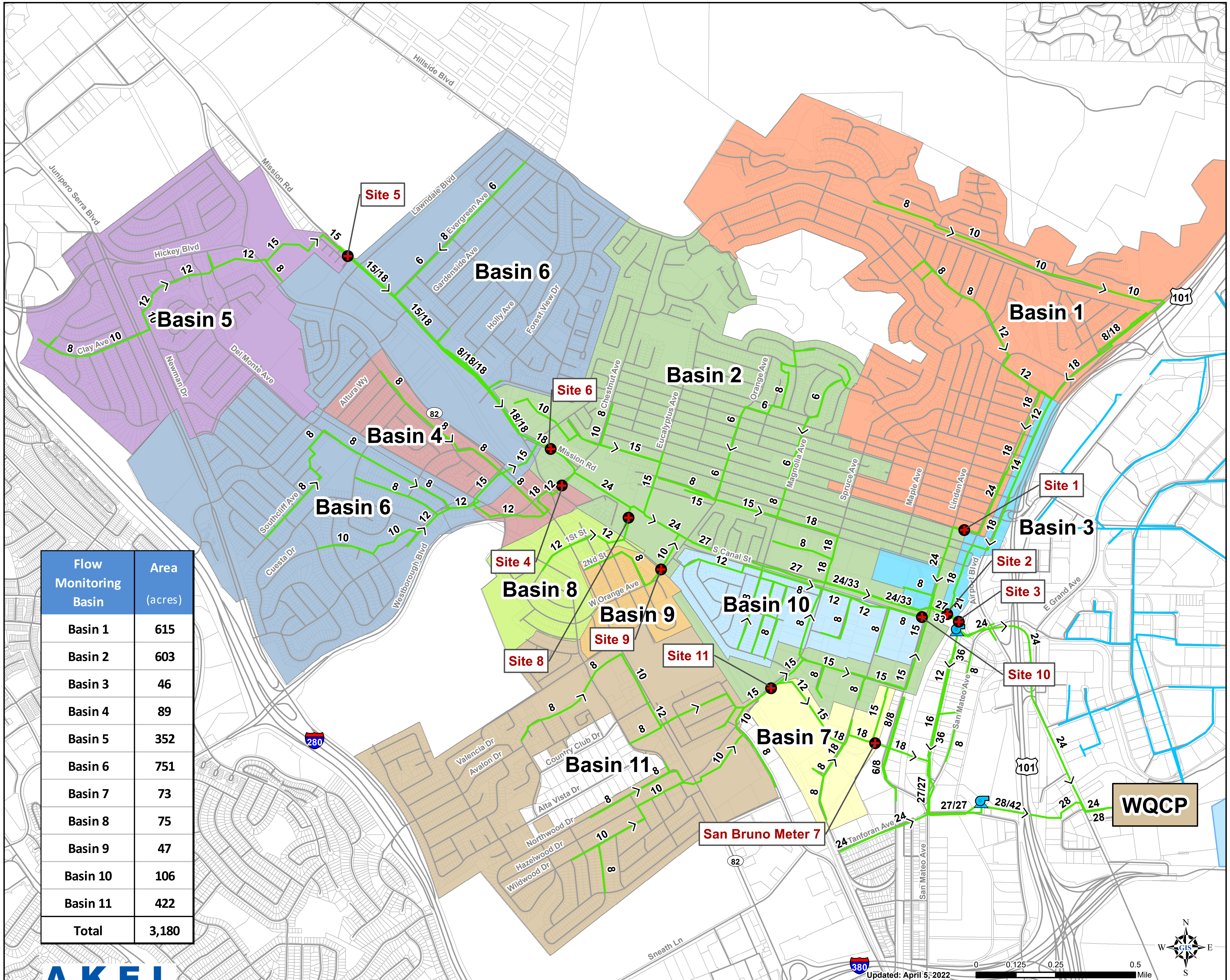


Flow Monitoring Basin	Area (acres)
Basin 1	615
Basin 2	603
Basin 3	46
Basin 4	89
Basin 5	352
Basin 6	751
Basin 7	73
Basin 8	75
Basin 9	47
Basin 10	106
Basin 11	422
Total	3,180

Legend

- Pump Stations
- Flow Monitor Locations
- SSF West Pipes
- SSF East Pipes

Flow Monitoring Basins

- Basin 1
- Basin 2
- Basin 3
- Basin 4
- Basin 5
- Basin 6
- Basin 7
- Basin 8
- Basin 9
- Basin 10
- Basin 11
- Parcels
- Street Centerlines

Figure 6.2
Flow Monitoring Basins
City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

6.4.1 Use of the Calibrated Model

The calibrated hydraulic model was used as an established benchmark in the capacity evaluation of the existing sewer collection system. The model was also used to identify improvements necessary for mitigating existing system deficiencies and for accommodating future growth. The hydraulic model is a valuable investment that will continue to prove its worth to the City as future planning issues or other operational conditions surface. It is recommended that the model be maintained and updated with new construction projects to preserve its integrity

CHAPTER 7 - EVALUATION AND PROPOSED IMPROVEMENTS

This section presents a summary of the sewer collection system capacity evaluation during peak dry weather flows and peak wet weather flows for the existing and buildout flows. The recommended sewer collection system improvements needed to mitigate capacity deficiencies are also discussed in this chapter.

7.1 OVERVIEW

The calibrated hydraulic model was used for evaluating the sewer collection system for capacity deficiencies during peak dry weather flows (PDWF) and peak wet weather flows (PWWF). The criteria used for evaluating the capacity adequacy of the sewer collection system facilities (gravity mains, force mains, and pump stations) were discussed and summarized Chapter 3.

7.2 WEST OF 101 – EXISTING SEWER COLLECTION SYSTEM CAPACITY EVALUATION

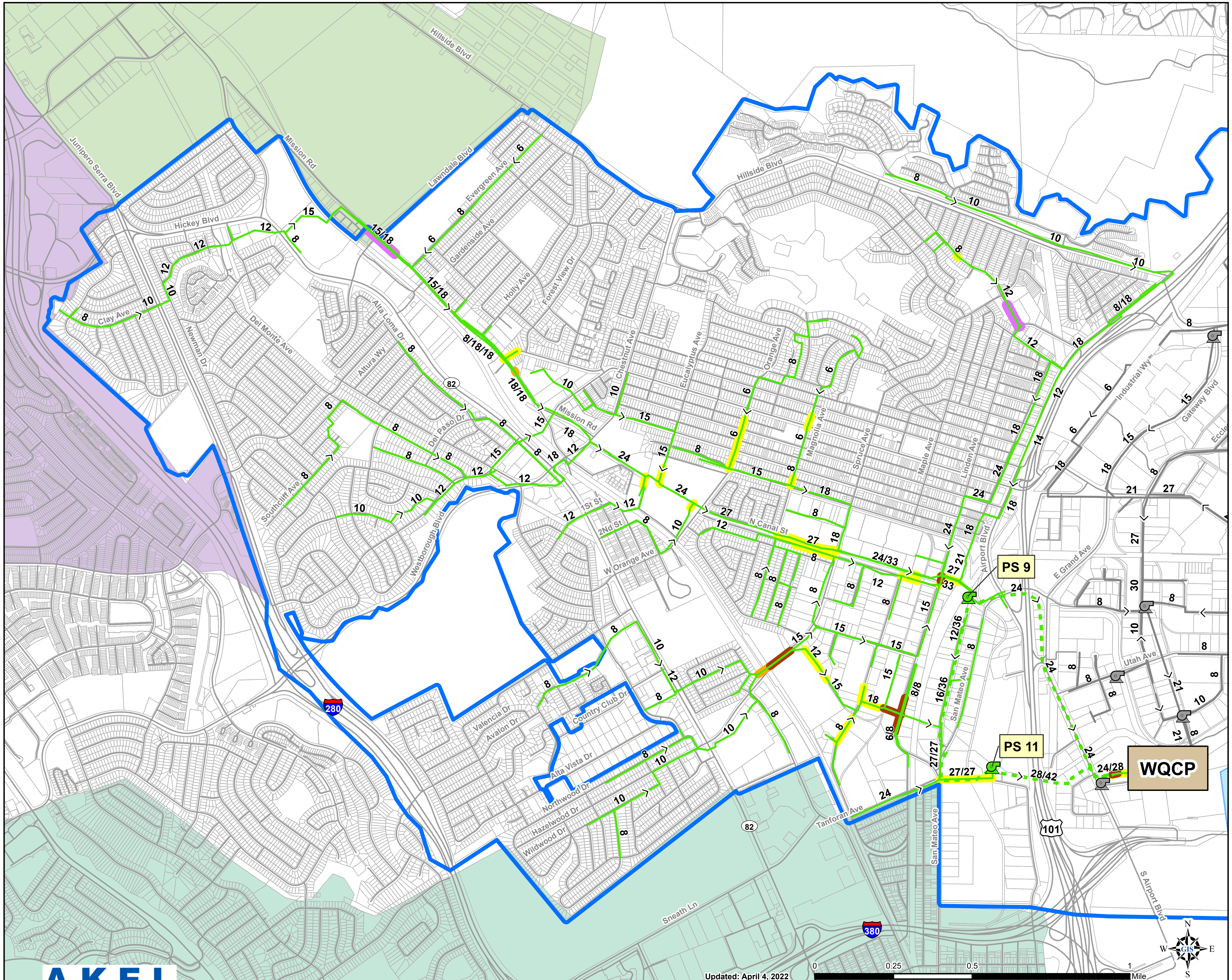
The system performance and design criteria, summarized on **Table 3.1**, were thus used as a basis to judge the capacity adequacy for the existing sewer collection system. The design flows simulated in the hydraulic model for existing conditions were summarized on **Table 5.6** and are documented as follows:

- Existing PDWF = 12.5 mgd
- Existing PWWF = 64.5 mgd
- Future PDWF = 14.6 mgd
- Future PWWF = 61.1 mgd

During the peak dry weather simulation, the maximum allowable pipe d/D criteria of 0.75 was used for new pipes. These pipes include proposed replacement, rehabilitation, and relocation pipelines as well as new service connections. For existing pipes, the criteria was relaxed to allow a maximum d/D ratio of 0.90 (full pipe capacity) to prevent unnecessary pipe replacements. During the peak wet weather simulations, capacity deficiencies included pipe segments with a hydraulic grade line (HGL) that rises within one foot of the manhole rim elevation.

The hydraulic model indicated that the sewer collection system exhibited generally acceptable performance to service the existing customers during peak dry weather flows (**Figure 7.1**), with some areas of noted deficiency.

The system has historically been designed to accommodate a 5-year return frequency event, with



Legend

Pipe d/D

- d/D > 0.90
- d/D 0.75 - 0.90
- d/D 0.50 - 0.75
- Slope Deficiencies

SSF West System

- Pump Stations
- Gravity Mains
- Force Mains

SSF East System

- Pump Stations
- Pipes
- Street Centerlines
- Sewer Service Area

Municipality

- Colma
- Daly City
- San Bruno
- Parcels

Figure 7.1
Existing West System Analysis for PDWF
City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

a 6 hour duration. However, based on current industry trends, and comparing against other local agencies (San Bruno, Daly City, and Pacifica) the City has elected to evaluate their system in accordance with a more stringent 10-year 24-hour design storm, increasing in both intensity and duration. Accordingly, the system exhibits more deficiencies than historically noted (**Figure 7.2**). However, City staff are proactively addressing issues related to I&I to mitigate the impacts of the larger design storm, and in an effort to reduce impacts of storms on the Water Quality Control Plant. These measures are discussed in more detail in Section 7.4.

7.2.1 West of 101 - Existing Peak Dry Weather Flows Capacity Evaluation

The existing dry weather flow analysis indicated several areas where pipelines experienced depth to diameter ratios exceeding the criteria, and which are documented on **Figure 7.1** Additionally, this figure documents pipelines that, while not deficient, may be approaching design capacity. Deficient pipelines are highlighted in red on the figure and discussed as follows:

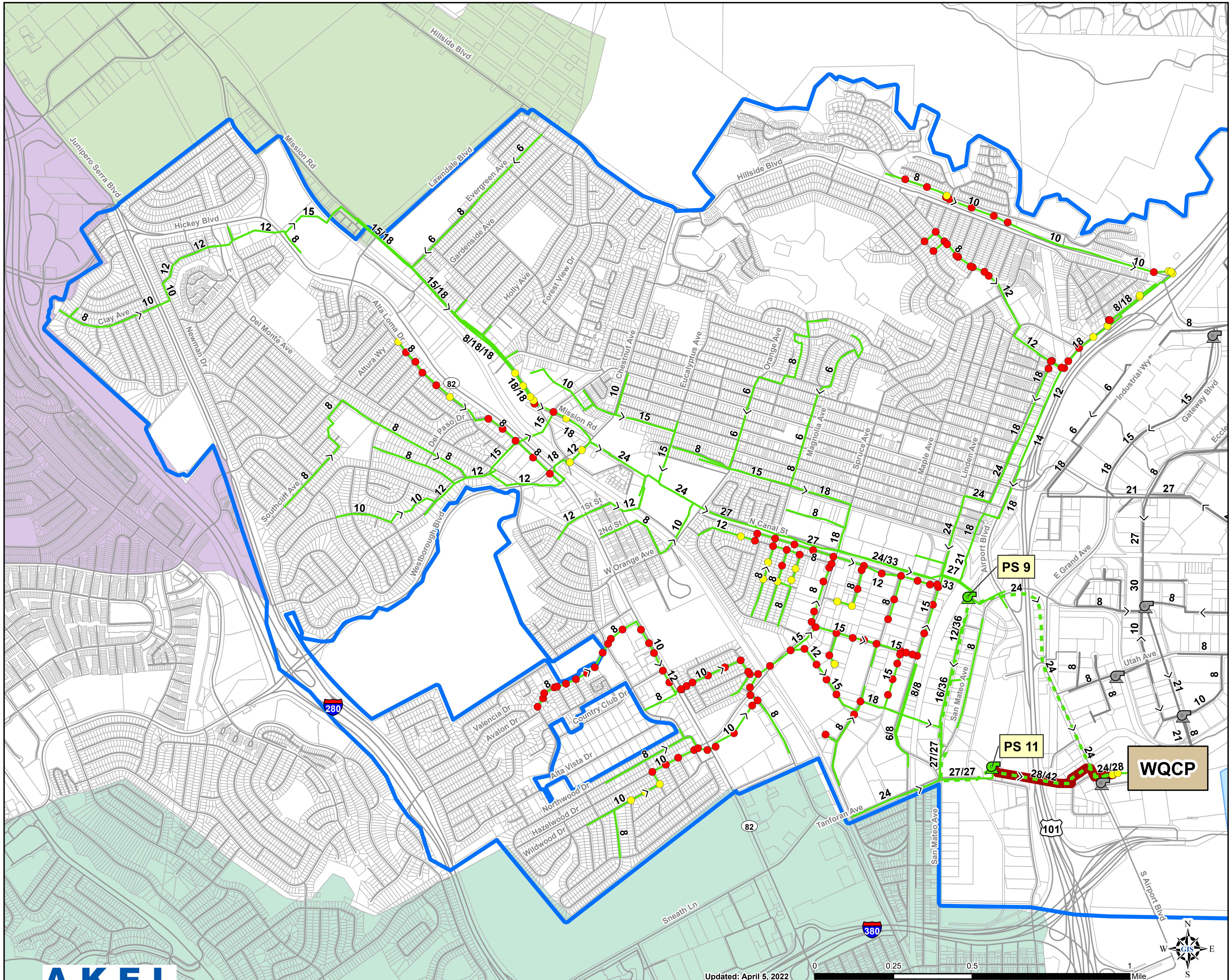
- Mission Road, from Lawndale Boulevard to Evergreen Drive. This segment experiences d/D ratios above 0.9. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- Hillside Boulevard from approximately 185 feet south of Spruce Avenue to Spruce Avenue. This segment experiences d/D ratios above 0.9. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- South Spruce Avenue, from approximately 270 feet south of Myrtle Avenue to Centennial Way Trial. This segment experiences d/D ratios above 0.9. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- Right-of-way, from approximately 315 feet west of Linden Avenue to Linden Avenue. This segment experiences d/D ratios above 0.9. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- Linden Avenue, from approximately 725 feet south of Victory Avenue to approximately 725 feet north of Shaw Road. This segment experiences d/D ratios above 0.9 and requires improvement.



Legend

Surcharging Manholes

- Flooding
- Manhole HGL Within 1 ft of Ground Elevation
- Velocity Greater than 10 ft/s

SSF West System

- Pump Stations
- Gravity Mains
- Force Mains

SSF East System

- Pump Stations
- Pipes
- Street Centerlines
- Sewer Service Area

Municipality

- Colma
- Daly City
- San Bruno
- Parcels

10-Year 24-Hour Storm

Figure 7.2
Existing West System Analysis for PWWF

City-Wide Sewer System Master Plan
City of South San Francisco

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7.2.1 West of 101 - Existing Peak Wet Weather Flows Capacity Evaluation

The wet weather flow analysis is intended to document the impact of significant rainfall events on the existing system, and to identify the improvements necessary to limit sewer overflows. The design criteria for wet weather events allows pipeline surcharging into the manhole to within one foot of the rim elevation. The hydraulic analysis predicted areas of surcharging and flooding throughout the system, and due to the more intense storm used as part of the study. The analysis results are shown on **Figure 7.2**, and documented in the following:

- Alta Loma Drive between Altura way and Westborough Boulevard
- Mission Road between Forest View drive and Chestnut Ave
- West of Highway 82 between Valencia Drive and Wildwood Drive
- South of Canal Street between Orange Avenue and Linden Avenue
- San Mateo Avenue between Canal Street and Tanforan Avenue
- Hillside Boulevard west of Airport Boulevard
- Sister Cities Boulevard west of Airport Boulevard
- Airport Boulevard between Sister Cities Boulevard and Hillside Boulevard

7.3 EAST OF 101 - EXISTING SEWER COLLECTION SYSTEM CAPACITY EVALUATION

The system performance and design criteria, summarized on **Table 3.1**, were thus used as a basis to judge the capacity adequacy for the existing sewer collection system. The design flows simulated in the hydraulic model for existing conditions were summarized on **Table 5.7.** and are documented as follows:

- Existing PDWF = 3.9 mgd
- Existing PWWF = 5.5 mgd
- Future PDWF = 8.8 mgd
- Future PWWF = 10.0 mgd

During the peak dry weather simulations, the maximum allowable pipe d/D criteria of 0.75 was used for new pipes. For existing pipes, the criteria was relaxed to allow a maximum d/D ratio of 0.90 (full pipe capacity) to prevent unnecessary pipe replacements. During the peak wet weather simulations, capacity deficiencies included pipe segments with a hydraulic grade line (HGL) that rises within one foot of the manhole rim elevation.

In general, the hydraulic model indicated that the sewer collection system exhibited acceptable performance to service the existing customers during both peak dry weather flows (**Figure 7.3**) and peak wet weather flows (**Figure 7.4**), with some exceptions throughout the study area.

7.3.1 East of 101 - Existing Peak Dry Weather Flows Capacity Evaluation

The hydraulic model indicated that the existing system is capable of routing existing peak dry weather flows within the design capacity of the system, as shown on **Figure 7.3** However, the evaluation did reveal pipes that, while not deficient, may be approaching maximum capacity; these pipelines are shown graphically on **Figure 7.3** and summarized as follows:

- Oyster Point Boulevard, from Eccles Avenue to Gull Drive. This segment experiences d/D ratios above 0.9 and requires improvement.

- Gateway Boulevard, from approximately 1,150 feet north of Corporate Drive to approximately 500 feet north of Corporate Drive. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase.

- Gateway Boulevard, from Corporate Drive to approximately 300 feet south of Corporate Drive. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Grand Avenue, from Gateway Boulevard to Harbor Way. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Harbor Way, from approximately 250 feet south of Grand Avenue to Railroad. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Forbes Boulevard, from approximately 300 feet northwest of DNA Way to the pump Station 8, located at 701 Forbes Boulevard. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Allerton Avenue, from Forbes Boulevard to approximately 625 feet south of Forbes Boulevard. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Allerton Avenue, from approximately 280 feet south of Cabot Road to approximately 420 feet north of Grand Avenue. This segment experiences d/D ratios between 0.5 and 0.75.

Legend

Pipe d/D
- d/D > 0.90
- d/D 0.75 - 0.90
- d/D 0.50 - 0.75
- Slope Deficiencies

To be Abandoned
- Pump Station
- Force Mains

Existing System
- Pump Stations
- Manholes

Gravity Pipes
- 8" and Smaller
- 10" and Larger

Force Mains
- 8" and Smaller
- 10" and Larger
- Street Centerlines
- Parcels

Figure 7.3
Existing East System Analysis for PDWF
City-Wide Sewer System Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\SSF_Fig7-3_East-PDWF_040422.mxd

Legend

HGL < 3 ft of Manhole Rim

Pipe d/D

d/D > 0.90

d/D 0.75 - 0.90

d/D 0.50 - 0.75

Slope Deficiencies

To be Abandoned

Pump Station

Force Mains

Existing System

Pump Stations

Manholes

Gravity Pipes

8" and Smaller

10" and Larger

Force Mains

8" and Smaller

10" and Larger

Street Centerlines

Parcels

Figure 7.4
Existing East System
Analysis for PWWF

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL
ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\SSF_Fig7-4_East-PWWF_040522.mxd

While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase

- Grand Avenue, from Allerton Avenue to Kimball Way. This segment experiences d/D ratios between 0.5 and 0.75. While not deficient, this pipeline may be approaching design capacity, and should be observed as buildout flows increase
- Mitchell Avenue, from Harrison Avenue to approximately 450 feet east of Harrison Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- Littlefield Avenue, from approximately 100 feet south of East Grand Avenue to East Grand Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- Littlefield Avenue, from approximately 50 feet north of East Grand Avenue to East Grand Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- East Grand Avenue, from Littlefield Avenue to approximately 310 feet southeast of Littlefield Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- Right-of-way, from Harbor Way to Pump Station 4. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- Harbor Way, from Utah Avenue to approximately 300 feet north of Utah Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

7.3.2 East of 101 - Existing Peak Wet Weather Flows Capacity Evaluation

The design existing PWWF was estimated at 5.5 mgd, as documented on **Table 5.7**. In general, the hydraulic model indicated that the sewer collection system had some surcharging, but did not exceed the allowable criteria discussed in a previous chapter. **Figure 7.4** documents the hydraulic analysis results, with areas impacted by the wet weather flows listed below:

- Oyster Point Boulevard, from approximately 500 feet west of Gull Drive to Gull Drive. This segment experiences d/D ratios between 0.5 and 0.9.
- Oyster Point Boulevard, from Eccles Avenue to approximately 500 feet west of Gull Drive. This segment experiences d/D ratios over 0.9.
- Industrial Way, from Corporate Drive to approximately 500 feet southwest of Corporate Drive
- Gateway Boulevard, from approximately 1,000 feet south of Oyster Point Boulevard to approximately 300 feet south of Corporate Drive. This segment experiences d/D ratios between 0.5 and 0.75.
- Gateway Boulevard, from approximately 350 feet north of Grand Avenue to Grand Avenue. This segment experiences d/D ratios between 0.5 and 0.75.
- Grand Avenue, from Gateway Boulevard to Harbor Way. This segment experiences d/D ratios between 0.5 and 0.75.
- Harbor Way, from approximately 250 feet south of Grand Avenue to Railroad. This segment experiences d/D ratios between 0.5 and 0.75.
- Forbes Boulevard, from approximately 300 feet northwest of DNA Way to the Pump Station 8, located at 701 Forbes Boulevard. This segment experiences d/D ratios between 0.5 and 0.75.
- Forbes Boulevard, from approximately 400 feet west of Allerton Avenue to Allerton Avenue. This segment experiences d/D ratios between 0.5 and 0.75.
- Allerton Avenue, from Forbes Boulevard to approximately 625 feet south of Forbes Boulevard. This segment experiences d/D ratios between 0.5 and 0.75.
- Allerton Avenue, from approximately 280 feet south of Cabot Road to approximately 115 feet north of Grand Avenue. This segment experiences d/D ratios between 0.5 and 0.75.
- Grand Avenue, from Allerton Avenue to Kimball Way. This segment experiences d/D ratios between 0.5 and 0.75.
- Mitchell Avenue, from Harrison Avenue to approximately 450 feet east of Harrison Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.
- Littlefield Avenue, from approximately 100 feet south of East Grand Avenue to East Grand Avenue. This hydraulic model indicated that this segment has a slope below the design

criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- Littlefield Avenue, from approximately 50 feet north of East Grand Avenue to East Grand Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- East Grand Avenue, from Littlefield Avenue to approximately 310 feet southeast of Littlefield Avenue. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

- Right-of-way, from Harbor Way to Pump Station 4. This hydraulic model indicated that this segment has a slope below the design criteria. As such, it is recommended that City staff field verify the slope condition, and should design conditions allow, replace the segment within the slope design criteria.

7.4 WEST OF 101 – FUTURE SYSTEM EVALUATION

The future pipeline analysis included the buildout flows identified in a previous chapter, and evaluated those pipelines against the City's planning and design criteria. During the peak dry weather simulations, the maximum allowable pipe d/D criterion of 0.75 was used for new pipes. For existing pipes, the criterion was relaxed to allow a maximum d/D ratio of 0.90 (full pipe capacity) to prevent unnecessary pipe replacements. During the peak wet weather simulations, capacity deficiencies included pipe segments with a hydraulic grade line (HGL) that rises within one foot of the manhole rim elevation.

The design flows simulated in the hydraulic model for the buildout of the study area were summarized on **Table 5.6** and they include:

- Future PDWF = 14.6 mgd

- Future PWWF = 61.1 mgd

7.4.1 Recommended Improvements

The proposed capacity improvements for the sewer collection system are listed on **Table 7.1**. Each improvement is assigned a uniquely coded identifier that is intended to aid in defining the location of the improvement for mapping purposes. These identifiers reflect the tributary basin, improvement type, and sequence in the improvement schedule.

The proposed improvements are shown with pipe sizes on **Figure 7.5** and are briefly described by sewer collection trunk as follows:

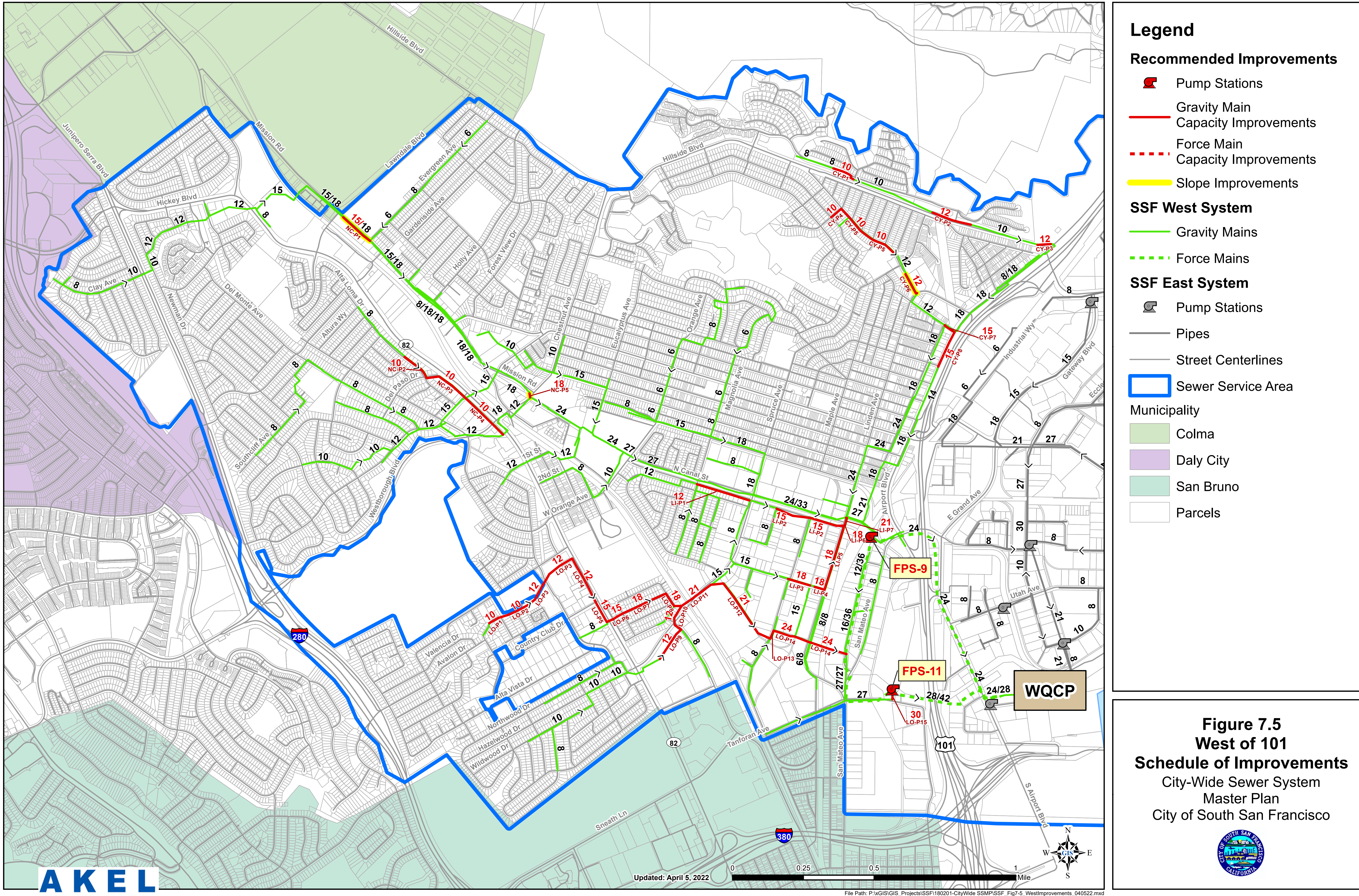

Figure 7.5
West of 101
Schedule of Improvements
City-Wide Sewer System
Master Plan
City of South San Francisco

Table 7.1 Schedule of Improvements (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Improvement No.	Improv. Type	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel/ Replace	Pipeline Improvements Diameter (in)	Pipeline Improvements Length (ft)
Gravity Main Improvements							
North Canal Trunk							
NC-P1	Existing-Slope	Mission Rd	From Lawndale Blvd to Evergreen Dr	15	Replace	15	675
NC-P2	Existing-Capacity	Alta Loma Dr	From 550' nw/o Del Paso Dr to Del Paso Dr	8	Replace	10	600
NC-P3	Existing-Capacity	Del Paso Dr	From Alta Loma Dr to Arroyo Dr	8	Replace	10	825
NC-P4	Existing-Capacity	El Camino Real	From Arroyo Dr to 270' s/o Westborough Blvd	8	Replace	10	1,050
NC-P5	Existing-Slope	Mission Rd	From 75' w/o Chestnut Ave to Chestnut Ave	18	Replace	18	100
Lowrie Trunk							
LO-P1	Existing-Capacity	Avalon Dr	From 65' e/o Dana Ct to Constitution Wy	8	Replace	10	250
LO-P2	Existing-Capacity	ROW	From Constitution Wy to Pisa Ct	8	Replace	10	350
LO-P3	Existing-Capacity	ROW	From Pisa Ct to El Camino Real	8	Replace	12	1,450
LO-P4	Existing-Capacity	El Camino Real	From 230' s/o Ponderosa Rd to 325' n/o Country Club Dr	10	Replace	12	625
LO-P5	Existing-Capacity	El Camino Real	From 325' n/o Country Club Dr to Portola Ave	10 / 12	Replace	15	750
LO-P6	Existing-Capacity	Portola Ave	From El Camino Real to Ramona Ave	12	Replace	15	350
LO-P7	Existing-Capacity	Portola Ave	From Ramona Drive to Francisco Dr	12	Replace	18	900
LO-P8	Existing-Capacity	Francisco Dr	From 160' w/o Centennial Way Tr to Portola Ave	10 / 12	Replace	18	425
LO-P9	Existing-Capacity	Spruce Ave	From 490' e/o El Camino Real to Huntington Ave	10	Replace	12	700
LO-P10	Existing-Capacity	Spruce Ave	From Huntington Ave to 160' w/o Centennial Way Tr	10	Replace	12	550
LO-P11	Existing-Capacity	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	15	Replace	21	675

Table 7.1 Schedule of Improvements (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Improvement No.	Improv. Type	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel/ Replace	Diameter (in)	Length (ft)
LO-P12	Existing-Capacity	ROW	From Spruce Ave to Maple Ave	12 / 15 / 18	Replace	21	1,625
LO-P13	Existing-Capacity	Maple Ave	From 605' n/o Browning Wy to 765' n/o Browning Wy	18	Replace	21	175
LO-P14	Existing-Capacity	ROW	From Maple Ave to Lowrie Ave	18	Replace	24	1,450
LO-P15	Existing-Capacity	ROW	From Shaw Road to Shaw Road LS-11	27	Replace	30	200
LO-P16	Casing	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	-	New	41	200
Linden Trunk							
LI-P1	Existing-Capacity	S Canal St	From Magnolia Ave to Spruce Ave	8	Replace	12	1,025
LI-P2	Existing-Capacity	S Canal St	From Starlite St to Linden Ave	8 / 12	Replace	15	1,300
LI-P3	Existing-Capacity	Victory Ave	From S Maple Ave to 280' w/o Linden Ave	15	Replace	18	450
LI-P4	Existing-Capacity	Victory Ave	From 190' w/o Linden Ave to Linden Ave	15	Replace	18	200
LI-P5	Existing-Capacity	Linden Ave	From Victory Ave to S Canal St	8 / 12 / 15	Replace	18	1,250
LI-P6	Existing-Capacity	Linden Ave	From S Canal St to N Canal St	15	Replace	18	125
LI-P7	Existing-Capacity	Linden Ave	From N Canal St to 100 ft n/o N Canal St	15	Replace	21	100
LI-P8	Casing	Linden Ave	From S Canal St to N Canal St	-	New	38	100
Cypress Trunk							
CY-P1	Existing-Capacity	San Francisco Dr	From 430' w/o Woods Cir to Woods Cir	8	Replace	10	475
CY-P2	Existing-Capacity	Sister Cities Blvd	From 115' e/o Spruce Ave to 80' e/o Pecks Ln	10	Replace	12	775
CY-P3	Existing-Capacity	Sister Cities Blvd	From 230' w/o Airport Blvd to Airport Blvd	10	Replace	12	250

Table 7.1 Schedule of Improvements (West of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Improvement No.	Improv. Type	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel/ Replace	Pipeline Improvements Diameter (in)	Pipeline Improvements Length (ft)
CY-P4	Existing-Capacity	Franklin Ave	From Hemlock Ave to Hillside Blvd	8	Replace	10	250
CY-P5	Existing-Capacity	Hillside Blvd	From Franklin Ave to Arden Ave	8	Replace	10	1,350
CY-P6	Existing-Slope	Hillside Blvd	From 185' s/o Spruce Ave	12	Replace	12	450
CY-P7	Existing-Capacity	Armour Ave	From Cypress Ave to Airport Blvd	-	New	15	250
CY-P8	Existing-Capacity	Airport Blvd	From Armour Ave to Pine Ave	12	Replace	15	725
Pump Station Improvements							
PS-9	Existing-Capacity				Capacity Upgrade	Replace Dry Weather Pumps 2 @ 5,600 gpm	
PS-11	Existing-Capacity				Capacity Upgrade	6 @ 8,300 gpm	

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7.4.1.1 *North Canal Trunk*

This section documents improvements within the North Canal Avenue Trunk sewer service area

- **Improvement NC-P1:** Replace the existing 15-inch gravity sewer in Mission Road from Lawndale Boulevard to Evergreen Drive with a new 15-inch pipe. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.

- **Improvement NC-P2:** Replace the existing 8-inch gravity sewer in Alta Loma Drive from 550 feet north-west of Del Paso Drive to Del Paso Drive with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement NC-P3:** Replace the existing 8-inch gravity sewer in Del Paso Drive from Alta Loma Drive to Arroyo Drive with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement NC-P4:** Replace the existing 8-inch gravity sewer in El Camino Real from Arroyo Drive to 270 feet south of Westborough Boulevard with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement NC-P5:** Replace the existing 18-inch gravity sewer in Mission Road from 75 feet west of Chestnut Avenue to Chestnut Avenue with a new 18-inch pipe. This improvement is intended to mitigate a future capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.

7.4.1.2 *Lowrie Trunk*

This section documents improvements within the Lowrie Avenue Trunk sewer service area.

- **Improvement LO-P1:** Replace the existing 8-inch gravity sewer in Avalon Drive from Dana Court to Constitution Way with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LO-P2:** Replace the existing 8-inch gravity sewer in right-of-way from Constitution Way to 260 feet east of Pisa Court with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LO-P3:** Replace the existing 8-inch gravity sewer in right-of-way from 260 feet east of Pisa Court to El Camino Real with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LO-P4:** Replace the existing 10-inch gravity sewer in El Camino Real from 230 feet south of Ponderosa Road to Country Club Drive with a new 15-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P5:** Replace the existing 12-inch gravity sewer in El Camino Real from Country Club Drive to Portola Avenue with a new 15-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P6:** Replace the existing 12-inch gravity sewer in Portola Avenue from Ramona Avenue to El Camino Real with a new 15-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P7:** Replace the existing 12-inch gravity sewer in Portola Avenue from Francisco Drive to Ramona with a new 18-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P8:** Replace the existing 10-inch and 12-inch gravity sewer in Francisco Drive from 160 feet west of Centennial Way Tr to Portola Avenue with a new 18-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P9:** Replace the existing 10-inch gravity sewer in Spruce Avenue from 490 feet east of El Camino Real to Huntington Avenue with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P10:** Replace the existing 10-inch gravity sewer in Spruce Avenue from Huntington Avenue to 160 feet west of Centennial Way Trail with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P11:** Replace the existing 15-inch gravity sewer in Spruce Avenue from 160 feet west of Centennial Way Tr to 265 feet southwest of Myrtle Avenue with a new 21-inch pipe. This improvement is intended to mitigate an existing capacity deficiency. This improvement also requires a casing for the segment across the canal.
- **Improvement LO-P12:** Replace the existing 15-inch gravity sewer in right-of-way from Spruce Avenue to Maple Avenue with a new 21-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P13:** Replace the existing 18-inch gravity sewer in Maple Avenue from 605 feet north of Browning Way to 765 feet north of Browning Way with a new 24-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement LO-P14:** Replace the existing 18-inch gravity sewer in right-of-way from Maple Avenue to Lowrie Avenue with a new 24-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LO-P15:** Replace the existing 24-inch gravity sewer in right-of-way from Victory Avenue to 935 feet south of Victory Avenue with a new 27-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LO-P16:** Replace the existing 27-inch gravity sewer in right-of-way from Shaw Road to Shaw Road LS-11 with a new 30-inch pipe. This improvement is intended to mitigate a future capacity deficiency.

7.4.1.3 *Linden Trunk*

This section documents improvements within the Linden Avenue Trunk sewer service area.

- **Improvement LI-P1:** Replace the existing 8-inch gravity sewer in South Canal Street from Magnolia Avenue to Spruce Avenue with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI-P2:** Replace the existing 8-inch and 12-inch gravity sewer in South Canal Street from Linden Avenue to Spruce Avenue with a new 15-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI-P3:** Replace the existing 15-inch gravity sewer in Victory Avenue from Spruce Avenue to Ryan Way with a new 18-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI-P4:** Replace the existing 15-inch gravity sewer in Victory Avenue from South Maple Avenue to 280 feet west of Linden Avenue with a new 21-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI-P5:** Replace the existing 15-inch gravity sewer in Victory avenue from 190 feet west of Linden Avenue to Linden Avenue with a new 18-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI-P6:** Replace the existing 8-inch, 12-inch, and 15-inch gravity sewer in Linden Avenue from Victory Avenue to South Canal Street with a new 18-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.

- **Improvement LI P7:** Replace the existing 15-inch gravity sewer in Linden Avenue from South Canal Street to North Canal Street. This improvement is intended to mitigate an existing capacity deficiency. This improvement will also require a casing for the segment across the canal.

- **Improvement LI P8:** Replace the existing 15-inch gravity sewer in Linden Avenue from North Canal Street to 100 feet north of North Canal Street. This improvement is intended to mitigate an existing capacity deficiency.

7.4.1.4 *Cypress Trunk*

This section documents improvements within the Cypress Avenue Trunk sewer service area.

- **Improvement CY-P1:** Replace the existing 8-inch gravity sewer in San Francisco Drive from 430 feet west of Woods Circle to Woods Circle with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement CY-P2:** Replace the existing 10-inch gravity sewer in Sister Cities Boulevard from 115 feet east of Spruce Avenue to 80 feet east of Pecks Lane with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement CY-P3:** Replace the existing 10-inch gravity sewer in Sister Cities Boulevard from 230 feet west of Airport Boulevard to Airport Boulevard with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement CY-P4:** Replace the existing 8-inch gravity sewer in Franklin Avenue from Hemlock Avenue to Hillside Boulevard with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement CY-P5:** Replace the existing 8-inch gravity sewer in Hillside Boulevard from Franklin Avenue to Arden Avenue with a new 10-inch pipe. This improvement is intended to mitigate an existing capacity deficiency.
- **Improvement CY-P6:** Replace the existing 12-inch gravity sewer in Hillside Boulevard from 185 feet south of Spruce Avenue with a new 12-inch pipe. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement CY-P7:** Install a new 15-inch gravity sewer in Armour Avenue from Airport Boulevard to Cypress Avenue. This improvement is intended to mitigate a future capacity deficiency in the Cypress Trunk.
- **Improvement CY-P9:** Replace the existing 12-inch gravity sewer in Airport Boulevard from Armour Avenue to Pine Avenue with a new 15-inch pipe. This improvement is intended to mitigate a future capacity deficiency.

7.4.2 Infiltration and Inflow Reduction Program

This master plan’s selected 10-year 24-hour design storm, which has become a more common choice for sewer systems capacity evaluations, exceeds the previous master plan’s design storm in both intensity and duration, and results with higher system infiltrations and inflows. This becomes evident when reviewing the identified capacity deficiencies and corresponding improvements, especially as it relates to the west of Highway 101 portion of the City.

The initial alternative consisted of developing a capital improvement program (CIP) for upgrading the capacities of the existing collection system facilities to accommodate the selected design storm. This project team also reviewed the consequences of the additional design flows on the Water Quality Control Plant (WQCP), and scheduled meeting with Carollo Engineers, the design engineers most familiar with the WQCP, to confirm the existing capacities and constraints of the WQCP components.

WQCP Storage Needs Analysis. The project team completed a storage analysis for the critical components at the WQCP, mapped the WQCP capacity constraints as shown on **Figure 7.6**, and reviewed these deficiencies with Carollo Engineers.

- **WQCP Influent Pump Station**. The existing 62 MGD influent pump station is exceeded by approximately 1.93 MG (deficiency) total during the design storm event. This deficiency can be mitigated by constructing additional storage at the headworks, in excess of the existing aeration basin overflow capacity.

- **WQCP Effluent Pump Station.** The existing 35 MGD effluent pump station is exceed by approximately 12.40 MG (deficiency) total during the design storm event. This deficiency can be mitigated with additional storage.

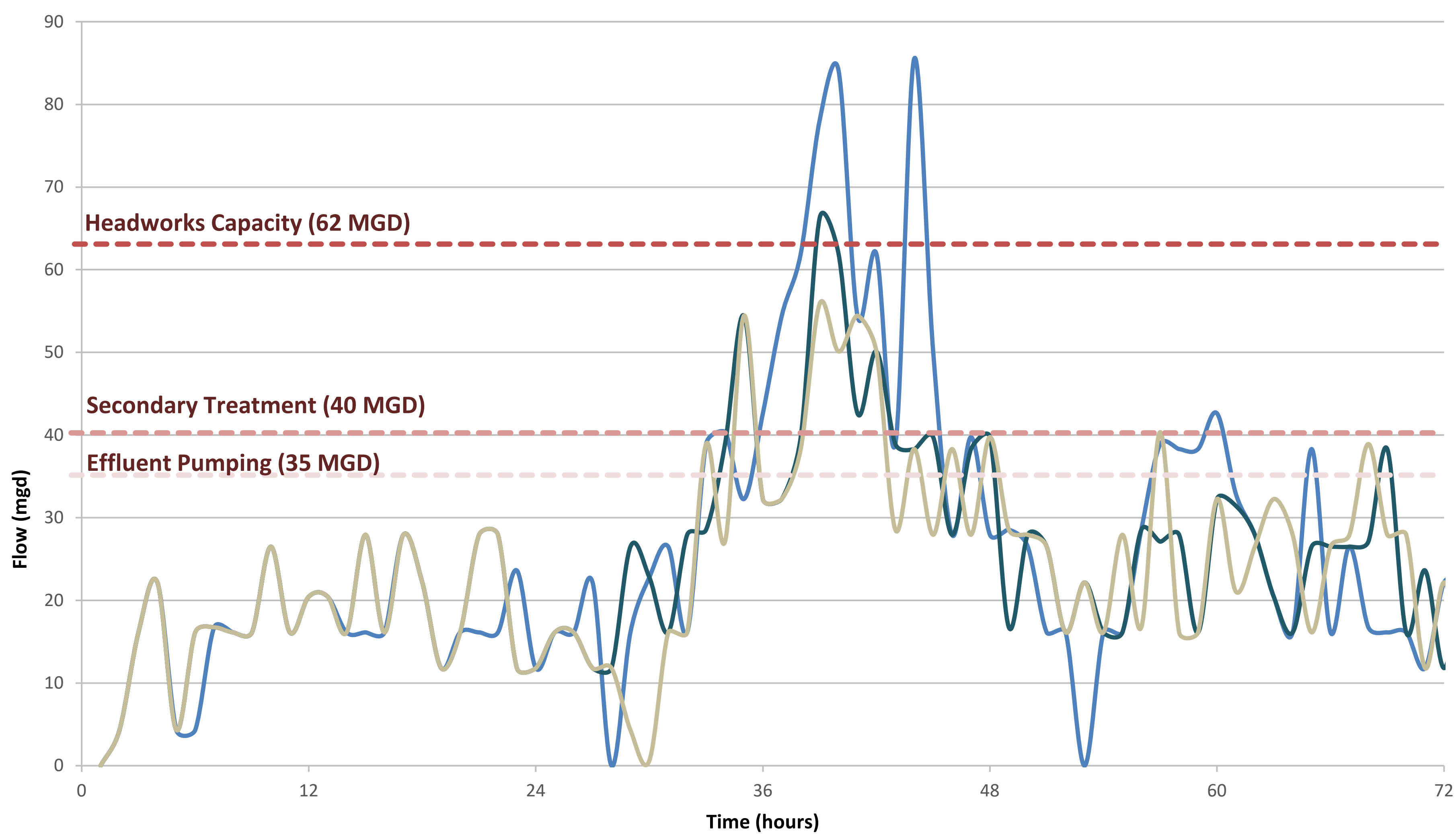
Improvement Alternatives to Mitigate Capacity Constraints at the WQCP. Due to proximity to the Bay, the WQCP is currently land constrained. Accordingly, the project team considered three improvements alternatives:

- **Alternative 1 - Increased Storage at the WQCP**. Increasing the storage basin volumes at the plant would be difficult and costly and would likely require vertical walls. However, this would be required to avoid even more costly improvements to the treatment components.

- **Alternative 2 - In-System Storage.** Evaluate the feasibility of constructing in-system storage, and how to appropriately operate such infrastructure. This may be spaced out across several facilities.

- **Alternative 3 - I/I Reduction Program (recommended).** Evaluate the impacts of reducing I/I and quantify the necessary reduction, and of relying on these reductions in I/I to mitigate costly improvements at the WQCP. This alternative was selected by the project team.

Sensitivity Analysis for Selecting Feasible I/I Reduction Program. The project team then completed a sensitivity analysis to evaluate the impacts of reducing I/I in the system and documenting the results downstream at the WQCP components, as shown on **Table 7.7**. Overall, the hydraulic model predicts that, if I/I amounts are reduced by a minimum of 20% in the upstream collection system, this would mitigate the need for costly improvements at the WQCP. Additional hydraulic analysis evaluated the impact of further reductions in RDII and up to 40%, as shown on **Table 7.2**.



LEGEND

WQCP Process

- 10-Year 24-Hour Base Storm
- 10-Year 24-Hour (20% I/I Reduction)
- 10-Year 24-Hour (40% I/I Reduction)

Capacities

- 62 mgd (Headworks Capacity)
- 40 mgd (Secondary Treatment Capacity)
- 35 mgd (Effluent Pumping Capacity)

August 20, 2020

Figure 7.6

Future WQCP PWWF

(10-Year 24-Hour Design Storm)

City-Wide Sewer System Master Plan

City of South San Francisco

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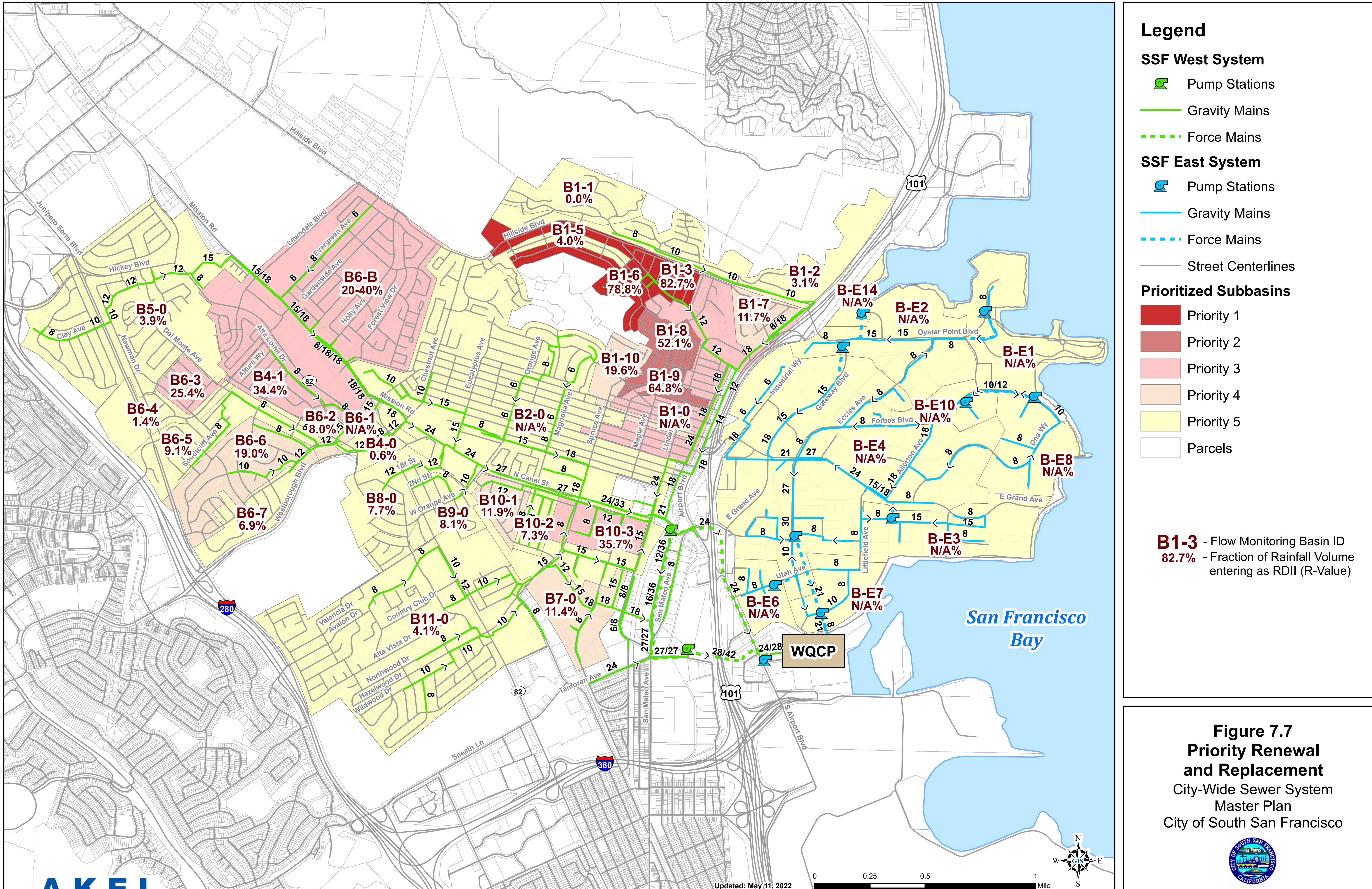

Updated: May 11, 2022

Figure 7.7
Priority Renewal and Replacement
City-Wide Sewer System Master Plan
City of South San Francisco

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Table 7.2 WQCP Storage Capacity Analysis

City-Wide Sewer System Master Plan
City of South San Francisco

			10-Year 24-Hour Storm Event Storage Analysis		
			Existing RDII Conditions	20% RDII Reduction	40% RDII Reduction
Treatment Capacity and Model Flows[1,2,3]	Headworks Pump Station Capacity	MGD	62.00	62.00	62.00
	Secondary Treatment Capacity	MGD	40.00	40.00	40.00
	Effluent Pump Station Capacity	MGD	35.00	35.00	35.00
	Peak Modeled Flow	MGD	85.54	66.24	55.87
Available Storage[4]	Aeration Basins 1-4	MG	0.64	0.64	0.64
	WWF Storage	MG	7.00	7.00	7.00
Estimated Storage Need	Headworks	MG	2.57	0.18	0.00
	Secondary Treatment	MG	9.00	3.14	2.72
	Effluent Pumping	MG	12.40	5.51	4.91
Storage Surplus (+) / Deficit (-)[5,6]	Headworks	MG	**-1.93**	**0.46**	**0.64**
	Secondary Treatment	MG	**-2.00**	**3.86**	**4.28**
	Effluent Pumping	MG	**-5.40**	**1.49**	**2.09**

Notes: 8/21/2020

1. Treatment capacities based on 2011 Facility Plan Update, April 2011.
2. Peak Modeled Flow as extracted from City of South San Francisco hydraulic model, and includes: SSF, San Bruno, Daly City, and Colma.
3. I/I reductions are based on a reduction in the West of 101 Rainfall percentage factor in the RDII calculations.
4. Available Storage as provided in the 2011 Facility Plan Update.
5. Secondary Treatment flows in excess of the treatment capacity may be blended and discharge directly pending compliance with effluent and rec water limits.
6. Effluent Pumping evaluation does not include other discharger flows that may use the combined outfall.

Based on a review of the cost and impact to the regional infrastructure, City staff selected an initial target goal of I&I reduction of 20 percent over the next 20 years. The 20 percent reduction in I&I would reduce costly improvements to the West of 101 pump stations and at the Water Quality Control Plant.

The industry recommended goal of pipeline Renewal and Replacement (R&R) budgets is at 1.0 percent of system pipeline length, based on a 100-year pipeline replacement cost. A reasonable goal of 20 years was selected assuming the City allocates adequate resources to its sewer collection system each year. If the target goal of 20 percent is not reached in 20 years, the City may consider updating this master plan to reflect higher flows.

Additional Flow Monitoring to Target Renewal and Replacement Program for I/I Reductions. Accordingly, City staff have embarked and completed on a significant flow monitoring effort, intended to capture I&I impacts during the 2021 rainfall season (**Appendix D**). The results of this study were used to categorize high priority I&I basins and to focus resources into the areas where infiltration and inflow are the highest. The resulting reduction in I&I across the system will reduce the burden on the WQCP, reduce infrastructure sizing requirements, and provide higher levels of service to the existing and future ratepayers.

7.5 EAST OF 101 – FUTURE SYSTEM EVALUATION

The future pipeline analysis included the buildout flows identified in a previous chapter and evaluated those pipelines against the City's planning and design criteria. During the peak dry weather simulations, the maximum allowable pipe d/D criterion of 0.75 was used for new pipes. For existing pipes, the criterion was relaxed to allow a maximum d/D ratio of 0.90 (full pipe capacity) to prevent unnecessary pipe replacements. During the peak wet weather simulations, capacity deficiencies included pipe segments with a hydraulic grade line (HGL) that rises within one foot of the manhole rim elevation.

The design flows simulated in the hydraulic model for the buildout of the study area were summarized on **Table 5.7** and they include:

- Future PDWF = 8.8 mgd
- Future PWWF = 10.0 mgd

It should be noted that this master plan also included a special study for the Oyster Point Redevelopment project. As such, this study was included in the hydraulic analysis, and a brief section was included to document the changes to the land use.

7.5.1 Oyster Point Redevelopment Special Study

During the preparation of this Master Plan, City staff initiated a special study to identify improvements necessary to serve the redevelopment of the northwest portion of the study area known as Oyster Point. This area is generally located east of the intersection of Oyster Point Boulevard and Marina Boulevard.

The existing land use for the Oyster Point area is currently marina, hotel, and office uses. This area is expected to redevelop into multiple land use types, including office and hotel land uses. As part of the analysis, City staff provided 60 percent design drawings to document the proposed realignment of the sewer infrastructure. These recommendations were included in the hydraulic model analysis to document the capacity adequacy of the proposed, and downstream, infrastructure. The results of this special study are documented in tables and figures included in **Appendix E**. It should be noted that the improvements included in for the Oyster Point Study Area were incorporated in the Capital Improvement Program listed in Chapter 8.

7.5.2 Recommended Improvements

The proposed capacity improvements for the sewer collection system are listed on **Table 7.3**. Each improvement is assigned a uniquely coded identifier that is intended to aid in defining the location of the improvement for mapping purposes. These identifiers reflect the tributary basin, improvement type, and sequence in the improvement schedule.

The proposed improvements are shown with pipe sizes on **Figure 7.8** and are briefly described by tributary basin as follows:

7.5.2.1 *Basin 1*

This section documents improvements within the Basin 1 sewer service area.

- **Improvement 1-P1**: Replace the existing 8-inch gravity sewer with a new 12-inch gravity sewer on Oyster Point Boulevard from 750 feet north of Pump Station 1 to Pump Station 1. This improvement is intended to mitigate a future capacity deficiency.

7.5.2.2 *Basin 2*

This section documents improvements within the Basin 2 sewer service area.

- **Improvement 2-P1**: Replace the existing 8-inch gravity sewer with a new 15-inch gravity sewer on Oyster Point Boulevard from Gull Drive to Eccles Avenue. This improvement is intended to mitigate an existing capacity deficiency.

7.5.2.3 *Basin 4*

This section documents improvements within the Basin 4 sewer service area.

- **Improvement 4-P1**: Replace the existing 21-inch gravity sewer with a new 24-inch gravity sewer From Gateway Boulevard to Forbes Boulevard. This improvement is intended to mitigate a future capacity deficiency.

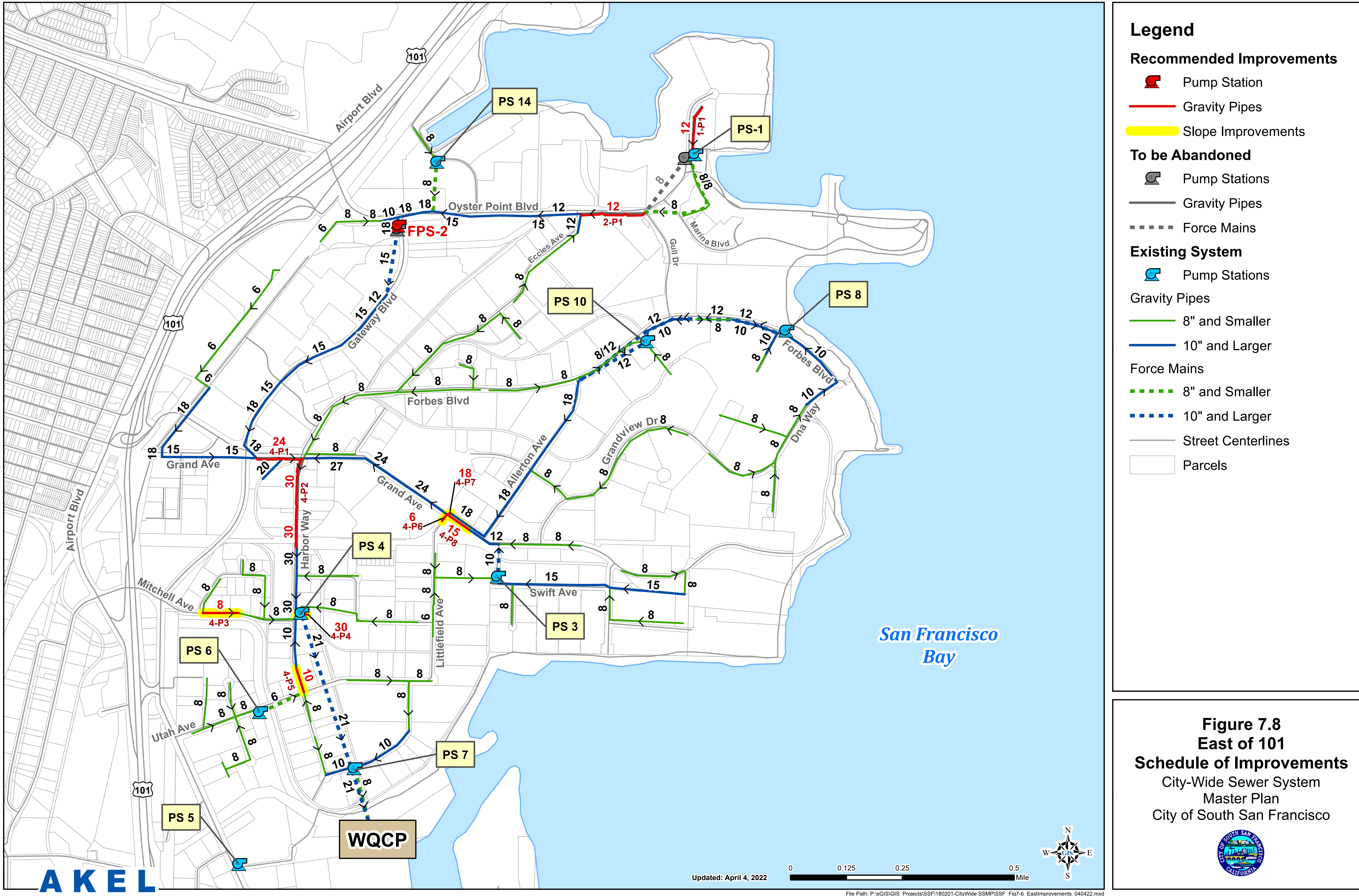

Figure 7.8
East of 101
Schedule of Improvements

City-Wide Sewer System
Master Plan
City of South San Francisco

Table 7.3 Schedule of Improvements (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Improv. No.	Improv. Type	Alignment	Limits	Existing Diameter (in)	Pipeline Improvements New/Parallel/ Replace	Diameter (in)	Length (ft)
Gravity Main Improvements							
Basin 1							
1-P1	Future-Capacity	Oyster Point Blvd	From 750 ft n/o Lift Station to Lift Station 1	8	Replace	12	700
Basin 2							
2-P1	Existing-Capacity	Oyster Point Blvd	From Gull Dr to Eccles Ave	8	Replace	12	790
Basin 4							
4-P1	Future-Capacity	E Grand Ave	From Gateway Blvd o Forbes Blvd	21	Replace	24	585
4-P2	Future-Capacity	Harbor Way	From E Grand Ave to 350 ft n/o Harris Ave	27	Replace	30	1,105
4-P3	Existing-Slope	Littlefield Ave	From 50 ft ne/o Grand Ave to Littlefield Ave to Grand Ave	8	Replace	8	425
4-P4	Existing-Slope	Littlefield Ave	From 100 ft s/o Grand Ave to Grand Ave	30	Replace	30	65
4-P5	Existing-Slope	E Grand Ave	From Littlefield Ave to 300 ft se/o Littlefield Ave	10	Replace	10	315
4-P6	Existing-Slope	Mitchell Ave	From West Harris Ave to 400 ft e/o Harris Ave	6	Replace	6	115
4-P7	Existing-Slope	50 feet n/o Mitchell Ave	From Harbor Way to Lift Station 4	18	Replace	18	50
4-P8	Existing-Slope	E Grand Ave	From 250 e/o Kimball Way to Kimball Way	15	Replace	15	330
Pump Station Improvements							
PS-2	Existing-Capacity	955 Gateway Blvd			Capacity Upgrade	2 @1,850 gpm	

- **Improvement 4-P2**: Replace the existing 27-inch gravity sewer with a new 30-inch gravity sewer on Harbor Way from Grand Avenue to 350 feet north of Harris Avenue. This improvement is intended to mitigate a future capacity deficiency.
- **Improvement 4-P3**: Replace the existing 18-inch gravity sewer with a new 18-inch gravity sewer on Littlefield Avenue from 50 feet north-east of Grand Avenue to Grand Avenue. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement 4-P4**: Replace the existing 6-inch gravity sewer with a new 6-inch gravity sewer on Littlefield Avenue from 100 feet south of Grand Avenue to Grand Avenue. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement 4-P5**: Replace the existing 15-inch gravity sewer with a new 15-inch gravity sewer on East Grand Avenue from Littlefield Avenue to 300 feet southeast of Littlefield Avenue. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement 4-P6**: Replace the existing 8-inch gravity sewer with a new 8-inch gravity sewer on Mitchell Avenue from West Harris Avenue to 400 feet east of Harris Avenue. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement 4-P7**: Replace the existing 30-inch gravity sewer with a new 30-inch gravity sewer on right-of-way located 50 feet north of Mitchell Avenue from Harbor Way to Pump Station 4. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.
- **Improvement 4-P8**: Replace the existing 10-inch gravity sewer with a new 10-inch gravity sewer on Harbor Way from Utah Avenue to 300 feet north of Utah Avenue. This improvement is intended to mitigate an existing capacity deficiency generated by a shallow pipeline slope. It is recommended that the City continue to monitor the depth of flow in the pipeline, pipeline slope be verified, and mitigation opportunities be explored.

7.6 PUMP STATIONS CAPACITY ANALYSIS

The City currently owns and operates eleven pump stations that convey collected sewer flows to the WQCP south of the study area. The maximum and average modeled inflows for each pump station, under existing and future PDWF and PWWF conditions are shown on **Table 7.4**. A summary of the pump station capacity analysis under PWWF conditions is provided below:

7.6.1 Pump Station 1

The maximum modeled existing and buildout PWWF tributary to Pump Station 1 is 0.21 and 1.86 mgd respectively. This increase in flows is due to the redevelopment of the Oyster Point area. As summarized on **Table 7.4**, the existing pumps of this newly constructed pump station are expected to be adequate to accommodate these future flows.

7.6.2 Pump Station 2

The maximum modeled existing and buildout PWWF tributary to Pump Station 2 is 1.79 and 2.66 mgd respectively. This increase in flows is due to the redevelopment of the Bay West Cove area. As summarized on **Table 7.4** the existing pumps of this pump station are inadequate to accommodate these future flows. To mitigate this deficiency it is recommended that the existing pumps be replaced with two new pumps rated at 1,850 gpm each for a total pump station capacity of 3,700 gpm (improvement ID PS-2).

7.6.3 Pump Station 3

The maximum modeled existing and buildout PWWF tributary to Pump Station 3 is 0.43 and 0.86 mgd respectively. This increase in flows is due to the redevelopment of portions of the Genentech campus. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

7.6.4 Pump Station 4

The maximum modeled existing and buildout PWWF tributary to Pump Station 4 is 5.27 and 9.82 mgd respectively. This increase in flows is due to the redevelopment of multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

7.6.5 Pump Station 6

The maximum modeled existing and buildout PWWF tributary to Pump Station 6 is 0.23 and 0.25 mgd respectively. This increase in flows is due to the redevelopment of multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

Table 7.4 Existing Pump Stations and Capacity Analysis

City-Wide Sewer System Master Plan
City of South San Francisco

Pump Station No.	Location	Firm Capacity[1] (Excludes Standby)	Total Capacity[1] (Includes Standby)	Existing Peak Flows including Oyster Point Redevelopment				Surplus/ Deficiency	2040 Peak Flows				Surplus/ Deficiency	Adequate Capacity	Capacity Upgrade
				Dry Weather		Wet Weather			Dry Weather		Wet Weather				
		(gpm)	(gpm)	(gpm)	(mgd)	(gpm)	(mgd)	(gpm)	(gpm)	(mgd)	(gpm)	(mgd)	(gpm)		(gpm)
PS-1	383 Oyster Pt. Blvd	1,400	2,800	70	0.100	144	0.208	1,256	1,101	1.585	1,293	1.861	108	Yes	
PS-2	955 Gateway Blvd	1,000	2,000	666	0.959	1,244	1.792	-244	1,540	2.218	1,844	2.655	-844	Replace	2 @ 1,850 gpm
PS-3	195 Kimball Way	1,600	2,400	116	0.167	301	0.434	1,299	425	0.613	595	0.857	1,005	Yes	
PS-4	249 Harbor Way	9,000	12,000	2,717	3.912	3,659	5.268	5,341	6,213	8.946	6,820	9.821	2,180	Yes	
PS-6	160 Utah Ave	600	1,200	134	0.194	158	0.227	442	147	0.211	170	0.245	430	Yes	
PS-7	220 Littlefield Ave	425	1,025	46	0.066	141	0.203	284	50	0.072	145	0.208	280	Yes	
PS-8	701 Forbes Blvd	2,800	4,200	700	1.008	799	1.151	2,001	780	1.123	879	1.266	1,921	Yes	
PS-9[2]	1749 San Mateo Ave	16,800	25,200	4,882	7.030	23,808	34.284	-7,008	5,240	7.545	19,490	28.065	-2,690	Replace	Dry Weather Wet Well 2 @ 5,600
PS-10	572 Forbes Blvd	1,097	2,194	49	0.070	109	0.157	988	504	0.725	539	0.777	558	Yes	
PS-11[3]	235 Shaw Rd	20,300	26,100	12,226	17.605	35,870	51.653	-15,570	14,011	20.175	41,242	59.388	-20,942	Replace	6 @ 8,300 gpm
PS-14	1191 Veterans Blvd	2,000	4,000	32	0.046	34	0.049	1,966	61	0.088	63	0.091	1,937	Yes	

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4/5/2022

Notes:
1. Pump Station capacity information provided by City Staff.
2. Pump Station 9 values include flows for Daly City and Town of Colma.
3. Pump Station 11 values include flows for San Bruno and flows from Pump Station 9's wet weather force main.

7.6.6 Pump Station 7

The maximum modeled existing and buildout PWWF tributary to Pump Station 7 is 0.20 and 0.21 mgd respectively. This increase in flows is due to the redevelopment of multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

7.6.7 Pump Station 8

The maximum modeled existing and buildout PWWF tributary to Pump Station 8 is 1.15 and 1.27 mgd respectively. This increase in flows is due to the redevelopment of multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

7.6.8 Pump Station 9

The maximum modeled existing and buildout PWWF tributary to Pump Station 9 is 34.28 and 27.91 mgd respectively. The decrease in flows is a result of the pipeline recommendations altering the divergence of flows specifically at the intersection of South Spruce Avenue and Centennial Way Trail, and the 20 percent reduction in I&I flow discussed in previous chapters. As summarized on **Table 7.4** the existing pumps of this pump station are inadequate to accommodate these future flows. To mitigate this deficiency, it is recommended that the existing dry weather pumps be replaced with two new pumps rated at 5,600 gpm each for a total pump station capacity of 28,000 gpm (improvement ID PS-9).

7.6.9 Pump Station 10

The maximum modeled existing and buildout PWWF tributary to Pump Station 10 is 0.16 and 0.78 mgd respectively. This increase in flows is due to the redevelopment multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

7.6.10 Pump Station 11

The maximum modeled existing and buildout PWWF tributary to Pump Station 11 is 51.65 and 59.39 mgd respectively. This slight increase in flows is due to the redevelopment of multiple parcels in the pump station tributary area, and the 20 percent reduction in I&I flow discussed in previous chapters. As summarized on **Table 7.4** the existing pumps of this pump station are inadequate to accommodate these future flows. To mitigate this deficiency, it is recommended that the existing pumps be replaced with six new pumps rated at 8,300 gpm each for a total pump station capacity of 49,800 gpm (improvement ID PS-11).

7.6.11 Pump Station 14

The maximum modeled existing and buildout PWWF tributary to Pump Station 14 is 0.05 and 0.09 mgd respectively. This slight increase in flows is due to the redevelopment multiple parcels in the pump station tributary area. The existing pumps of this pump station are expected to be adequate to accommodate these future flows.

CHAPTER 8 – CONDITION AND RISK ASSESSMENT

This section documents the condition and risk assessment of the existing sanitary sewer pipelines within the South San Francisco service area. This risk assessment included the following elements:

- Review available system data
- Define risk criteria
- Perform a risk analysis for existing pipelines
- Recommended improvements

The following sections include discussion of the data reviewed to perform the analysis, the condition and risk assessment criteria used to evaluate the risk of each pipeline, the results of the condition and risk assessment, and recommended improvements.

8.1 AVAILABLE DATA

The following data was used as a basis for this risk assessment. The review included system maps, asset data inventory, CCTV review, and pipeline maintenance records. The availability and quality of data are discussed below and documented on **Table 8.1**.

- **System Maps**: This included pipeline connections and alignments based on GIS current as of August 2019.

- **Asset Data Inventory**: This included pipeline age, material, and capacity. Pipeline age was available for approximately 96 percent of pipelines; pipeline capacity was available for critical pipelines over 8" in diameter. Pipeline material was unavailable.

- **CCTV Review**: This included closed circuit television recordings for approximately 27 percent of total pipe length. CCTV information was utilized in an access database, and pipeline defects were assigned into the GIS based on the identification number in the PACP. CCTV inspections provided by the City were conducted between January 2013 to April 2018.

- **Geographic Data Inventory**: This included geographical information on local channels and rivers.

- **Municipal Data Inventory**: This included an inventory of all local roads, as well as critical facilities such as medical and childcare facilities.

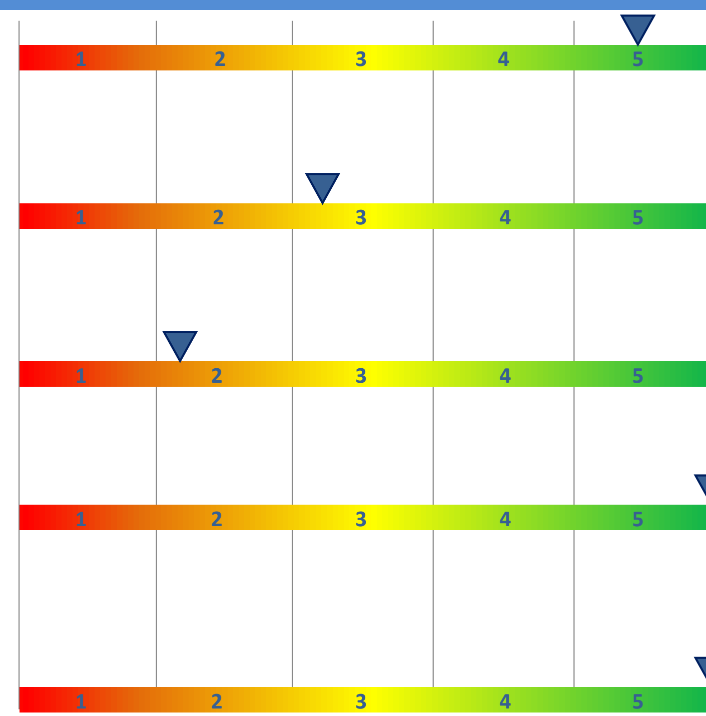
Table 8.1 Condition Assessment Data Availability and Quality

City-Wide Sewer System Master Plan
South San Francisco

	Focus	Group	Availability
1	**Asset Information**	**Up-to-Date System Maps**	The system maps were updated based on the GIS current as of August 2019.
2	**Asset Information**	**Asset Data Inventory (Age, Material, Capacity)**	Age: Available for 89% of pipes Material: Unavailable Capacity: Available for critical pipelines over 8" in diameter.
3	**Asset Knowledge**	**Closed Circuit Television of Gravity Mains**	Approximately 27% of the total length has CCTV. Some PACP errors.
4	**Geographic Information**	**Geographic Data Inventory**	Channels/Rivers: Available
5	**Municipal Information**	**Municipal Data Inventory**	Roads: Available Medical/Childcare Facilities: Available

Quality

Needs Improvement — Excellent



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8.2 RISK ASSESSMENT

Risk assessment and analysis is at the heart of asset management planning, and is one of the primary tools used for identifying and prioritizing renewal projects with the highest urgency. The results of this process guide optimized decisions on financial planning, and are used for choosing where the limited available public funds are more wisely spent.

8.2.1 Methodology

Risk analysis consists of assessing the probability (or likelihood) of an asset failing, and more importantly linking it to a consequence if such failure was to occur. This analysis allows the agency to identify existing and future risks that potentially impact the level of customer service and the associated costs. Thus, the risk, also known as the business risk exposure (BRE), is calculated by multiplying the probability or likelihood of failure (LOF) by the consequence of failure (COF).

The probability (or likelihood) of failure analysis allows a prediction of failure timing for a particular asset. Did the asset fail to meet the level of service? Has capacity become inadequate? How is the structural condition? Is the lifecycle cost efficient? A numerical LOF score is assigned to each asset based on this assessment.

The consequence of failure analysis assesses the impact of such failure on the residential or commercial environment, and the resulting anticipated economic loss.

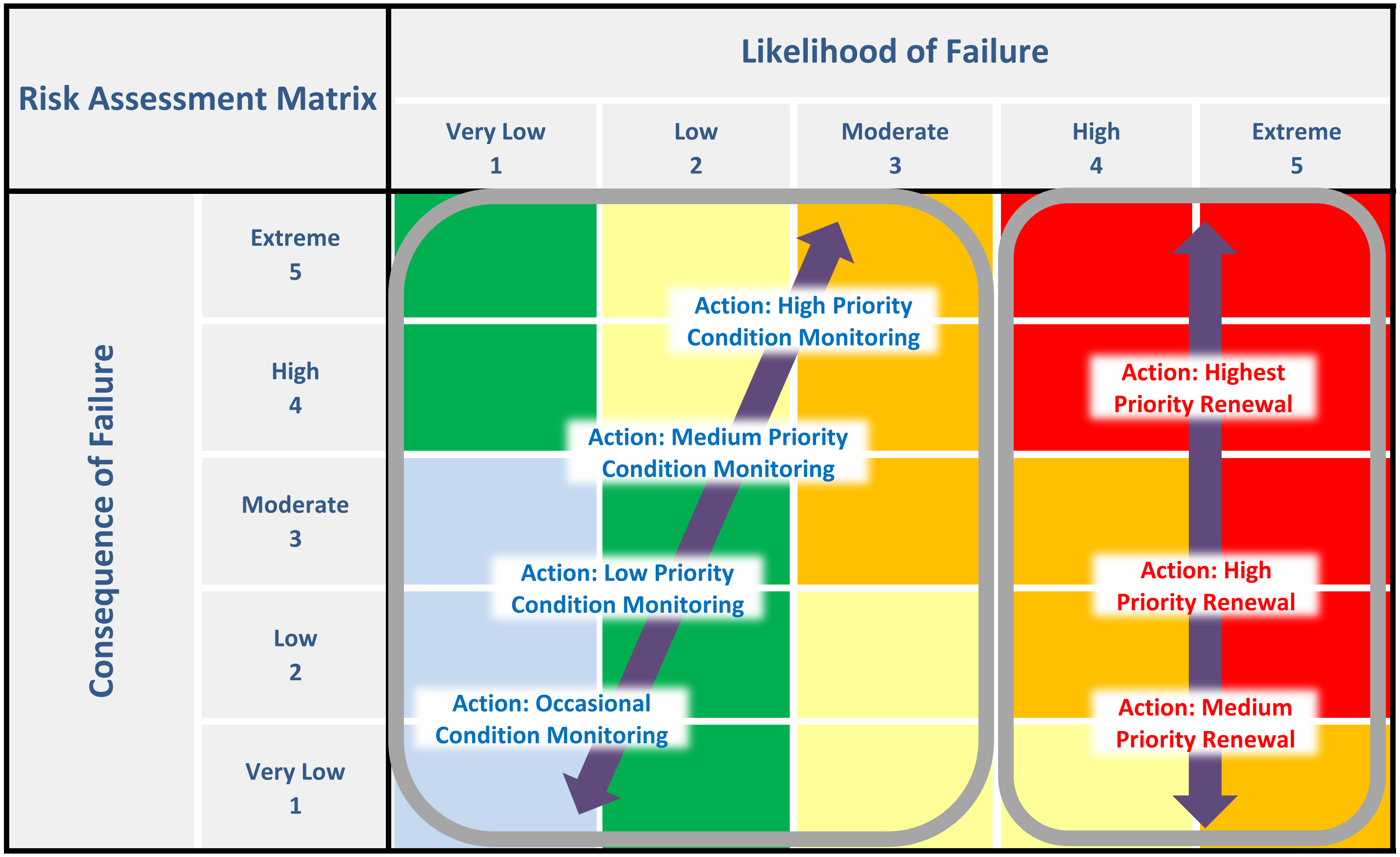
A total of 5 categories were used to assign numerical scores to each likelihood of failure and consequence of failure category. Furthermore, each identified category was assigned a weight based on its criticality. A higher weight means the score for a pipeline from a particular criterion will contribute more to total COF or LOF score than a criterion with a lower weight. The five Risk rating categories include: Extreme, High, Moderate, Low, and Very Low. High scores are associated with the Extreme and High rating categories and represent at risk assets that require immediate attention. Low scores are associated with the Very Low or Low rating categories and may represent new or low risk assets.

The Risk Assessment Matrix on **Figure 8.1** illustrates how assets are classified in the Extreme rating category (red) or High rating category (orange), by combining their LOF and COF scores.

The red and orange zone on this figure indicate the projects requiring immediate attention for either renewal or replacement. The yellow zone highlights assets for more aggressive monitoring. The green and blue zone require simple monitoring.

8.2.2 Consequence of Failure Criteria

The COF criteria are intended to qualitatively identify the consequences of the failure of pipelines within the system and are used in the calculation of the COF score; the measure or proxy, scale, and weights vary for each criterion. These criteria, as well as the scores and weights, were reviewed and approved by city staff before incorporation into the risk assessment. The specific



LEGEND

Risk Color Coding

Extreme | *High* | *Moderate* | *Low* | *Very Low*

Renewal Actions Levels

Highest Priority | *High Priority* | *Medium Priority*

Condition Monitoring Levels

High Priority | *Medium Priority* | *Low Priority* | *Occasional*

July 20, 2022

Figure 8.1

Risk Assessment Scoring and Action Plan

City-Wide Sewer System Master Plan

South San Francisco

score values and weights for each COF criteria are summarized on Table 8.2 and a brief description for each is as follows:

- **Diameter (30%):** This criterion assesses the consequence of failure of a pipeline based on the diameter. Scores range from a value of 1 for pipelines less than or equal to 6-inches in diameter to a value of 5 for pipelines greater than 21-inches in diameter.

- **Critical Pipe Flow (15%):** This criterion assesses the consequence of failure of pipelines based on the flow conveyed in the pipes under peak wet weather flow conditions. Scores range from a value of 1 for non-critical pipelines with unknown flows to a value of 5 for pipelines with flows greater than or equal to 2,500 gpm.

- **Force Main (15%):** This criterion assesses the consequence of failure of pipelines operating as force mains. Scores range from a value of 1 for gravity mains to a value of 5 for force mains.

- **Channel Crossing (20%):** This criterion assesses the consequence of failure of pipelines located partially or completely within regional channels or tributary rivers. Scores range from a value of 1 for pipelines not in proximity to channels to a value of 5 for pipelines located within channels.

- **Critical Facilities (5%):** This criterion assesses the consequence of failure of pipelines in close proximity to critical facilities, which were assumed to include schools, child care facilities, and medical facilities. Scores range from a value of 1 for pipelines not in proximity to a critical facility to a value of 5 for pipelines within 150 feet of a critical facility.

- **Major Road Crossing (10%):** This criterion assesses the consequence of failure of pipelines in major roads. Scores range from a value of 1 for pipelines not in major roads to a value of 5 for pipelines constructed within highway roads.

- **Access (5%):** This criterion assesses the consequence of failure of pipelines based on accessibility. Scores range from a value of 1 for pipelines within existing right of way (ROW) to a value of 5 for pipelines located in Highway roads.

8.2.3 Likelihood of Failure Criteria

These criteria are intended to qualitatively identify the likelihood of the failure of pipelines within the system and are used in the calculation of the total LOF score; the types, score values, and weights vary for each criterion. These criteria, as well as the scores and weights, were reviewed and approved by city staff before incorporation into the risk assessment. The specific score values and weights for each LOF criterion are summarized on Table 8.3 and a brief description for each is as follows:

- **CCTV Results - Structural (35%):** This criterion assesses the likelihood of failure of pipelines based on the structural score extracted from existing CCTV data. Scores range

Table 8.2 Consequence of Failure Criteria

City-Wide Sewer System Master Plan

South San Francisco

1	2	3	4	5	6	7	8	9	10	11	12
						Consequence of Failure	Very Low	Low	Moderate	High	Extreme
						Rating	1	2	3	4	5
No.	**Consequence Categories**	**Criteria**	**Description**	**Weighting**	**Category Weighting**	**Measure or Proxy**	**Consequence Scale**				
1	**Potential Spill Volume**	**Diameter**	Larger diameter pipelines typically carry higher flows, and failures can lead to larger spill quantities.	**30%**	**60%**	Pipeline Diameter	≤ 6"	8" - 10"	12" - 15"	18" - 21"	> 21"
2		**Critical Pipe Flow**	Failures in high flow pipelines result in larger spills and a higher likelihood of contamination of adjacent infrastructure.	**15%**		Maximum Pipeline Flow	Unknown	≤ 500 gpm	500 - 1,000 gpm	1,000 - 2,500 gpm	≥ 2,500 gpm
3		**Force Main**	Force main pipelines typically carry higher flows, and failures can lead to larger spill quantities.	**15%**		Pipeline Main Type	Gravity Mains				Force Mains
4	**Environmental Impact**	**Channel Crossing**	Failures near creeks pose environmental hazards and potentially costly mitigation measures.	**20%**	**20%**	Proximity to channels	Other Mains				Located within Channel
5	**Public Exposure**	**Critical Facilities**	Failures adjacent to schools and parks may require greater levels of clean up, and more critical response.	**5%**	**5%**	Proximity to critical customers	Other Mains				Within 150 feet of: Schools, Child Care Facilities, Medical Facilities, Skilled Nursing Facilities
6	**Emergency Response and Construction Impact**	**Major Road Crossing**	Failures in arterial streets are costly and have adverse impacts to public opinion.	**10%**	**15%**	Traffic Disruption (Road Crossing)	Other Mains			Pipelines in Arterial Roads	Pipelines in Highway Roads
7		**Access**	Difficult to access pipelines are more costly to repair.	**5%**		Pipeline Location	Other Mains				All or Portion of the Pipeline Located Outside of ROW

Table 8.3 Likelihood of Failure Criteria

City-Wide Sewer System Master Plan
South San Francisco

							Likelihood of Failure	Very Low	Low	Moderate	High	Extreme
							Rating	1	2	3	4	5
1	2	2	3	4	4	4	5	6	7	8	9	10
No.	Likelihood Categories	Criteria	Description	Weighting with CCTV	Weighting without CCTV	Category Weighting	Measure or Proxy	Likelihood Scale				
1	Structural Failure	CCTV Results - Structural	Pipelines with higher structural peak scores have more significant defects, and therefore are more likely to fail.	35%	-	45%	Structural Defect Peak Score	1	2	3	4	5
2		Installation Year	Pipeline Age can contribute to increased chance of failure.	-	35%		Installation Year	After 1980	1960 - 1980	Unknown	1940 - 1960	Before 1940
3		Channel Crossing	Pipelines within channel are more vunerable to damage, and therefore are more likely to fail.	10%	10%		Proximity to channel	Other				Located within Channel
4	Maintenance Failure	CCTV Results - O&M	Pipelines with higher O&M peak scores have more significant defects, and therefore are more likely to fail.	25%	25%	25%	O&M Defect Peak Score	1	2	3 or No CCTV data	4	5
5	Hydraulic Capacity Failure	Infiltration per Meter Basin	Pipelines with higher infiltration are more likely to experience sanitary sewer overflows as a result of rain events.	20%	20%	30%	Percent of rain-dependent infiltration (RDI) per average faily dry weather flow (ADWF) per basin	0%	0% - 5%	5% - 10%	10% - 20%	> 20%
6		Pipeline Velocity	Pipelines with full flow velocities under minimum scour velocity are more likely to accumulate deposits.	10%	10%		Maximum Pipeline Velocity	Unknown	> 5 ft/s	3.5 - 5 ft/s	2 - 3.5 ft/s	< 2 ft/s

- from a value of 1 for pipelines with a peak structural score of 1 to a value of 5 for pipelines with a peak structural score of 5.
- **Installation Year (35%):** This criterion assesses the likelihood of failure of pipelines based on the installation year. Scores range from a value of 1 for pipelines constructed after 1980 to a value of 5 for pipelines constructed before 1940. This criterion was used to estimate the Structural CCTV results for pipelines without CCTV inspection (73 percent of SSF System).
- **Channel Crossing (10%):** This criterion assesses the likelihood of failure of pipelines located partially or completely within regional channels or tributary rivers, which can affect pipeline survivability. Scores range from a value of 1 for pipelines not within channels to a score of 5 for pipelines constructed within channels.
- **CCTV Results – Operational and Maintenance (25%):** This criterion assesses the likelihood of failure of pipelines based on the operational and maintenance score extracted from existing CCTV data. Scores range from a value of 1 for pipelines with a peak operational and maintenance score of 1 to a value of 5 for pipelines with a peak operational and maintenance score of 5. Pipelines without CCTV inspections were given a moderate score of 3.
- **Infiltration per Meter Basin (20%):** This criterion assesses the likelihood of failure of pipelines based on the percent of rain-dependent infiltration and inflow (RDII) per average daily dry weather flow (ADWF) per basin. Scores range from a value of 1 for basins with an R-value of 0 percent to a value of 5 for basins with an R-value greater than 20 percent.
- **Pipeline Velocity (10%):** This criterion assesses the likelihood of failure of pipelines based on a comparison of the full flow velocity and a minimum scour velocity of 2 ft/s. Scores range from a value of 1 for pipelines with a full flow velocity greater than or equal to 5 ft/s to a value of 5 for pipelines with a full flow velocity less than or equal to 2 ft/s.

8.2.4 Pipeline Condition Assessment

Sewer mains were assessed to provide a general understanding of the existing system's condition and to determine improvements to mitigate condition deficiencies. The condition assessment involved a review of CCTV information recorded of the sewer lines from 2013 to 2018. The review of the CCTV was completed in accordance with National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) scoring. This included determining structural, operational and maintenance, construction, and miscellaneous defects.

Based on a review of the existing condition information, the gravity sewer mains were generally found to be in good condition. Defects within the system generally consist of defective end lining, fine roots at joints, multiple cracks, and water line sagging. The condition assessment focused on documenting major defects (PACP Rating > 3), and determining an appropriate rehabilitation method, as major structural defects can lead to costly pipeline failures. Other defects (PACP Rating 1-3) were used in the process of evaluating how critical the individual pipe segments were.

8.2.5 Risk Assessment Results

The risk assessment was performed to assess the risk of failure of sanitary sewer pipelines within the existing system. Using the consequence (COF) and likelihood of failure (LOF) criteria discussed in a previous section a consequence of failure score and likelihood of failure score was determined for each pipeline. The total pipeline length for each COF score and LOF score are summarized graphically on **Figure 8.2** and **Figure 8.3**. Figures documenting the COF and LOF scores received for each individual criterion can be found in **Appendix F**. The risk score is a combination of the consequence of failure and likelihood of failure scores.

Based on discussions with City staff, and the breakdown of the COF and LOF scores, risk category thresholds were determined to classify the pipelines as Very Low, Low, Moderate, High, and Extreme risk. These risk thresholds are briefly summarized as follows:

- **Very Low:** Pipelines with a COF and LOF score less than or equal to 100 and 230, respectively, were categorized as Very Low risk. Approximately 36.5 miles of pipelines were categorized as Very Low risk, which represents 30 percent of all pipelines included in the risk assessment.

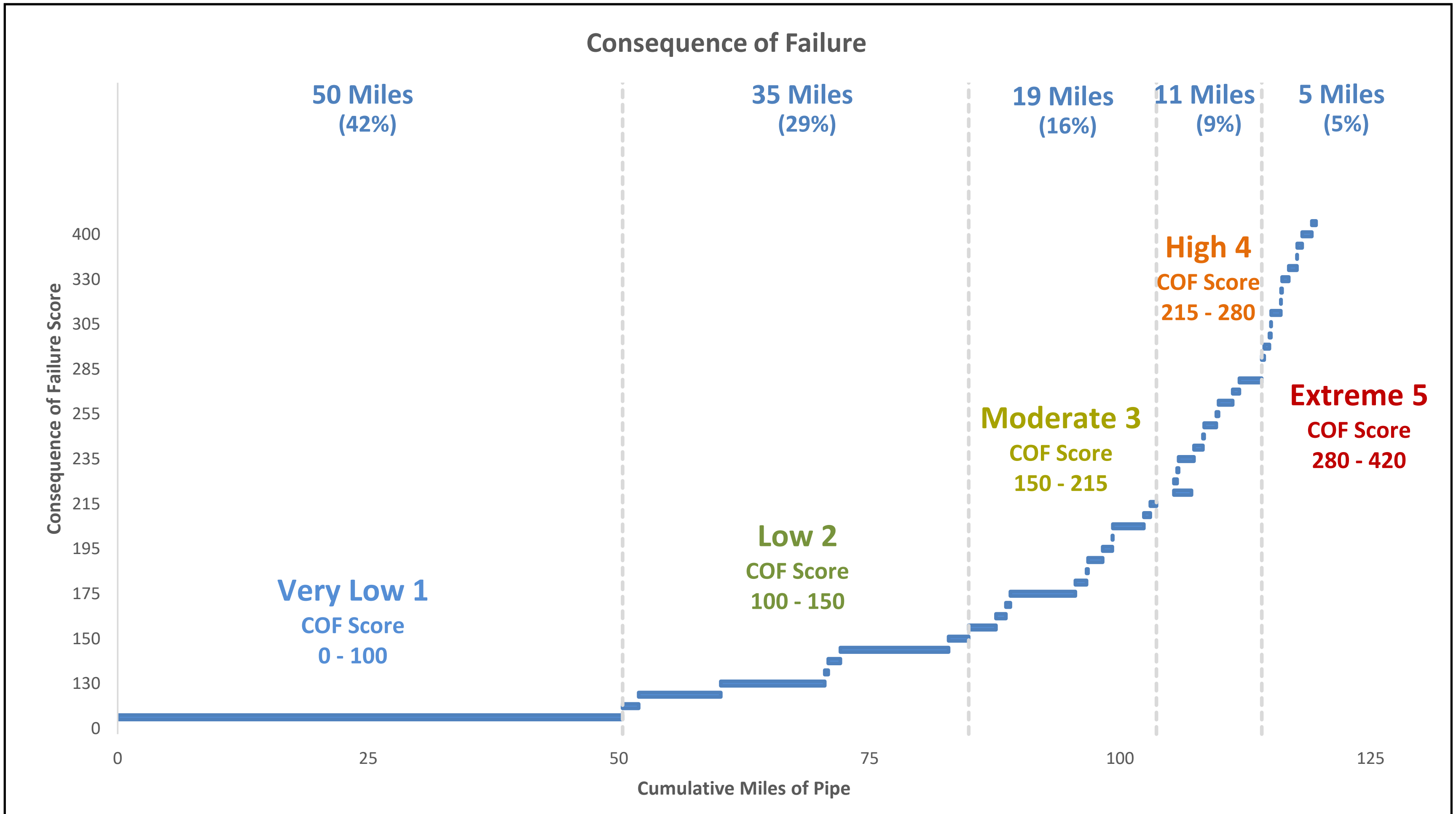
- **Low:** Pipelines with a COF score between 105 and 150 and a LOF score between 235 and 290 were categorized as Low risk. Approximately 42.9 miles of pipelines were categorized as Low risk, which represents 36 percent of all pipelines included in the risk assessment.

- **Moderate:** Pipelines with a COF score between 155 and 215 and a LOF score between 295 and 330 were categorized as Moderate risk. Approximately 21.9 miles of pipelines were categorized as Moderate risk, which represents 18 percent of all pipelines included in the risk assessment.

- **High:** Pipelines with a COF score between 220 and 280 and a LOF score between 335 and 350 categorized as High risk. Approximately 12.4 miles of pipelines were categorized as High risk, which represents 10 percent of all pipelines included in the risk assessment.

- **Extreme:** Pipelines with a COF score greater than 280 and a LOF score greater than 350 were categorized as Extreme risk. Approximately 6.0 miles of pipelines were categorized as Extreme risk, which represents 5 percent of all pipelines included in the risk assessment.

The results of the pipeline risk assessment are summarized on **Figure 8.4**, with results shown graphically on **Figures 8.5** and **Figure 8.6**. **Table 8.4** summarizes the total pipeline length by overall risk score and ranking. The high and extreme-risk pipelines represent the most critical assets in the system. Failure of these assets results in the largest impact to customer level of service. Overall, approximately 15 percent of the assessed pipes were determined to have high or extreme risk of failure.



LEGEND

March 10, 2022

Figure 8.2
Consequence of Failure
City-Wide Sewer System Master Plan
South San Francisco

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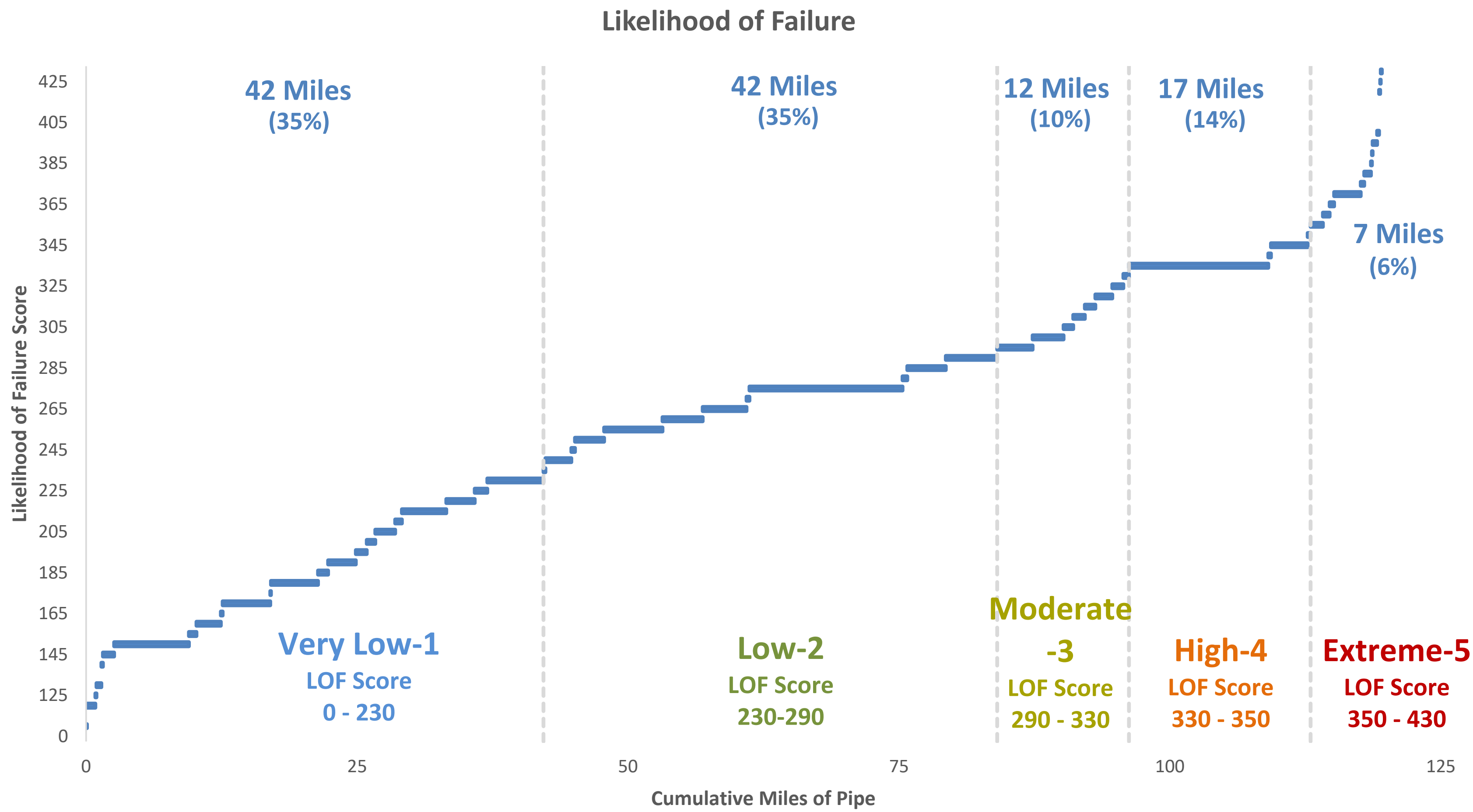

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Figure 8.3
Likelihood of Failure
City-Wide Sewer System Master Plan
South San Francisco

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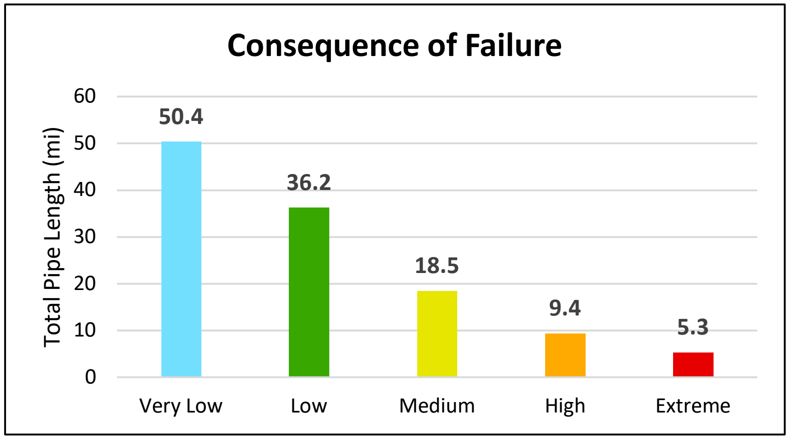

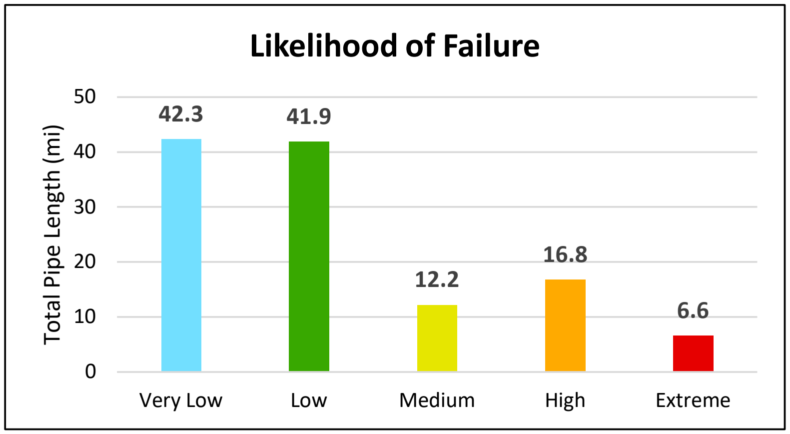

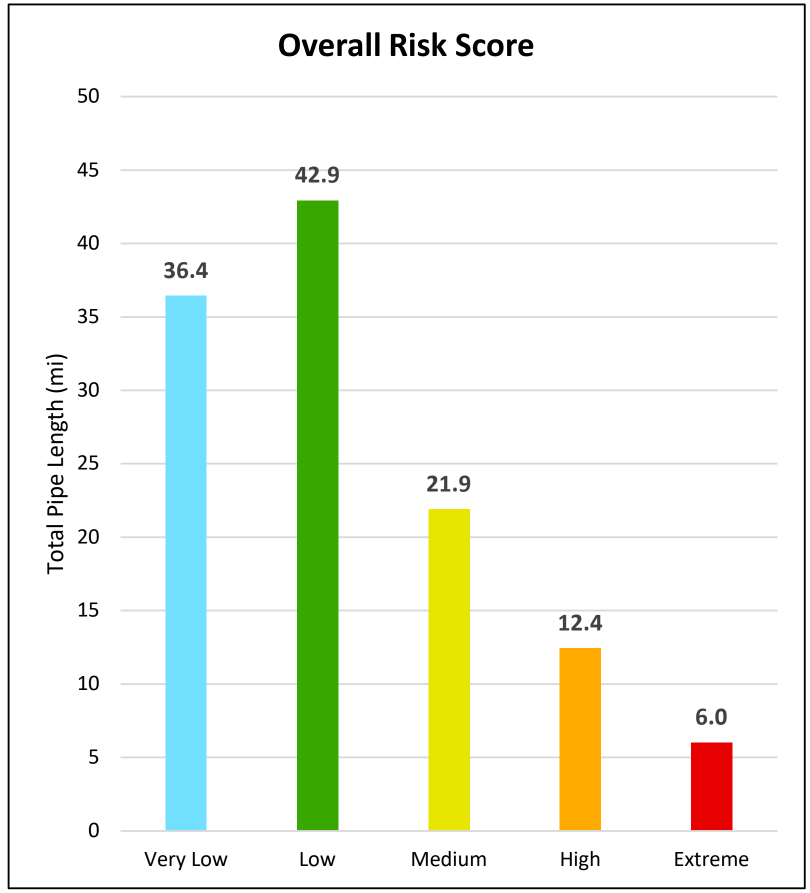

LEGEND

Risk Ranking, by Pipe

- Extreme
- High
- Moderate
- Low
- Very Low

March 10, 2022

Figure 8.4
Risk Assessment

City-Wide Sewer System Master Plan

City of South San Francisco

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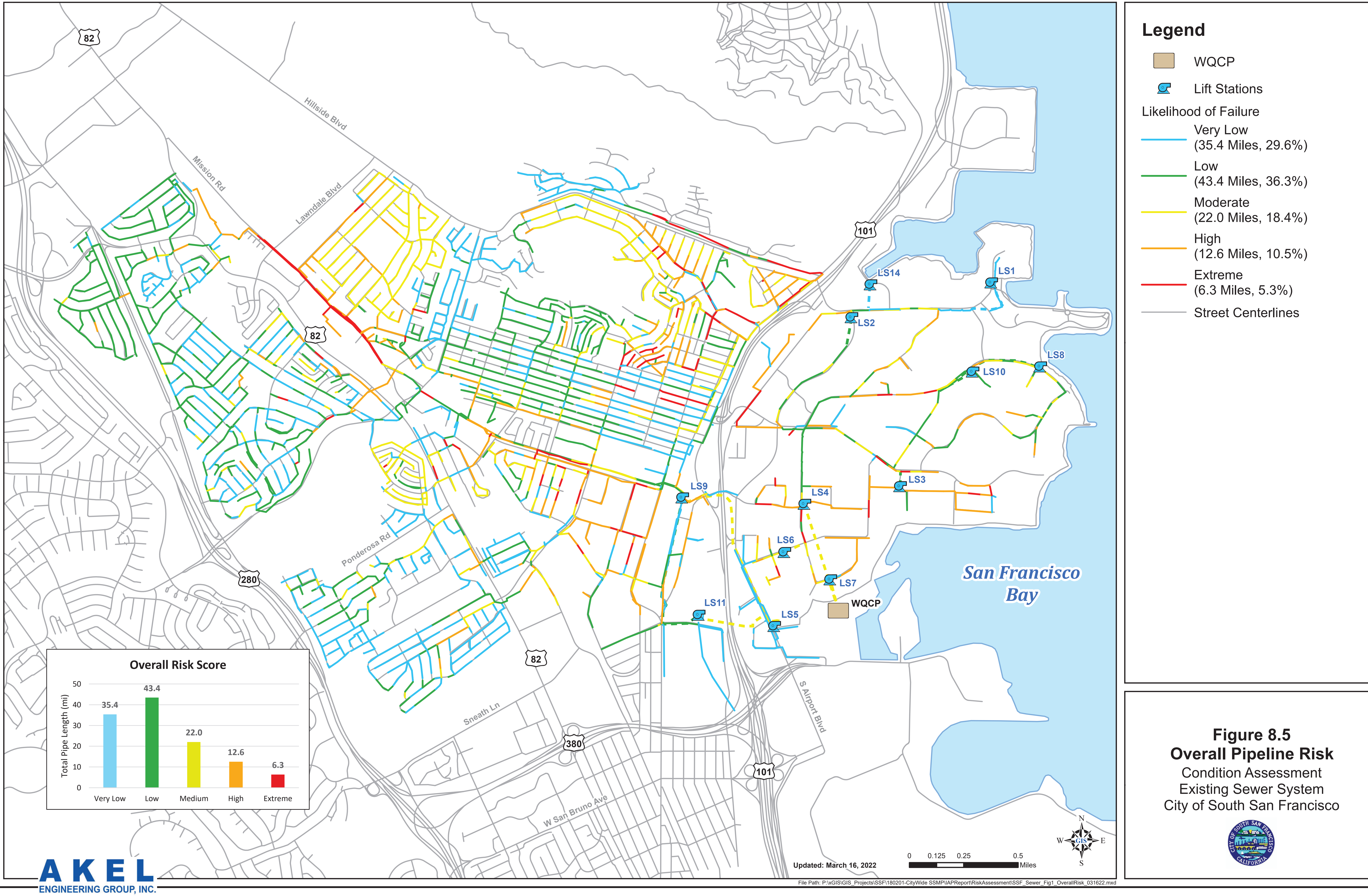
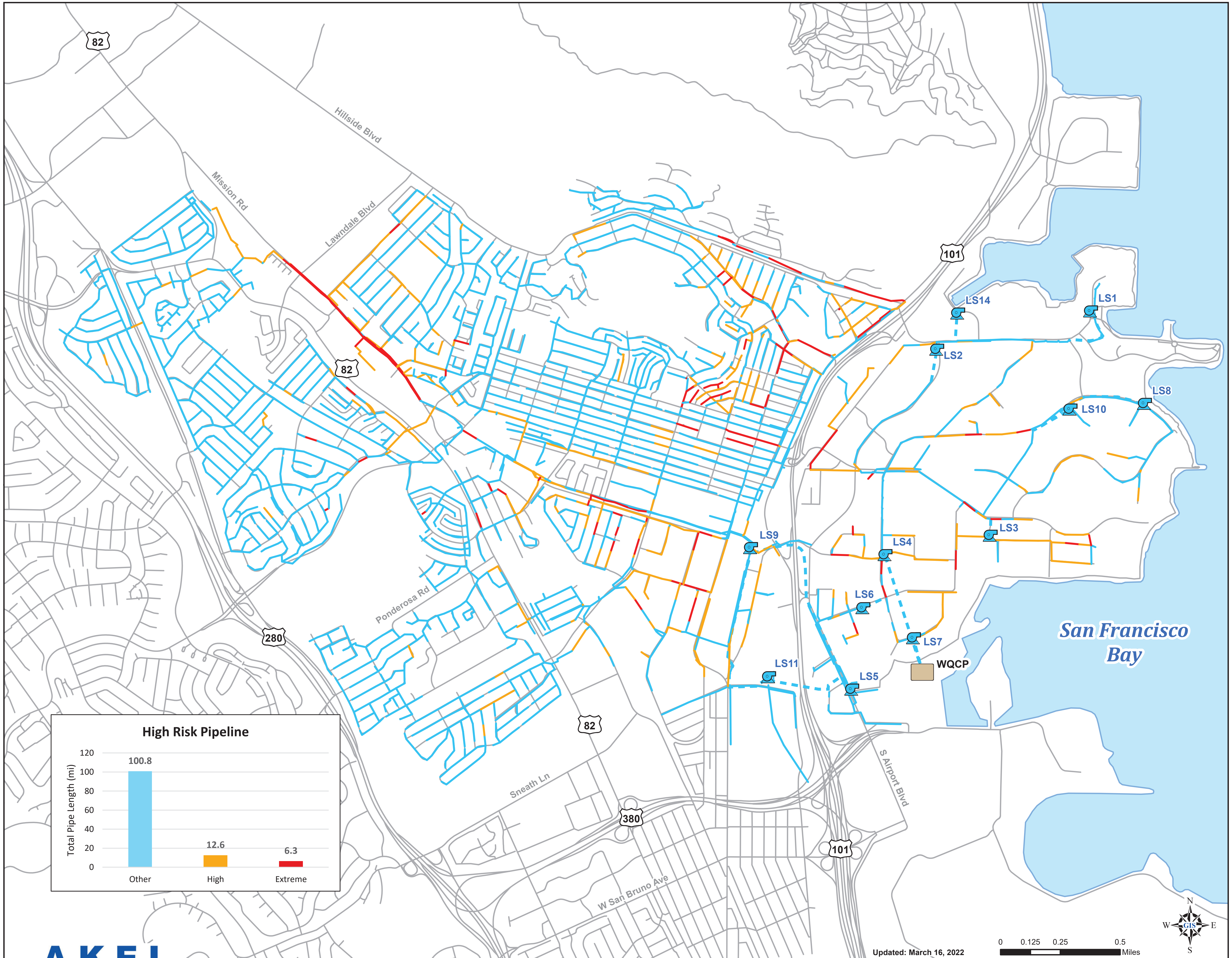


Figure 8.5
Overall Pipeline Risk
Condition Assessment
Existing Sewer System
City of South San Francisco



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WQCP

Lift Stations

Likelihood of Failure

Other (100.8 Miles, 84.2%)

High (12.6 Miles, 10.5%)

Extreme (6.3 Miles, 5.3%)

Street Centerlines

Figure 8.6
High Pipeline Risk
Condition Assessment
Existing Sewer System
City of South San Francisco

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File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\RiskAssessment\SSF_Sewer_Fig2_HighRisk_031622.mxd

Table 8.4 Total Pipe Length, by Risk Score

City-Wide Sewer System Master Plan
South San Francisco

Pipe Diameter	Total Pipe Length, by Risk Score					
	Very Low	Low	Medium	High	Extreme	Total
(in)	(mi)	(mi)	(mi)	(mi)	(mi)	(mi)
4	1.0	0.3	0.2	0.1	-	1.5
6	20.8	28.1	14.9	5.8	1.7	71.3
8	8.5	5.5	1.9	2.1	1.5	19.4
10	1.4	1.6	0.3	0.9	0.6	4.8
12	1.6	1.7	-	1.0	0.1	4.5
14	0.2	-	-	-	-	0.2
15	2.4	0.6	0.3	1.6	0.5	5.4
16	0.2	0.1	-	-	-	0.4
18	0.2	0.9	1.0	0.5	1.3	4.0
21	-	0.3	0.6	0.1	-	1.0
24	-	1.0	1.9	0.2	0.1	3.1
27	-	1.3	0.1	0.1	0.2	1.8
28	-	-	0.4	-	-	0.4
30	-	0.3	-	-	-	0.30
33	-	0.3	0.2	-	-	0.5
36	0.1	0.8	-	-	-	1.0
Total	**36.4**	**42.9**	**21.9**	**12.4**	**6.0**	**119.6**
	30%	**36%**	**18%**	**10%**	**5%**	

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3/10/2022

8.2.6 Recommendations

As part of the condition and risk assessment a capital project development matrix (**Figure 8.7**) was developed, which was used to determine both the specific pipelines recommended for renewal and the specific renewal method to be implemented. For ease of reference the project groupings are documented graphically on **Figure 8.8** while **Figure 8.9 - 8.17** document the specific improvements planned within each project group.

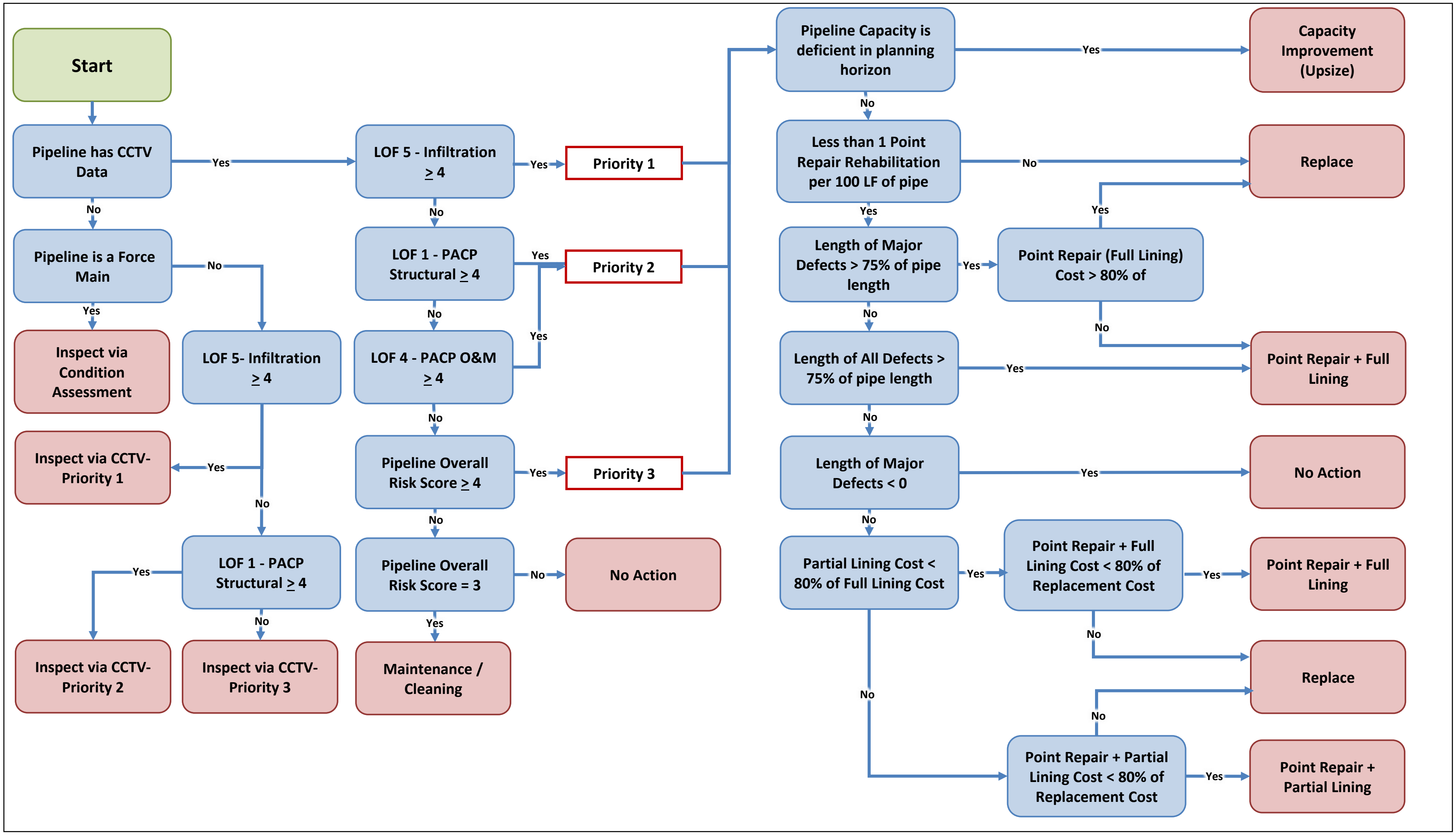
Each pipeline improvement has a unique improvement ID that includes abbreviations corresponding to the specific project group as well as the repair or rehabilitation method associated with each improvement. The abbreviations incorporated in the improvement IDs are briefly summarized as follows:

Improvement Group: The initial term in the improvement ID indicates the pipeline's improvement group, with values between 1 and 10.
Renewal Method: Improvement IDs include abbreviations indicating the renewal method being implemented, which includes: Replacement (RP), Repair with Full Lining (FR), Repair with Partial Lining (PR), gravity main condition assessment (CC), force main condition assessment (CA), or periodic maintenance / cleaning (M)

- **Replacement (RP)**: This includes replacing an existing pipeline by trenching along the existing pipeline alignment.
- **Point Repair with Full Lining (FR)**: This includes conducting point repairs on a defective existing pipeline and replacing the full lining.
- **Point Repair with Partial Lining (PR)**: This includes conducting point repairs on a defective existing pipeline and replacing the partial lining around the repaired defect.
- **Gravity Main Condition Assessment (CC)**: This includes performing new and periodic CCTV inspections for gravity mains. This is intended to determine if the failure rate is progressing.
- **Force Main Condition Assessment (CA)**: This includes performing leak detection or other means for force mains. This is intended to determine if the failure rate is progressing.
- **Periodic Maintenance (M)**: This includes periodic maintenance activities such as root removal or pipeline cleaning.
- **Improvement Number:** Each ID includes a unique number within each improvement group for improvement sequencing.

In addition to Improvement Groupings and Renewal Methods, pipelines were assigned a priority ranking based on the results of the Risk Assessment. The assigned priorities are briefly summarized as follow:

- **Priority 1**: This includes pipelines in sewer basins exceeding an R-Value of 20 percent. High RDII received the highest priority in order to aid the City in achieving at least



LEGEND

- Decision Point
- Renewal Choice
- Renewal Priority

Feburary 11, 2022

Figure 8.7
Decision Matrix
City-Wide Sewer System Master Plan
South San Francisco

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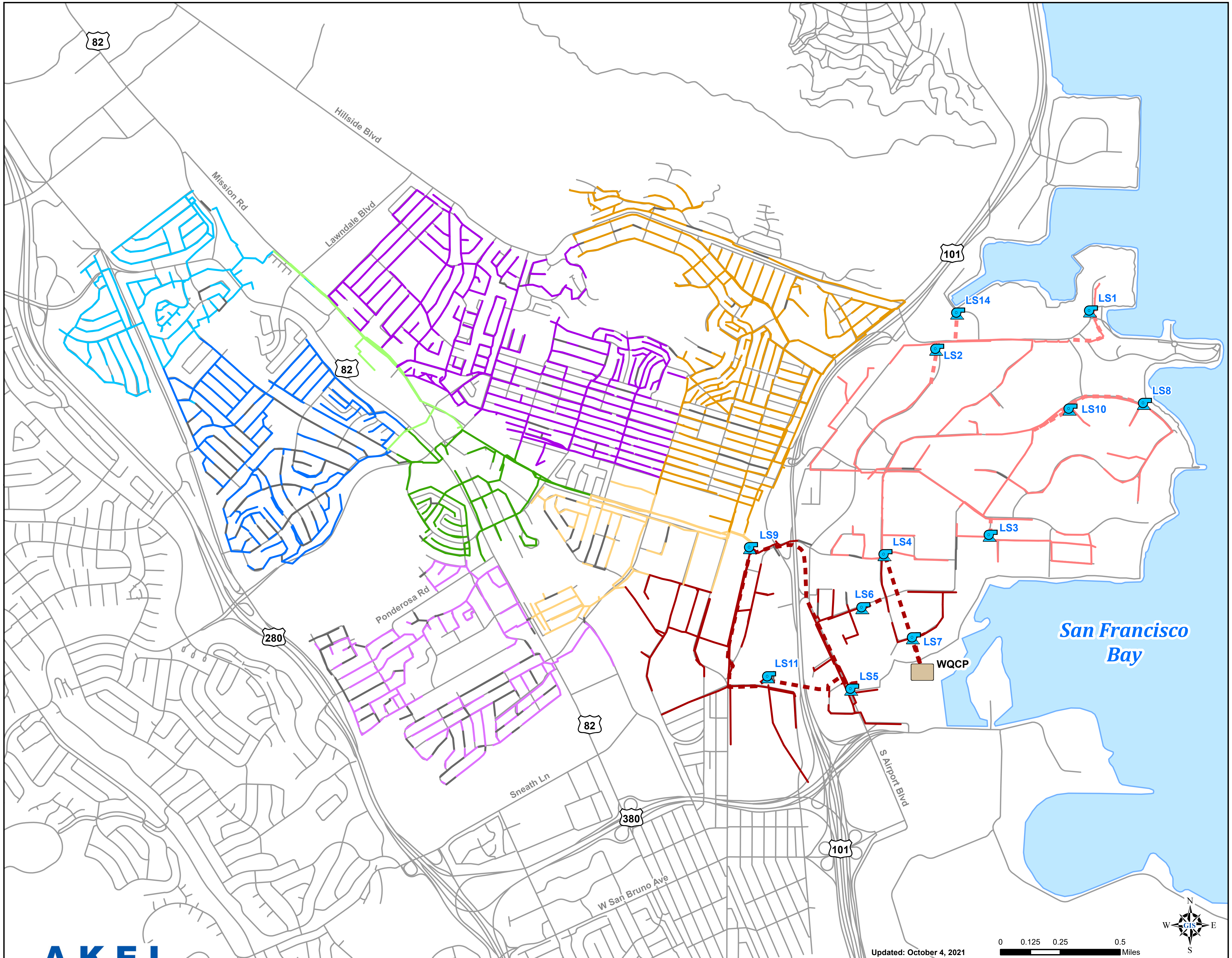

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WQCP

Lift Stations

Condition Assessment Grouping

- Group 1
- Group 2
- Group 3
- Group 4
- Group 5
- Group 6
- Group 7
- Group 8
- Group 9
- Group 10
- Force Main
- Existing Pipes
- Street Centerlines

Figure 8.8
Condition Assessment Improvements

City-Wide Sewer System
Master Plan
City of South San Francisco

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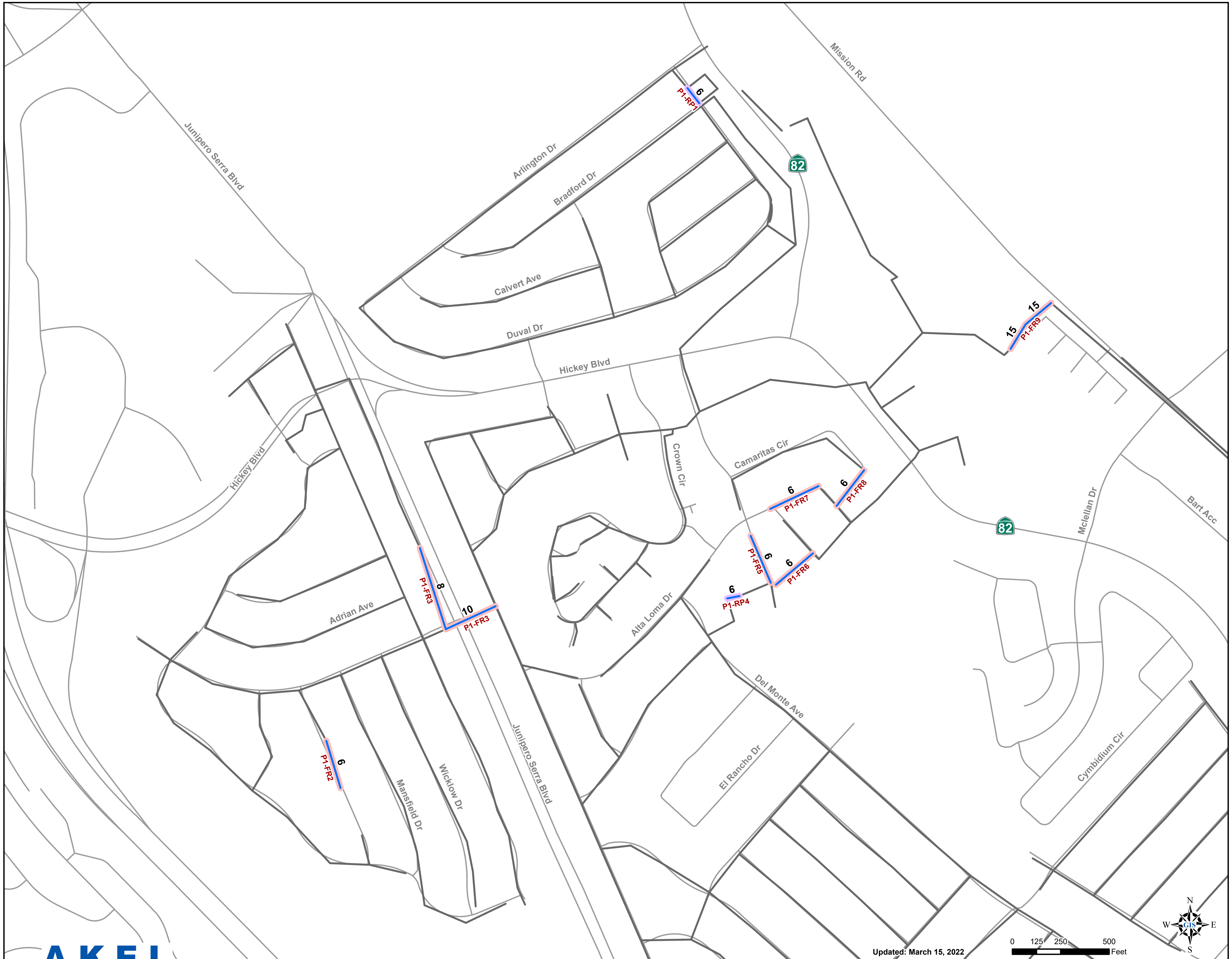

Legend

WQCP

Lift Stations

Improvement Needed

Pipes

Improvement Type

Repair & Full Lining

Replace

Existing Pipes

Street Centerlines

Figure 8.9
Group 1
Condition Assessment

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

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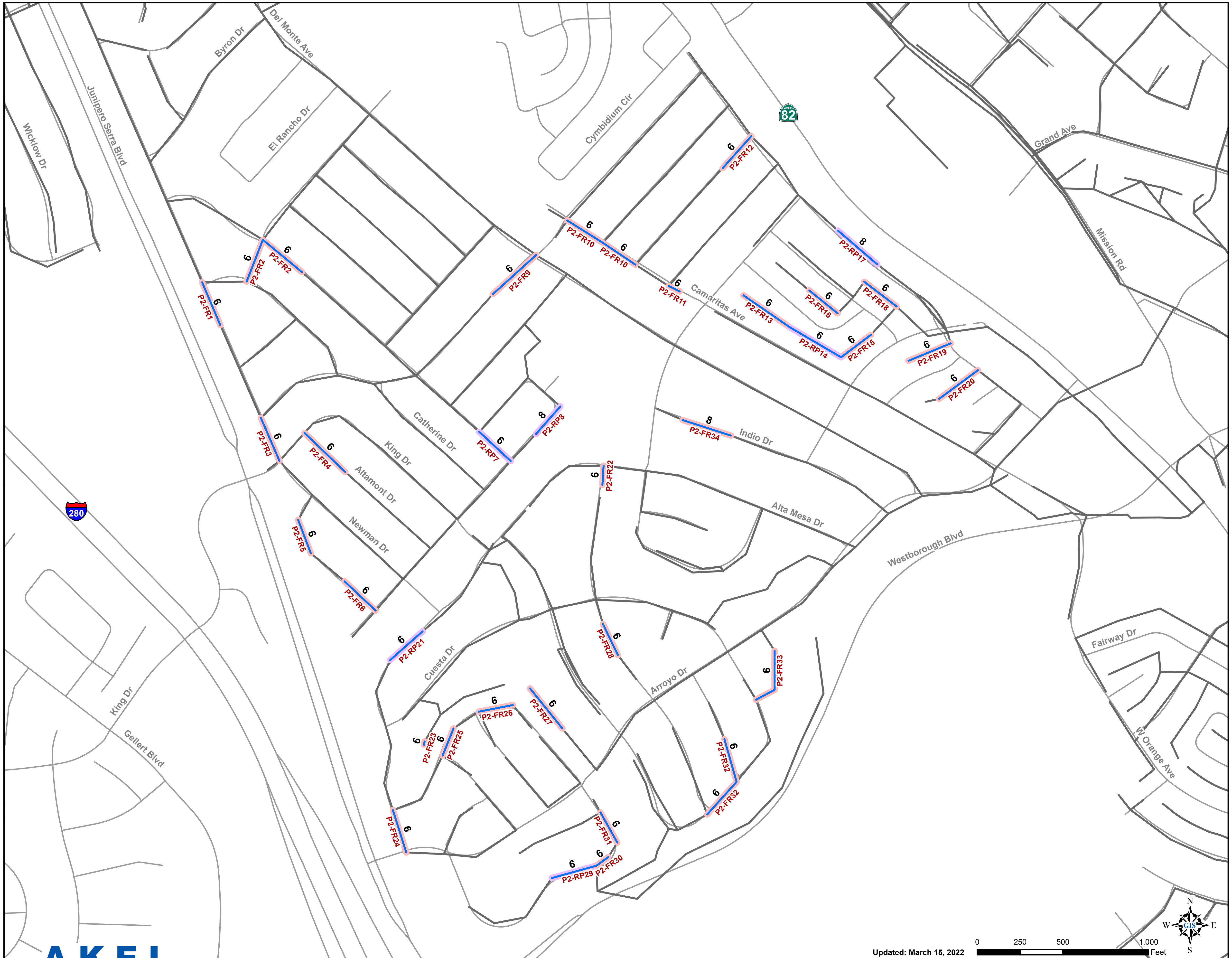


Legend

- WQCP
- Lift Stations

Improvement Needed

- Pipes

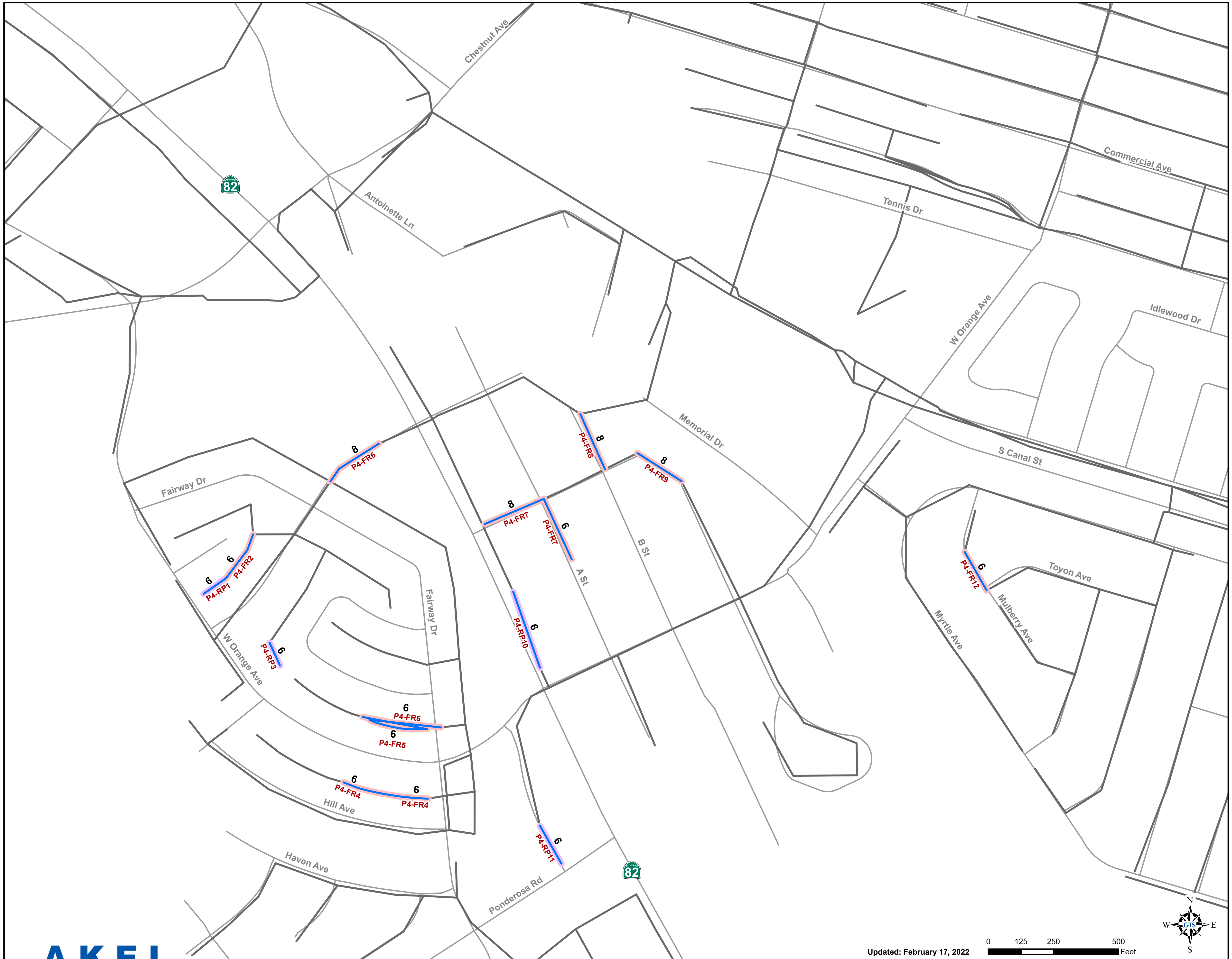
Improvement Type

- Repair & Full Lining
- Replace
- Existing Pipes
- Street Centerlines

Figure 8.10
Group 2
Condition Assessment
City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\ConditionAssessment\SSF_Group2_Improvements_031522.mxd



Legend

- WQCP
- Lift Stations

Improvement Needed

- Pipes

Improvement Type

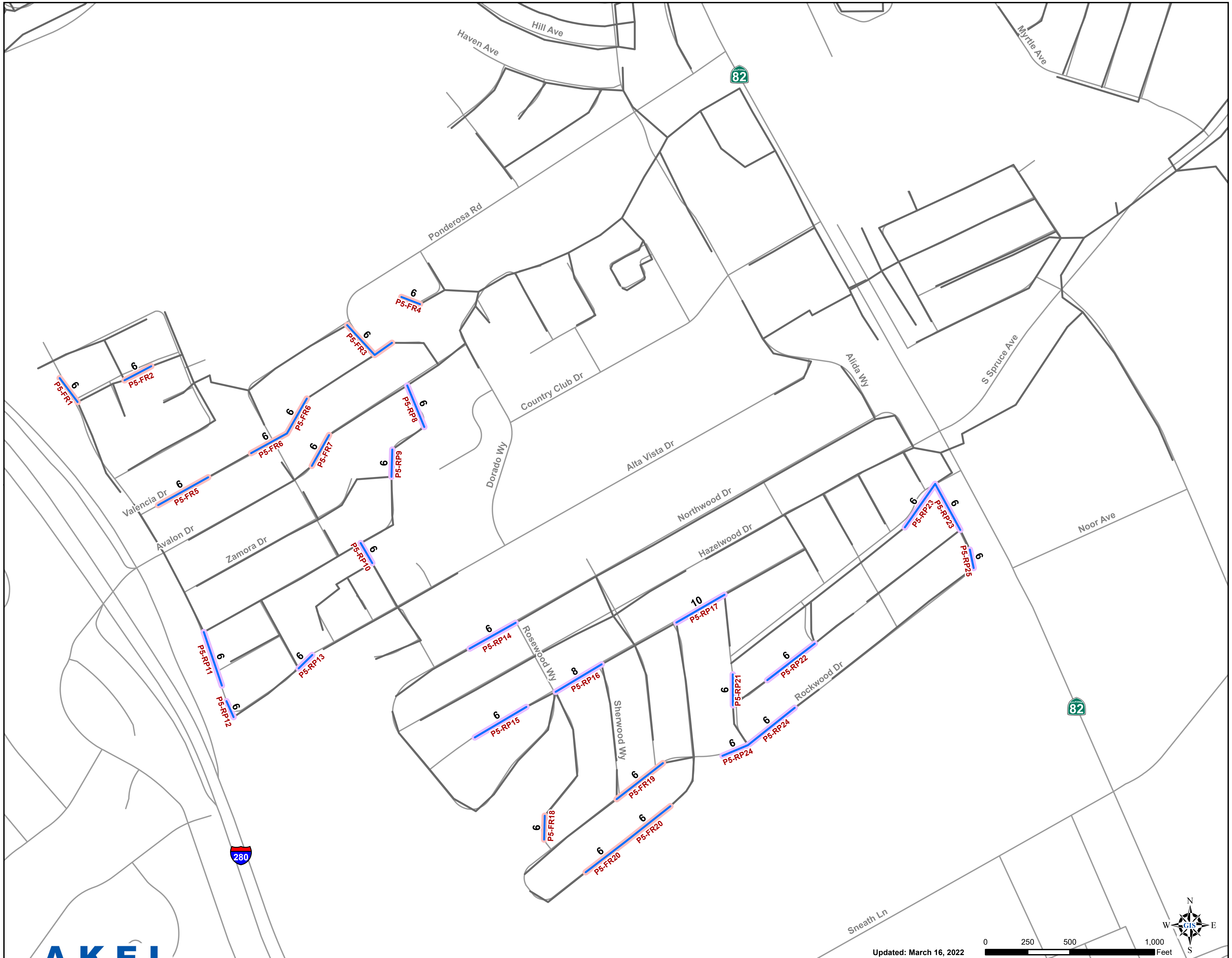
- Repair & Full Lining
- Replace
- Existing Pipes
- Street Centerlines

Figure 8.11
Group 4
Condition Assessment

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\ConditionAssessment\SSF_Group4_Improvements_031522.mxd



Legend

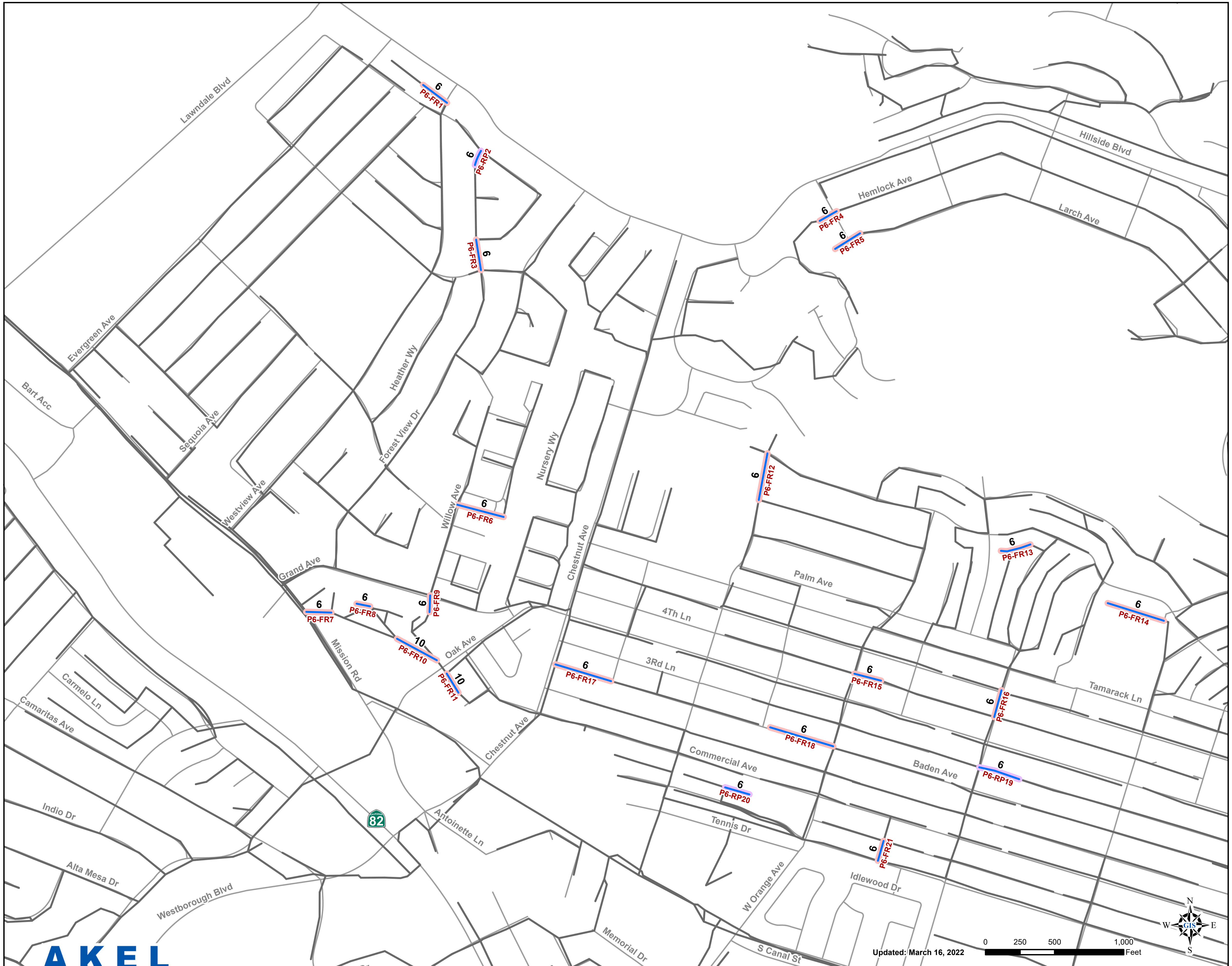
- WQCP
- Lift Stations
- Improvement Needed
- Pipes
- Improvement Type
- Repair & Full Lining
- Replace
- Existing Pipes
- Street Centerlines

Figure 8.12
Group 5
Condition Assessment

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\ConditionAssessment\SSF_Group5_Improvements_031622.mxd

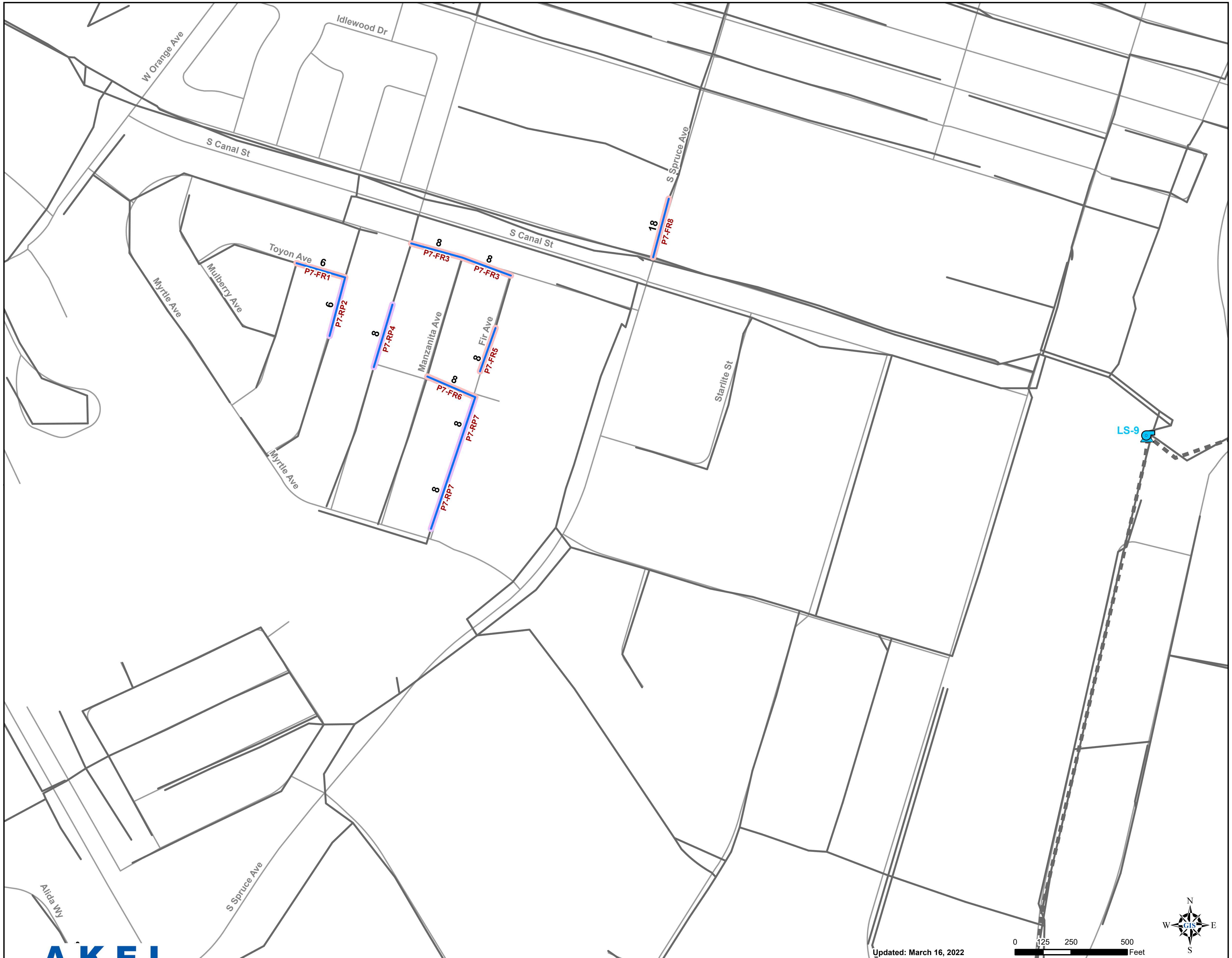


AKEL
ENGINEERING GROUP, INC.

Legend

- WQCP
- Lift Stations
- Improvement Needed
  - Pipes
- Improvement Type
  - Repair & Full Lining
  - Replace
- Existing Pipes
- Street Centerlines

Figure 8.13
Group 6
Condition Assessment
City-Wide Sewer System
Master Plan
City of South San Francisco



Legend

- WQCP
- Lift Stations

Improvement Needed

- Pipes

Improvement Type

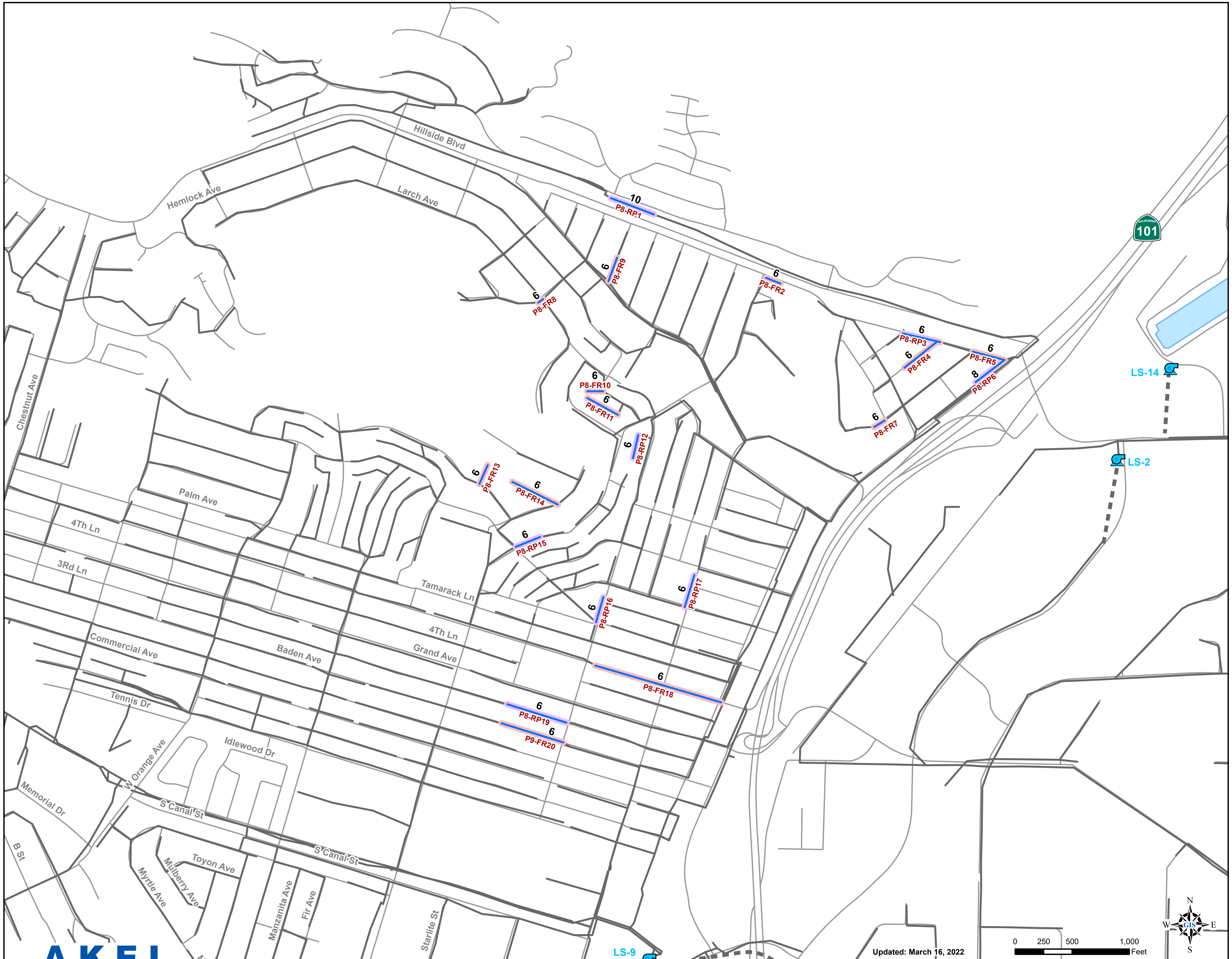
- Repair & Full Lining
- Replace
- Existing Pipes
- Street Centerlines

Figure 8.14
Group 7
Condition Assessment

City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\ConditionAssessment\SSF_Group7_Improvements_031622.mxd



Legend

- WQCP
- Lift Stations

Improvement Needed

- Pipes

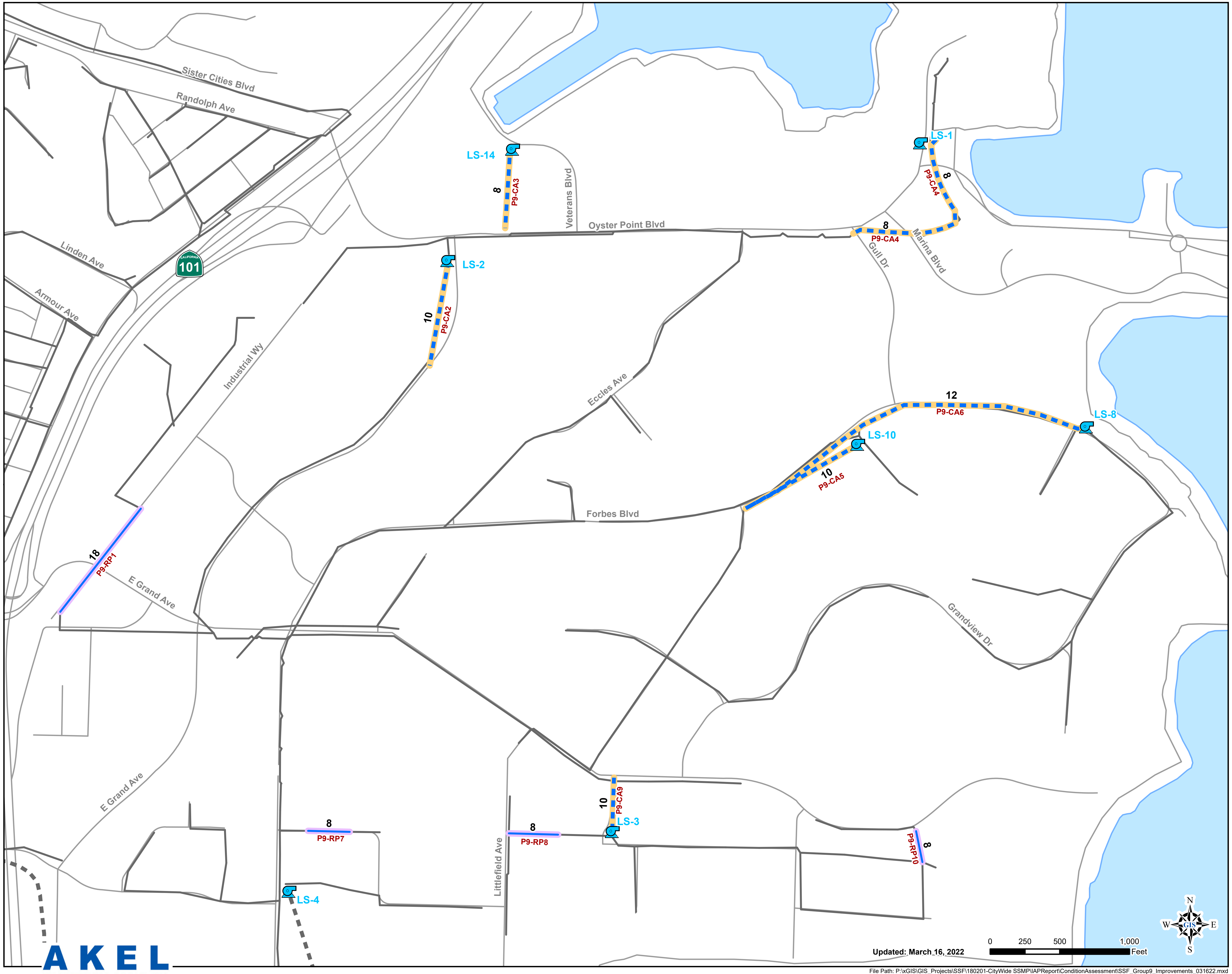
Improvement Type

- Replace
- Repair & Full Lining
- Existing Pipes
- Street Centerlines

Figure 8.15
Group 8
Condition Assessment
City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\IAPReport\ConditionAssessment\SSF_Group8_Improvements_031622.mxd



Legend

- WQCP
- Lift Stations

Improvement Needed

- Pipes

Improvement Type

- Condition Assessment
- Replace
- Existing Pipes
- Street Centerlines

Figure 8.16
Group 9
Condition Assessment

City-Wide Sewer System
Master Plan
City of South San Francisco

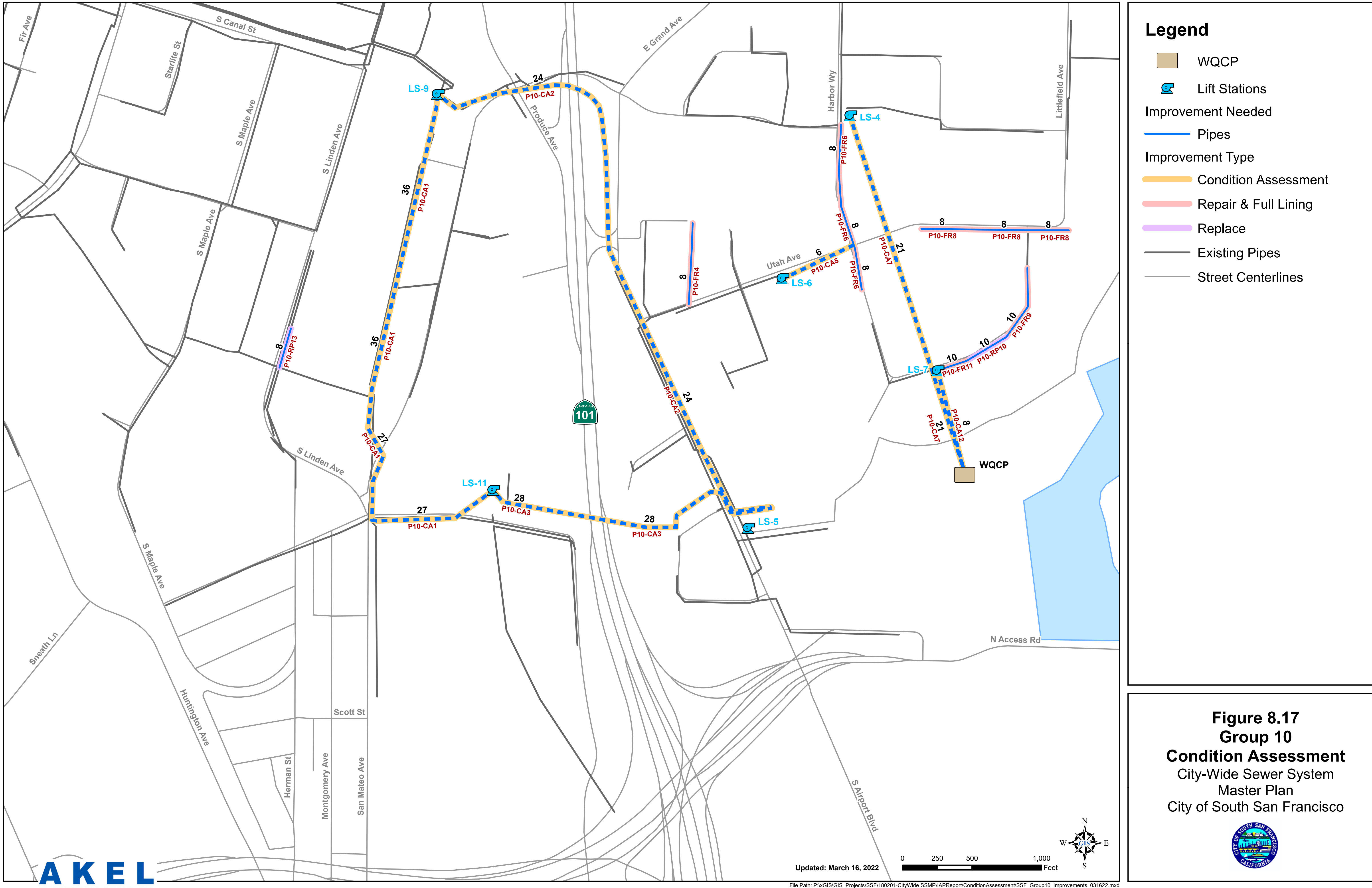


Figure 8.17
Group 10
Condition Assessment
City-Wide Sewer System
Master Plan
City of South San Francisco

20 percent I&I reduction within the next 20 years via their I&I Reduction Program.

- **Priority 2**: This includes pipelines with a PACP Structural score value greater than or equal to 4, or a PACP Operational and Maintenance score value greater than or equal to 4.
- **Priority 3**: This includes pipelines with an overall risk score value greater than or equal to 4.

8.2.6.1 *Pipeline Renewal Improvements*

The following section documents the pipeline renewal improvements identified as part of the condition assessment.

- **P1-RP1:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Duval Drive from 120 feet southwest of Arlington Drive to Elkwood Drive.
- **P1-FR2:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Clifden drive from 290 feet southwest of Clay Avenue to 420 feet northwest of Dundee Drive.
- **P1-FR3:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Junipero Serra Blvd/Clay Avenue from 170 feet east of Buxton Avenue to Newman Drive.
- **P1-RP4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Del Monte Avenue and Camaritas Avenue.
- **P1-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Camaritas Avenue from 70 feet south of Alta Loma Drive to 540 feet north of Del Monte Avenue.
- **P1-FR6:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Camaritas Avenue and McDonell Drive.
- **P1-FR7:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Alta Loma Drive from McDonell Drive to 125 feet northwest of Camaritas Circle.
- **P1-FR8:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Camaritas Circle from eastern corner of Camaritas Circle to Alta Loma Drive.
- **P1-FR9:** Conduct point repair with full lining replacement on the 15-inch gravity main located along ROW between Mission Road and Colma Creek.

- **P2-FR1:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Newman Drive from Keoncrest Drive to 270 feet northwest of Lamonte Avenue.
- **P2-FR2:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Romney Avenue/Serra Drive from Keoncrest Drive to 630 feet northwest of Lacrosse Avenue.
- **P2-FR3:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Newman Drive from King Drive to San Felipe Avenue.
- **P2-FR4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Altmont Drive from King Drive to 670 feet northwest of Southcliff Avenue.
- **P2-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Arbor Drive from 500 feet northwest of Southcliff Avenue to 175 feet southwest of Newman Drive.
- **P2-FR6:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Arbor Drive from Southcliff Avenue to 250 feet northwest of Southcliff Avenue.
- **P2-RP7:** Replace 6-inch gravity main located along Serra Drive from April Avenue to Southcliff Avenue.
- **P2-RP8:** Replace 8-inch gravity main located along Southcliff Avenue from where April Avenue becomes Southcliff Avenue to 200 feet northeast of Serra Drive.
- **P2-FR9:** Conduct point repair with full lining replacement on the 6-inch gravity main located along San Felipe Avenue from Del Monte Avenue to 650 feet northeast of Serra Drive.
- **P2-FR10:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Camaritas Avenue from San Felipe Avenue to Clara Avenue.
- **P2-FR11:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Camaritas Avenue from Los Flores Avenue to 150 feet northwest of El Campo Drive.
- **P2-FR12:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Clara Avenue from 750 feet northeast of Carmaritas Avenue to Alta Loma Drive.
- **P2-FR13:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Camaritas Avenue and Carmelo Lane.

- **P2-RP14:** Replace 6-inch gravity main located along ROW between Camaritas Avenue and Carmelo Lane.
- **P2-FR15:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Carmelo Lane and Del Paso Drive.
- **P2-FR16:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Carmelo Lane and Bonita Avenue.
- **P2-RP17:** Replace 8-inch gravity main located along Alta Loma Drive from 300 feet southeast of El Campo Drive to 500 feet northwest of Del Paso Drive.
- **P2-FR18:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Bonita Avenue and Alta Loma Dr.
- **P2-FR19:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Del Paso Drive and Hermosa Lane.
- **P2-FR20:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Hermosa Lane and Chico Court.
- **P2-RP21:** Replace 6-inch gravity main located along Alta Mesa drive from 110 feet southwest of Newman Drive to 380 feet northeast of intersection with Cuestra Drive.
- **P2-FR22:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Verano Drive from Alta Mesa Drive to 280 feet northwest of Tunitas Lane.
- **P2-FR23:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Cuestra Dr and Escanyo Dr.
- **P2-FR24:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Alta Mesa drive from Escanyo Drive to Arroyo Drive.
- **P2-FR25:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Escanyo Drive from Casey Drive to 165 feet west of Berenda Drive.
- **P2-FR26:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Escanyo Drive from Berenda Drive to 600 feet northwest of Arroyo Drive.
- **P2-FR27:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW east of Escanyo Drive to 300 feet northwest of Arroyo Drive.
- **P2-FR28:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Verano Drive from 145 feet south of Cuestra Drive to 340 feet northwest of Arroyo Drive .
- **P2-RP29:** Replace 6-inch gravity main located along Escanyo Drive from 340 feet south of Arroyo Drive to 440 feet southeast of Berenda Drive.

- **P2-FR30:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Escanyo Drive from 440 feet southeast of Berenda Drive to 390 feet west of Capay Circle.

- **P2-FR31:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Escanyo Drive from 190 feet south of Arroyo Drive to 250 feet north of Westborough Blvd.

- **P2-FR32:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Jacinto Lane from 415 feet south of Arroyo Drive to Verano Drive.

- **P2-FR33:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Arroyo Dr and Capay Circle.

- **P2-FR34:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Indio Drive from 170 feet east of El Campo Dr to 475 feet west of Del Paso Dr.

- **P4-RP1:** Replace 6-inch gravity main located along ROW between Hillcrest Court and Southwood Drive.

- **P4-FR2:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Hillcrest Ct and Southwood Dr.

- **P4-RP3:** Replace 6-inch gravity main located along ROW between Orange Avenue and Knoll Circle.

- **P4-FR4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Orange Avenue and Hill Avenue.

- **P4-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Knoll Circle and Orange Avenue.

- **P4-FR6:** Conduct point repair with full lining replacement on the 8-inch gravity main located along 1st St from 130 feet north of Fairway Drive to 100 feet west of El Camino Real.

- **P4-FR7:** Conduct point repair with full lining replacement on the 6-inch gravity main located along 2nd St/A St from El Camino Real to 400 feet northwest of Orange Avenue.

- **P4-FR8:** Conduct point repair with full lining replacement on the 8-inch gravity main located along B St from northernmost point of B St to 2nd street.

- **P4-FR9:** Conduct point repair with full lining replacement on the 8-inch gravity main located along ROW from 2nd St to C St.

- **P4-RP10:** Replace 6-inch gravity main located along El Camino Real from 300 feet southeast of 2nd St to 90 feet northwest of Orange Avenue.

- **P4-RP11:** Replace 6-inch gravity main located along Southwood Center from Ponderosa Road to 370 feet east of Hill Avenue.
- **P4-FR12:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Mulberry Avenue from 200 feet south of Mayfair Avenue to Toyon Avenue.
- **P5-FR1:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Valverde Drive from 100 feet south of Yellowstone Drive to Almanor Drive.
- **P5-FR2:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Almanor Avenue from 90 feet east of Tahoe Ct to 160 feet west of Yosemite Drive.
- **P5-FR3:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Ponderosa Road/Valencia Drive from Alhambra Road to 270 feet northwest of Granada Drive.
- **P4-FR4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Cornerwood Court and Ponderosa Road.
- **P5-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Valencia Drive from 120 feet east of Valverde Drive to 410 feet east of Alhambra Road.
- **P5-FR6:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Valencia Drive from 135 feet west of Alhambra Road to 450 feet west of Ponderosa Road.
- **P5-FR7:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Avalon Drive from 130 feet east of Alhambra Road to 540 feet west of Granada Drive.
- **P5-RP8:** Replace 6-inch gravity main located along Granada Drive from Avalon Drive to 530 feet northeast of Zamora Drive.
- **P5-RP9:** Replace 6-inch gravity main located along Granada Drive from 275 feet south of Avalon Drive to 250 feet east of Zamora Drive.
- **P5-RP10:** Replace 6-inch gravity main located along Conmur St from Granada drive to 300 feet northwest of Alta Vista Drive.
- **P5-RP11:** Replace 6-inch gravity main located along Valverde Drive from Granada Drive to 100 feet south of Corrido Way.
- **P5-RP12:** Replace 6-inch gravity main located along Valverde Drive from 190 feet south of Corrido Way to Alta Vista Drive.

- **P5-RP13:** Replace 6-inch gravity main located along Alta Vista Drive from Mira Vista Way to 140 feet west of De Nardi Way.
- **P5-RP14:** Replace 6-inch gravity main located along Northwood Drive from 250 feet east of Conmur St to Rosewood Way.
- **P5-RP15:** Replace 6-inch gravity main located along Wildwood Drive from 325 feet east of Briarwood Drive to 175 feet west of Rosewood Way.
- **P5-RP16:** Replace 8-inch gravity main located along Wildwood Drive from Rosewood Way to 220 feet west of Ravenwood Way.
- **P5-RP17:** Replace 10-inch gravity main located along Wildwood Drive from Greenwood Drive to Springwood Way.
- **P5-FR18:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Rosewood Way from 200 feet northeast of Rockwood Drive to 50 feet north of Rockwood Drive.
- **P5-FR19:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Rockwood Drive from Sherwood Way to 190 feet west of Greenwood Drive.
- **P5-FR20:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Greenwood Drive from 250 feet southeast of Rosewood Way to 310 feet southwest of Rockwood Drive.
- **P5-RP21:** Replace 6-inch gravity main located along Springwood Way from 100 feet south of Brentwood Drive to Manor Drive.
- **P5-RP22:** Replace 6-inch gravity main located along Manor Drive from 200 feet east of Springwood Way to Aptos Way.
- **P5-RP23:** Replace 6-inch gravity main located along Brentwood Drive/Rockwood Drive from 100 feet east of Mosswood way to Manor Drive.
- **P5-RP24:** Replace 6-inch gravity main located along Rockwood Drive from 170 feet east of Greenwood Drive to 750 feet southwest of Pinehurst Way.
- **P5-RP25:** Replace 6-inch gravity main located along Rockwood Drive from 570 feet east of Pinehurst Way to 120 feet south of Manor Drive.
- **P5-RP26:** Replace 6-inch gravity main located along Hazelwood Drive from 275 feet east of Rosewood Way to Ravenwood Way.
- **P6-FR1:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Holly Avenue and Evergreen Drive.

- **P6-RP2:** Replace 6-inch gravity main located along Forest View Drive from Morningside Avenue to 235 feet north of Iris Court.
- **P6-FR3:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Forest View Drive from Morningside Avenue to Crestwood Drive.
- **P6-FR4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Hemlock Avenue from 105 feet west of Lincoln St to 30 feet east of Lincoln St.
- **P6-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Larch Avenue from westernmost point of Larch Avenue to 100 feet east of intersection with Lincoln St.
- **P6-FR6:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Nora Way from Willow Avenue to Susie Way.
- **P6-FR7:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Mission Road and Grand Avenue.
- **P6-FR8:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Grand Avenue and Mission Road.
- **P6-FR9:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Oak Avenue and Grand Avenue.
- **P6-FR10:** Conduct point repair with full lining replacement on the 10-inch gravity main located along ROW 300 feet southwest of Willow Avenue to Oak Avenue.
- **P6-FR11:** Conduct point repair with full lining replacement on the 10-inch gravity main located along ROW from 50 feet southeast of Oak Avenue to 100 feet northwest of Daly Court.
- **P6-FR12:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Eucalyptus Avenue from Park Way to Cottonwood Avenue.
- **P6-FR13:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Poplar Avenue and Magnolia Avenue.
- **P6-FR14:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Telford Avenue and Elm Court.
- **P6-FR15:** Conduct point repair with full lining replacement on the 6-inch gravity main located along 4th lane from Orange Avenue to 200 feet west of Locust Avenue.
- **P6-FR16:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Magnolia Avenue from 4th Lane to Miller Avenue.

- **P6-FR17:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Baden Avenue beginning at Chestnut/Baden intersection to Laurel Avenue.
- **P6-FR18:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Baden Avenue begins at intersection of Acacia Avenue and Baden Avenue to Orange Avenue.
- **P6-RP19:** Replace 6-inch gravity main located along 3rd Lane from Magnolia Avenue to 750 feet west of Spruce Avenue.
- **P6-RP20:** Replace 6-inch gravity main located along ROW between Commercial Avenue and Circle Court.
- **P6-FR21:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Railroad Avenue 550 feet east of Orange Avenue to 1st Lane.
- **P7-FR1:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Toyon Avenue from Sycamore Avenue to Cherry Avenue.
- **P7-RP2:** Replace 6-inch gravity main located along Cherry Avenue from Toyon Avenue to 600 feet northeast of Myrtle Avenue.
- **P7-FR3:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Mayfair Avenue from S Magnolia Avenue to Fir Avenue.
- **P7-RP4:** Replace 8-inch gravity main located along Magnolia Avenue from 285 feet south of Mayfair Avenue to Redwood Avenue .
- **P7-FR5:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Fir Avenue 225 feet south of Mayfair Avenue to 115 feet north of Redwood Avenue.
- **P7-FR6:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Redwood Avenue from Manzanita Avenue to Fir Avenue.
- **P7-RP7:** Replace 8-inch gravity main located along Fir Avenue from Redwood Avenue to 50 feet north of Myrtle Avenue.
- **P7-FR8:** Conduct point repair with full lining replacement on the 18-inch gravity main located along S Spruce Avenue from N Canal St to 500 feet south of Railroad Avenue.
- **P8-RP1:** Replace 10-inch gravity main located along Sister Cities BLVD from 190 feet north of Franklin Avenue to 180 feet north of Drake Avenue.
- **P8-FR2:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Randolph Avenue from 150 feet north of Damonte Court to 640 feet northwest of Pecks Lane.

- **P8-RP3:** Replace 6-inch gravity main located along Randolph Avenue from Green Avenue to Madrone Avenue.
- **P8-FR4:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Madrone Avenue from Randolph Avenue to 155 feet northeast of Chapman Avenue.
- **P8-FR5:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Randolph Avenue from Gardiner Avenue to Airport Blvd.
- **P8-RP6:** Replace 8-inch gravity main located along Airport Blvd from 100 feet east of Randolph Avenue to 230 feet northeast of Butler Avenue.
- **P8-FR7:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW from Gardiner Avenue to 150 feet east of Pecks Lane.
- **P8-FR8:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Franklin Avenue from 25 feet west of Larch Avenue to Larch Avenue.
- **P8-FR9:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Edison Avenue from Hillside Blvd to 290 feet south of Randolph Avenue.
- **P8-FR10:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Beech Avenue and Hemlock Avenue.
- **P8-FR11:** Conduct point repair with full lining replacement on the 6-inch gravity main located along ROW between Beech Avenue and Hemlock Avenue.
- **P8-RP12:** Replace 6-inch gravity main located along ROW between Spruce Avenue and Maple Avenue.
- **P8-FR13:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Rocca Court from end of Rocca Court cul-de-sac to Rocca Avenue.
- **P8-FR14:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Cortesi Avenue from end of the Cortesi Avenue cul-de-sac to Telford Avenue.
- **P8-RP15:** Replace 6-inch gravity main located along Spruce Avenue from Park Way to 340 feet southwest of Cortesi Avenue.
- **P8-RP16:** Replace 6-inch gravity main located along Maple Avenue from 120 feet south of California Avenue to Lux Avenue.
- **P8-RP17:** Replace 6-inch gravity main located along Linden Avenue from California Avenue to 80 feet south of Pine Avenue.

- **P8-FR18:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Miller Avenue from 90 feet east of Maple Avenue to Cypress Avenue.
- **P8-RP19:** Replace 6-inch gravity main located along 3rd Lane 500 feet east of Spruce Avenue to Maple Avenue.
- **P8-FR20:** Conduct point repair with full lining replacement on the 6-inch gravity main located along Baden Avenue from 510 feet east of Spruce Avenue to Maple Avenue.
- **P9-RP1:** Replace 18-inch gravity main located along Poletti Way from E Grand Avenue to 630 feet west of Gateway Blvd.
- **P9-RP7:** Replace 8-inch gravity main located along E Harris Avenue from 200 feet east of Harbor Way to 200 feet west of Lawrence Avenue.
- **P9-RP8:** Replace 8-inch gravity main located along ROW between Littlefield Avenue and Swift Avenue.
- **P9-RP10:** Replace 8-inch gravity main located along ROW between E Grand Avenue and E Jamie Ct.
- **P10-FR4:** Conduct point repair with full lining replacement on the 8-inch gravity main located along ROW between Utah Avenue and S Airport Blvd.
- **P10-FR6:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Harbor Way from Mitchell Avenue to 700 feet north of Littlefield Avenue.
- **P10-FR8:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Utah Avenue from 500 feet east of Harbor Way to Littlefield Avenue.
- **P10-FR9:** Conduct point repair with full lining replacement on the 8-inch gravity main located along Littlefield Avenue from 270 feet south of Utah Avenue to 900 feet northeast of Harbor Way.
- **P10-RP10:** Replace 10-inch gravity main located along Littlefield Avenue from 780 feet southwest of Utah Avenue to 580 feet east of Harbor Way.
- **P10-FR11:** Conduct point repair with full lining replacement on the 10-inch gravity main located along Littlefield Avenue from 350 feet east of Harbor Way to 575 feet east of Harbor Way.
- **P10-RP13:** Replace 8-inch gravity main located along S Linden Avenue from 675 feet northwest of Dollar Avenue to 700 feet south of Victory Avenue.

8.2.6.2 *Pipeline Condition Assessment Recommendations*

The following section documents the pipeline renewal improvements identified as part of the condition assessment.

- **P9-CA2:** Conduct condition assessment on the 10-inch force main located along ROW between Oyster Point Blvd and Gateway Blvd.
- **P9-CA3:** Conduct condition assessment on the 8-inch force main located along ROW between Oyster Point Blvd and Veterans Blvd.
- **P9-CA4:** Conduct condition assessment on the 8-inch force main located along ROW from Gull Drive to 200 feet north of San Francisco Bay Trail.
- **P9-CA5:** Conduct condition assessment on the 10-inch force main located along Forbes Blvd from Allerton Avenue to 2300 feet northwest of DNA Way.
- **P9-CA6:** Conduct condition assessment on the 12-inch force main located along Forbes Blvd from Allerton Avenue to 850 feet northwest of DNA Way.
- **P9-CA9:** Conduct condition assessment on the 10-inch force main located along Kimball Way from E Grand Avenue to 100 feet north of Swift Avenue.
- **P10-CA1:** Conduct condition assessment on the 36-inch force main located along Lowrie Avenue from LS-9 to LS-11.
- **P10-CA2:** Conduct condition assessment on the 24-inch force main located along ROW from LS-9 to LS-5.
- **P10-CA3:** Conduct condition assessment on the 28-inch force main located along ROW from LS-11 to LS-5.
- **P10-CA5:** Conduct condition assessment on the 6-inch force main located along Utah Avenue from Colma Creek to Harbor Way.
- **P10-CA7:** Conduct condition assessment on the 21-inch force main located along ROW from 100 feet east of Mitchell Avenue to WQCP.
- **P10-CA12:** Conduct condition assessment on the 8-inch force main located along ROW from Littlefield Avenue to WQCP.

8.2.6.3 *Pipeline Closed Circuit Television Recommendations*

As part of the condition assessment, pipelines with no CCTV inspection data (73 percent of the sewer collection system) were identified and grouped by priority to aid the City in establishing a plan to CCTV the remainder of the system. Priorities are consistent with the rehab action priorities documented in Chapter 8 Section 2.6. CCTV priorities are shown graphically on **Figure 8.18.**

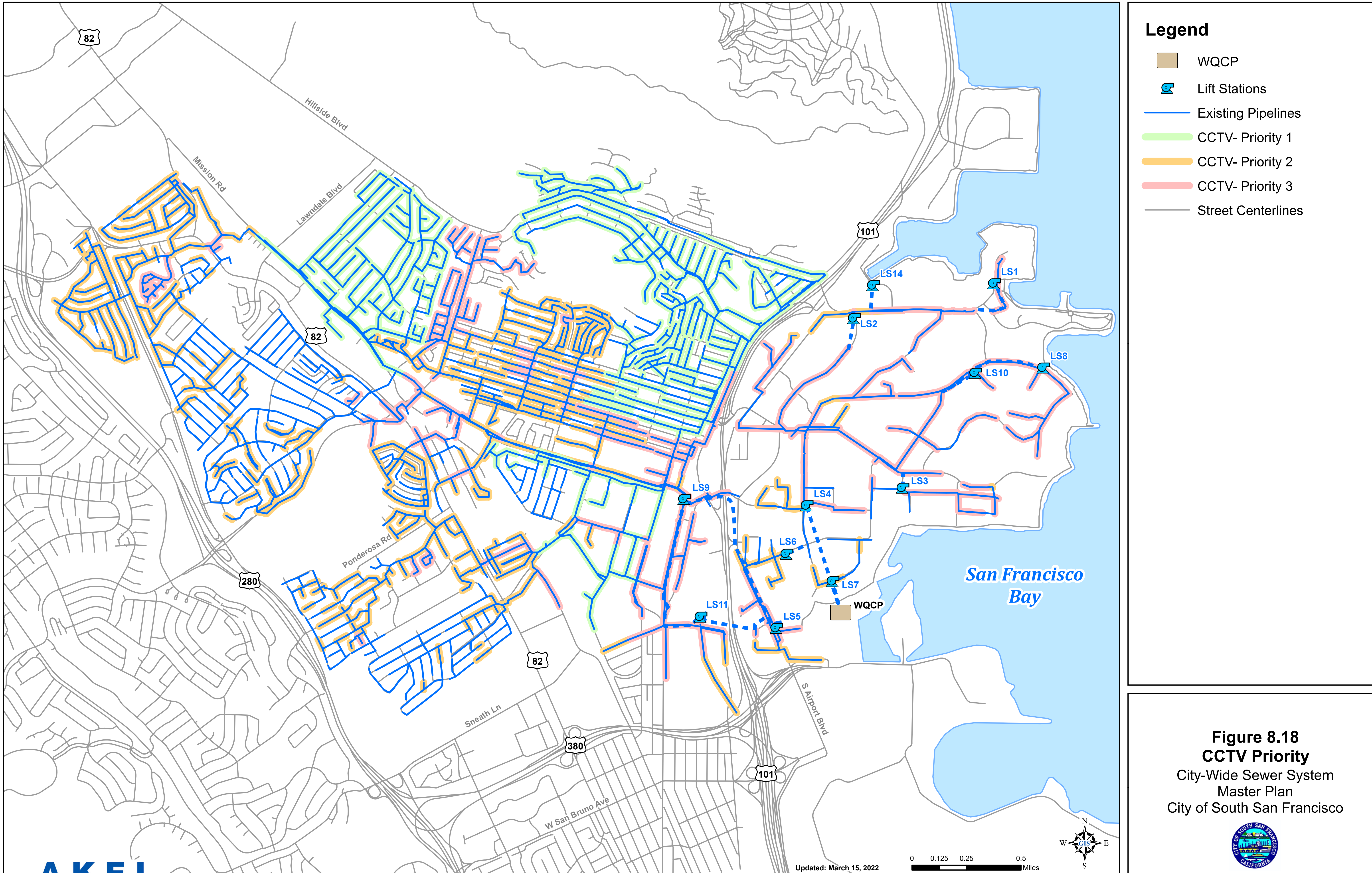


Figure 8.18
CCTV Priority
City-Wide Sewer System
Master Plan
City of South San Francisco

AKEL ENGINEERING GROUP, INC.

File Path: P:\xGIS\GIS_Projects\SSF\180201-CityWide SSMP\APReport\ConditionAssessment\SSF_Fig1_CCTVPriority_031522.mxd

CHAPTER 9 - CAPITAL IMPROVEMENT PROGRAM

This chapter provides a summary of the recommended Capital Improvement Program (CIP) for the City of South San Francisco sewer collection system. The program is based on the evaluation of the City's sewer collection system and on the recommended projects described in the previous chapters. The CIP has been prepared to assist the City in planning and constructing the collection system improvements through the ultimate buildout scenario. This chapter also presents the cost criteria and methodologies for developing the capacity improvement costs.

9.1 COST ESTIMATE ACCURACY

Cost estimates presented in the capacity improvement costs were prepared for general master planning purposes and, where relevant, for further project evaluation. Final costs of a project will depend on several factors including the final project scope, costs of labor and material, and market conditions during construction.

The Association for the Advancement of Cost Engineering (AACE International), formerly known as the American Association of Cost Engineers, has defined three classifications. These classifications are presented in order of increasing accuracy: Order of Magnitude, Budget, and Definitive.

- **Order of Magnitude Estimate.** This classification is also known as an "original estimate", "study estimate", or "preliminary estimate", and is generally intended for master plans and studies.

  This estimate is not supported with detailed engineering data about the specific project, and its accuracy is dependent on historical data and cost indices. It is generally expected that this estimate would be accurate within -30 percent to +50 percent.

- **Budget Estimate.** This classification is also known as an "official estimate" and generally intended for pre-design studies. This estimate is prepared to include flow sheets and equipment layouts and details. It is generally expected that this estimate would be accurate within -15 percent to +30 percent.

- **Definitive Estimate.** This classification is also known as a "final estimate" and prepared during the time of contract bidding. The data includes complete plot plans and elevations, and equipment data sheets, and complete specifications. It is generally expected that this estimate would be accurate within -5 percent to +15 percent.

Costs developed in this study should be considered "Order of Magnitude" and have an expected accuracy range of **-30 percent** and **+50 percent**.

9.2 COST ESTIMATE METHODOLOGY

Cost estimates presented in this chapter are opinions of probable construction and other relevant costs developed from several sources including cost curves, Akel experience on other master planning projects, and input from City staff on the development of public and private cost sharing. Where appropriate, costs were escalated to reflect the more current Engineering News Records (ENR) Construction Cost Index (CCI).

This section documents the unit costs used in developing the opinion of probable construction costs, the Construction Cost Index, the land acquisition costs, and markups to account for construction contingency and other project related costs.

9.2.1 Unit Costs

The unit cost estimates used in developing the Capital Improvement Program are summarized on **Table 9.1**. The unit costs are intended for developing the Order of Magnitude estimate, and do not account for site specific conditions, labor or material costs during the time of construction, final project scope, implementation schedule, detailed utility and topography surveys, investigation of alternative routings for pipes, and other various factors. These factors are assumed included in the contingencies applied to the final capital improvement cost.

The unit costs include:

- **Pipeline Unit Costs**: These costs vary by pipeline size (up to 48 inches in diameter) and are based on the length of pipe, in linear feet. Costs were estimated for replacement as well as various rehabilitation and condition assessment methods.
- **Manhole Replacement and Rehabilitation Costs:** These costs were approximated based on information from comparable projects, and consist of a flat cost for either replacing or rehabilitating existing manholes.
- **Pump Station Costs:** These costs are based on a pump station project equation, and were adjusted to reflect the current ENR CCI.

9.2.2 Construction Cost Index

Costs estimated in this study are adjusted utilizing the ENR CCI, which is widely used in the engineering and construction industries.

The costs in this master plan were benchmarked using the City of San Francisco ENR CCI of 15,327, reflecting a date of June 2022.

9.2.3 Construction Contingency Allowance

Knowledge about site-specific conditions for each proposed project is limited at the master planning stage; therefore construction contingencies were used. The estimated construction costs

Table 9.1 Unit Costs

City-Wide Sewer System Master Plan
South San Francisco

Pipeline Replacement and Renewal						
Pipe Size	Improvement Type Unit Cost					
	New/Parallel/ Replace	Pipe Bursting	Lining	Force Main Condition Assessment	CCTV	Cleaning
(in)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)	($/Linear Foot)
4	$289	$62	$15	$6.7	$2.7	$2.3
6	$271	$107	$22	$6.7	$2.7	$2.3
8	$334	$145	29.63	$6.7	$2.7	$2.3
10	$390	$167	$37	$6.7	$2.7	$2.3
12	$446	$177	$44	$6.7	$2.7	$2.3
14	$519	$180	$52	$6.7	$2.7	$2.3
15	$556	$181	$56	$6.7	$2.7	$2.3
16	$593	$201	$59	$6.7	$2.7	$2.3
18	$668	$221	$67	$6.7	$2.7	$2.3
21	$780	$160	$105	$6.7	$2.7	$2.3
24	$836	$141	$143	$6.7	$2.7	$2.3
27	$890	$159	$181	$6.7	$2.7	$2.3
28	$937	$164	$194	$6.7	$2.7	$2.3
30	$1,005	$176	$219	$6.7	$2.7	$2.3
33	$1,097	$194	$257	$6.7	$2.7	$2.3
36	$1,188	$212	$295	$6.7	$2.7	$2.3
42	$1,372	$169	$371	$6.7	$2.7	$2.3
48	$1,554	$283	$448	$6.7	$2.7	$2.3

Manhole Replacement and Rehabilitation[4]

Manhole Rehabilitation is estimated to cost approximately $4,350 per manhole

Manhoe Replacement is estimated to cost approximately $32,800 per manhole

Lift Stations

Estimated Pump Station Project Cost = 1,914,694*$Q^{0.60}$ (where Q is in mgd)

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7/11/2022

Notes:

1. Units Costs are based on an ENR CCI Index Value of 15,327 June 2022.
2. Units Costs for Pipe Bursting are based on study of underground construction costs.
3. Units Costs for Lining are based on a USDA summary of trenchless technology.
4. Unit Costs for Manhole Replacement and Rehabilitation are based on bid sheets for comparable projects.

in this master plan include a **30 percent** contingency allowance to account for unforeseen events and unknown field conditions.

9.2.4 Project Related Costs

The capital improvement costs also account for project-related costs, comprising of engineering design, project administration (developer and City staff), construction management and inspection, and legal costs. The project related costs in this master plan were estimated by applying an additional **50 percent** to the estimated construction costs.

9.3 CAPITAL IMPROVEMENT PROGRAM

The Capital Improvement Costs for the previously identified projects, shown on **Figure 9.1** and **Figure 9.2** are summarized on **Table 9.2** and **Table 9.3** respectively. The Capital Improvement Program lists the type of improvement, location, cost, construction triggers, suggested phasing, and cost sharing.

9.3.1 Pipelines

The recommended pipeline improvements are grouped by collection trunk and basin, and listed on **Table 9.2** and **Table 9.3**. Each improvement includes a general description of the street alignment and limits as well as existing pipe diameter and length.

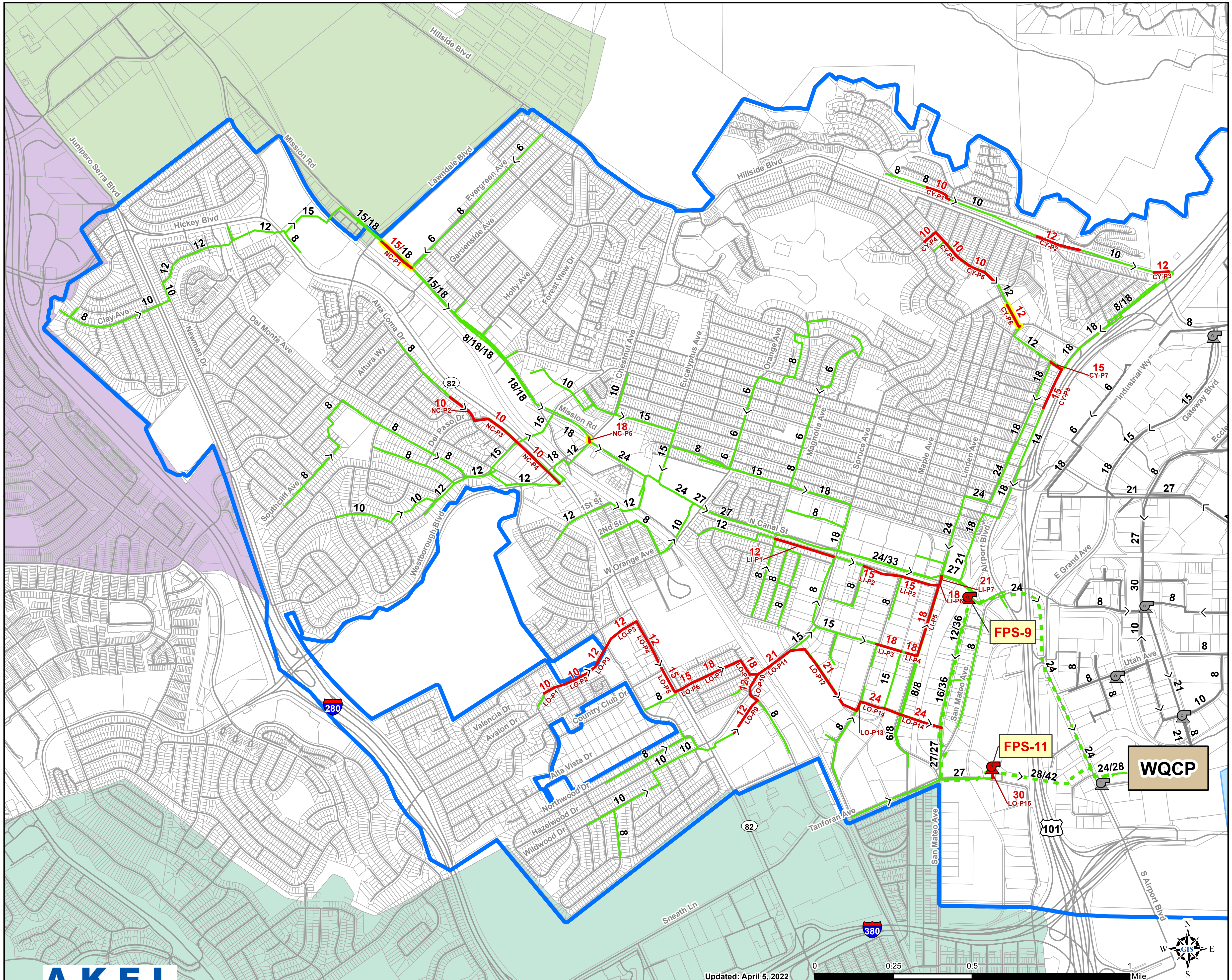
The following two pipeline improvements categories were identified:

- **New Pipeline.** The new pipeline is proposed where none exists.
- **Capacity Replacement Pipeline.** This improvement is intended as a replacement to an existing pipeline and along the same alignment. The existing pipeline should be abandoned when the replacement pipeline has been constructed. For pipeline replacements recommended to mitigate an existing adverse slope deficiency, a +50 percent contingency has been added to the baseline construction cost to account for additional costs for extending the pipeline length upstream or downstream, and adding manholes, to gain a positive slope.

The opinion of probable construction costs, for the projects included in this master plan, are based on the pipe unit costs summarized on **Table 9.1**. It is assumed that any replacement pipes will be in the same alignment and the same slope as the existing pipe, except in the cases where the improvement is meant to mitigate existing pipe deficiencies and comply with minimum slope design criteria. However, this study recommends an investigation of the alignment during the pre-design stage of each project.

9.3.2 Pump Stations

The recommended pump station improvements are also shown on **Table 9.2** and **Table 9.3**. The table lists the approximate location of the pump station, the anticipated capacity upgrade, and the



Legend

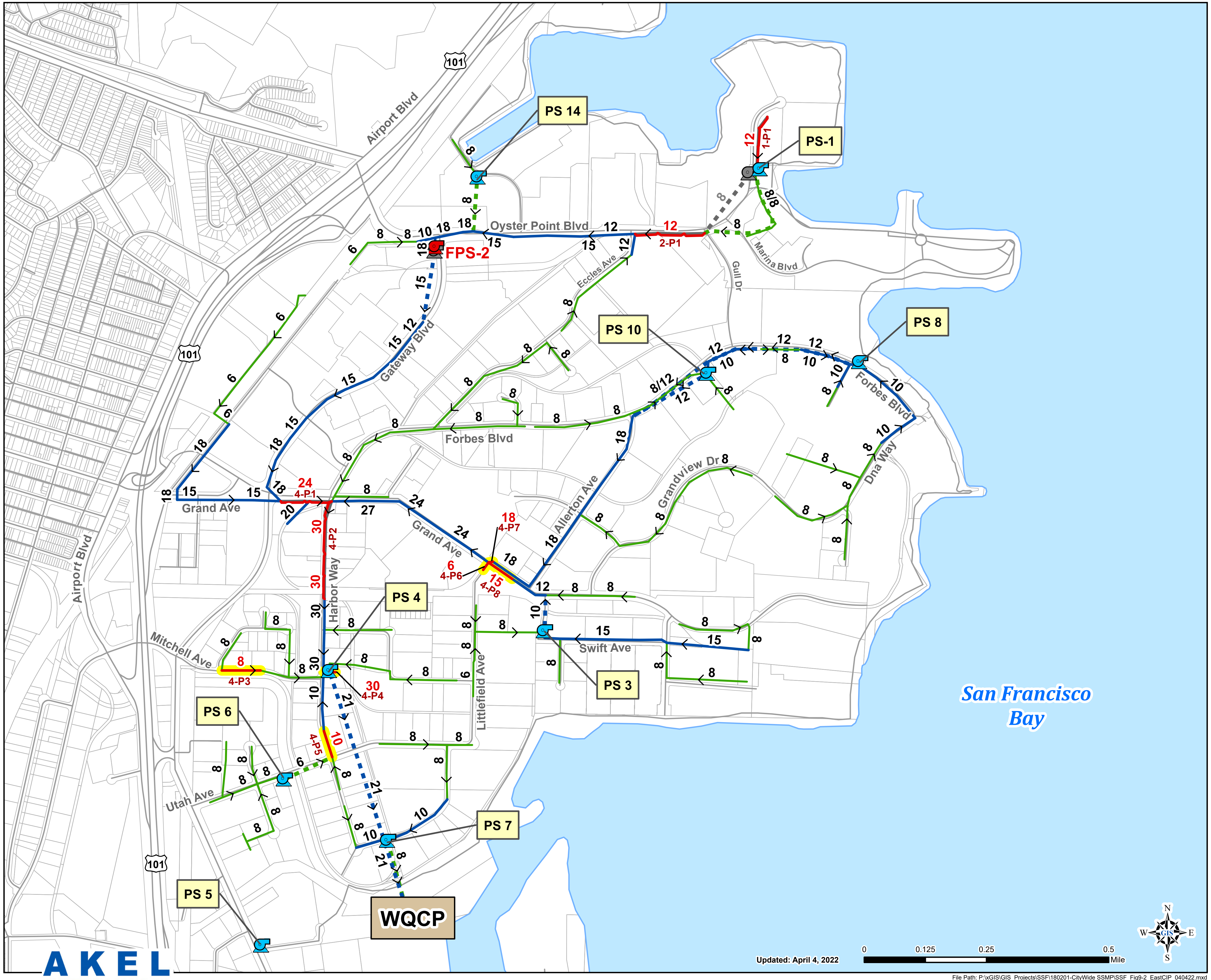
Recommended Improvements
- Pump Stations
- Gravity Main Capacity Improvements
- Force Main Capacity Improvements
- Slope Improvements

SSF West System
- Gravity Mains
- Force Mains

SSF East System
- Pump Stations
- Pipes
- Street Centerlines
- Sewer Service Area

Municipality
- Colma
- Daly City
- San Bruno
- Parcels

Figure 9.1
West of 101
Capital Improvement Program
City-Wide Sewer System
Master Plan
City of South San Francisco



Legend

Recommended Improvements
- Pump Station
- Gravity Pipes
- Slope Improvements

To be Abandoned
- Pump Stations
- Gravity Pipes
- Force Mains

Existing System
- Pump Stations

Gravity Pipes
- 8" and Smaller
- 10" and Larger

Force Mains
- 8" and Smaller
- 10" and Larger
- Street Centerlines
- Parcels

Figure 9.2
East of 101
Capital Improvement Program
City-Wide Sewer System
Master Plan
City of South San Francisco

Table 9.2 Capital Improvement Program (West of 101)
City-Wide Sewer System Master Plan
City of South San Francisco

Improvement No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	Pipeline Improvements: New/Parallel/ Replace	Pipeline Improvements: Diameter (in)	Pipeline Improvements: Length (in)	Pipeline Improvements: Pipe Unit Cost[3,4] ($/unit)	Infrastructure Costs: Baseline Constr. Costs ($)	Infrastructure Costs: Estimated Constr. Costs[5] ($)	Infrastructure Costs: Capital Improv. Costs[6] ($)	Construction Trigger (gpm)	Suggested Cost Allocation: Existing Users (%)	Suggested Cost Allocation: Future Users (%)	Cost Sharing: Existing Users ($)	Cost Sharing: Future Users ($)
Gravity Main Improvements																	
North Canal Trunk																	
NC-P1[7]	Existing-Slope	Mission Rd	From Lawndale Blvd to Evergreen Dr	15	3	Replace	15	675	556	563,250	732,300	1,098,500	-	69%	31%	762,939	335,561
NC-P2	Existing-Capacity	Alta Loma Dr	From 550' nw/o Del Paso Dr to Del Paso Dr	8	3	Replace	10	600	390	234,000	304,200	456,300	-	100%	0%	456,300	0
NC-P3	Existing-Capacity	Del Paso Dr	From Alta Loma Dr to Arroyo Dr	8	3	Replace	10	825	390	321,700	418,300	627,500	-	100%	0%	627,500	0
NC-P4	Existing-Capacity	El Camino Real	From Arroyo Dr to 270' s/o Westborough Blvd	8	4	Replace	10	1,050	390	409,500	532,400	798,600	-	100%	0%	798,600	0
NC-P5[7]	Existing-Slope	Mission Rd	From 75' w/o Chestnut Ave to Chestnut Ave	18	5	Replace	18	100	668	100,350	130,500	195,800	-	97%	3%	189,660	6,140
							Subtotal - North Canal Trunk			**1,628,800**	**2,117,700**	**3,176,700**				**2,834,998**	**341,702**
Lowrie Trunk																	
LO-P1	Existing-Capacity	Avalon Dr	From 65' e/o Dana Ct to Constitution Wy	8	5	Replace	10	250	390	97,500	126,800	190,200	-	46%	54%	87,152	103,048
LO-P2	Existing-Capacity	ROW	From Constitution Wy to Pisa Ct	8	5	Replace	10	350	390	136,500	177,500	266,300	-	45%	55%	120,753	145,547
LO-P3	Existing-Capacity	ROW	From Pisa Ct to El Camino Real	8	5	Replace	12	1,450	446	646,500	840,500	1,260,800	-	45%	55%	563,647	697,153
LO-P4	Existing-Capacity	El Camino Real	From 230' s/o Ponderosa Rd to 325' n/o Country Club Dr	10	5	Replace	12	625	446	278,700	362,400	543,600	-	42%	58%	230,507	313,093
LO-P5	Existing-Capacity	El Camino Real	From 325' n/o Country Club Dr to Portola Ave	10 / 12	5	Replace	15	750	556	417,200	542,400	813,600	-	39%	61%	320,054	493,546
LO-P6	Existing-Capacity	Portola Ave	From El Camino Real to Ramona Ave	12	5	Replace	15	350	556	194,700	253,200	379,800	-	38%	62%	142,992	236,808
LO-P7	Existing-Capacity	Portola Ave	From Ramona Drive to Francisco Dr	12	5	Replace	18	900	668	601,300	781,700	1,172,600	-	39%	61%	460,409	712,191
LO-P8	Existing-Capacity	Francisco Dr	From 160' w/o Centennial Way Tr to Portola Ave	10 / 12	5	Replace	18	425	668	284,000	369,200	553,800	-	46%	54%	254,760	299,040
LO-P9	Existing-Capacity	Spruce Ave	From 490' e/o El Camino Real to Huntington Ave	10	5	Replace	12	700	446	312,100	405,800	608,700	-	38%	62%	230,799	377,901
LO-P10	Existing-Capacity	Spruce Ave	From Huntington Ave to 160' w/o Centennial Way Tr	10	5	Replace	12	550	446	245,200	318,800	478,200	-	33%	67%	159,806	318,394
LO-P11	Existing-Capacity	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	15	5	Replace	21	675	780	526,400	684,400	1,026,600	-	40%	60%	408,884	617,716
LO-P12	Existing-Capacity	ROW	From Spruce Ave to Maple Ave	12 / 15 / 18	4	Replace	21	1,625	780	1,267,200	1,647,400	2,471,100	-	38%	62%	947,780	1,523,320
LO-P13	Existing-Capacity	Maple Ave	From 605' n/o Browning Wy to 765' n/o Browning Wy	18	4	Replace	21	175	780	136,500	177,500	266,300	-	43%	57%	113,379	152,921
LO-P14	Existing-Capacity	ROW	From Maple Ave to Lowrie Ave	18	4	Replace	24	1,450	836	1,211,800	1,575,400	2,363,100	-	41%	59%	973,218	1,389,882
LO-P15[7]	Existing-Capacity	ROW	From Shaw Road to Shaw Road LS-11	27	5	Replace	30	200	1,005	201,000	261,300	392,000	-	78%	22%	304,018	87,982
LO-P16	Casing	Spruce Ave	From 160' w/o Centennial Way Tr to 265' sw/o Myrtle Ave	-	5	New	41	200	1,006	201,200	261,600	392,400	-	40%	60%	156,289	236,111
							Subtotal - Lowrie Trunk			**6,757,800**	**8,785,900**	**13,179,100**				**5,474,448**	**7,704,652**
Linden Trunk																	
LI-P1	Existing-Capacity	S Canal St	From Magnolia Ave to Spruce Ave	8	3	Replace	12	1,025	446	457,000	594,100	891,200	-	100%	0%	891,200	0
LI-P2	Existing-Capacity	S Canal St	From Starlite St to Linden Ave	8 / 12	3	Replace	15	1,300	556	723,100	940,100	1,410,200	-	79%	21%	1,115,280	294,920
LI-P3	Existing-Capacity	Victory Ave	From S Maple Ave to 280' w/o Linden Ave	15	5	Replace	18	450	668	300,700	391,000	586,500	-	53%	47%	309,331	277,169
LI-P4	Existing-Capacity	Victory Ave	From 190' w/o Linden Ave to Linden Ave	15	5	Replace	18	200	668	133,700	173,900	260,900	-	52%	48%	136,010	124,890
LI-P5	Existing-Capacity	Linden Ave	From Victory Ave to S Canal St	8 / 12 / 15	3	Replace	18	1,250	668	835,100	1,085,700	1,628,600	-	56%	44%	911,813	716,787
LI-P6	Existing-Capacity	Linden Ave	From S Canal St to N Canal St	15	3	Replace	18	125	668	83,600	108,700	163,100	-	73%	27%	118,614	44,486
LI-P7	Existing-Capacity	Linden Ave	From N Canal St to 100 ft n/o N Canal St	15	3	Replace	21	100	780	78,000	101,400	152,100	-	73%	27%	110,678	41,422
LI-P8	Casing	Linden Ave	From S Canal St to N Canal St	-	3	New	38	100	937	93,700	121,900	182,900	-	73%	27%	133,014	49,886
							Subtotal - Linden Trunk			**2,704,900**	**3,516,800**	**5,275,500**				**3,725,939**	**1,549,561**

Table 9.2 Capital Improvement Program (West of 101)

City-Wide Sewer System Master Plan

City of South San Francisco

Improvement No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	Pipeline Improvements: New/Parallel/ Replace	Diameter (in)	Length (in)	Pipe Unit Cost[3,4] ($/unit)	Infrastructure Costs: Baseline Constr. Costs ($)	Estimated Constr. Costs[5] ($)	Capital Improv. Costs[6] ($)	Construction Trigger (gpm)	Suggested Cost Allocation: Existing Users (%)	Future Users (%)	Cost Sharing: Existing Users ($)	Future Users ($)
Cypress Trunk																	
CY-P1	Existing-Capacity	San Francisco Dr	From 430' w/o Woods Cir to Woods Cir	8	5	Replace	10	475	390	185,300	240,900	361,400	-	86%	14%	310,960	50,440
CY-P2	Existing-Capacity	Sister Cities Blvd	From 115' e/o Spruce Ave to 80' e/o Pecks Ln	10	5	Replace	12	775	446	345,600	449,300	674,000	-	81%	19%	547,696	126,304
CY-P3	Existing-Capacity	Sister Cities Blvd	From 230' w/o Airport Blvd to Airport Blvd	10	5	Replace	12	250	446	111,500	145,000	217,500	-	81%	19%	176,749	40,751
CY-P4	Existing-Capacity	Franklin Ave	From Hemlock Ave to Hillside Blvd	8	1	Replace	10	250	390	97,500	126,800	190,200	-	48%	52%	91,890	98,310
CY-P5	Existing-Capacity	Hillside Blvd	From Franklin Ave to Arden Ave	8	1	Replace	10	1,350	390	526,400	684,400	1,026,600	-	55%	45%	565,483	461,117
CY-P6	Existing-Slope	Hillside Blvd	From 185' s/o Spruce Ave	12	3	Replace	12	450	446	301,050	391,400	587,100	-	59%	41%	347,647	239,453
CY-P7	Existing-Capacity	Armour Ave	From Cypress Ave to Airport Blvd	-	3	New	15	250	556	139,100	180,900	271,400	-	9%	91%	23,974	247,426
CY-P8	Existing-Capacity	Airport Blvd	From Armour Ave to Pine Ave	12	3	Replace	15	725	556	403,300	524,300	786,500	Construction of CY-P7	9%	91%	69,474	717,026
									Subtotal - Cypress Trunk	**2,109,750**	**2,743,000**	**4,114,700**				**2,133,872**	**1,980,828**
									Subtotal - Gravity Main Improvements	**13,201,250**	**17,163,400**	**25,746,000**				**14,169,258**	**11,576,742**
Lift Station Improvements																	
PS-9[7]	Existing-Capacity				5	Capacity Upgrade	Replace Dry Weather Pumps 2 @ 5,600 gpm			10,154,300	13,200,600	19,800,900	-	92%	8%	18,230,529	1,570,371
PS-11[7]	Existing-Capacity				5	Capacity Upgrade	6 @ 8,300 gpm			24,857,400	32,314,700	48,472,100	-	92%	8%	44,441,542	4,030,558
									Subtotal - Lift Station Improvements	**35,011,700**	**45,515,300**	**68,273,000**				**62,672,071**	**5,600,929**
									Gravity Main Improvement Costs	**13,201,250**	**17,163,400**	**25,746,000**				**14,169,258**	**11,576,742**
									Lift Station Improvement Costs	**35,011,700**	**45,515,300**	**68,273,000**				**62,672,071**	**5,600,929**
									Total Improvement Costs	**48,212,950**	**62,678,700**	**94,019,000**				**76,841,330**	**17,177,670**

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Notes:

1. Improvements are categorized by the type of deficiency they are intended to mitigate.
   - Existing-Slope: This improvement is required to fix an existing pipeline with a slope beneath master plan criteria.
   - Existing-Capacity: This improvement is required to mitigate an existing capacity deficiency as observed in the hydraulic model.
   - Future-Capacity: This improvement is required to mitigate an existing system deficiency caused by buildout flows.
2. Rank Grouping:
   - **Rank 1** = R-Value ≥ 75%
   - **Rank 2** = 75% > R-Value ≥ 50%
   - **Rank 3** = 50% > R-Value ≥ 25%
   - **Rank 4** = 25% > R-Value ≥ 10%
   - **Rank 5** = R-Value ≤ 10%
3. Unit costs based on San Francisco June 2022 ENR CCI of 15,327.
4. For pipeline slope improvements, a 50 percent contingency has been added to the baseline construction cost to account for addition costs such as construction of new manholes.
5. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
6. Estimated construction cost plus 50 % to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.
7. Improvement collects flows from neighboring municipality. Cost allocation for neighboring municipalities documented on Table 9.3.

Table 9.3 West of 101 - ADWF Distribution for Serviced Municipalities

City-Wide Sewer System Master Plan

South San Francisco

Improvement ID	Existing User ADWF					Future User ADWF					Total ADWF
	Total Existing	South San Francisco	San Bruno[1]	Colma[2]	Daly City[3,4,5]	Total Future	South San Francisco	San Bruno[1]	Colma[2]	Daly City[3,4,5]	
LO-P15	78%	14%	64%	-	-	22%	7%	16%	-	-	$392,000
	$304,018	$54,957	$249,037	-	-	$87,982	$26,402	$61,604	-	-	
NC-P1	69%	42%	-	-	28%	31%	22%	-	-	8%	$1,098,500
	$762,939	$456,720			$306,219	$335,561	$246,846			$88,715	
NC-P5	97%	79%	-	8%	10%	3%	3%	-	0.4%	0.3%	$195,800
	$189,660	$155,177	-	$15,252	$19,232	$6,140	$4,825	-	$713	$602	
PS-9	92%	86%	-	3%	3%	8%	7%	-	0.3%	0.3%	$19,800,900
	$18,230,529	$17,024,192	-	$513,414	$692,923	$1,570,371	$1,456,177	-	$59,215	$54,979	
PS-11	92%	53%	36%	1%	2%	8%	4%	4%	0.1%	0.1%	$48,472,100
	$44,441,542	$25,538,796	$17,514,661	$601,923	$786,162	$4,030,558	$2,140,754	$1,780,305	$47,482	$62,016	
Subtotal Existing Users	$63,928,688	$43,229,841	$17,763,697	$528,666	$1,018,374	-	-	-	-	-	-
Subtotal Future Users	-	-	-	-	-	$6,030,612	$3,875,004	$1,841,909	$59,928	$144,297	-
Total	-	-	-	-	-	-	-	-	-	-	$69,959,300

6/9/2022

Notes:

1. Peak Flow Source: City of San Bruno existing and future sewer model flows provided by Woodard & Curran on April 29, 2021.
2. Peak Flow Source: Town of Colma, 2019 Wastewater Collection System Master Plan, provided by CSG Consultants on January 19, 2021.
3. Average Flow Source: City of South San Francisco/San Bruno, 2011 Water Quality Control Plant Facility Plan Update.
4. Peak Day Dry Weather Flow and Peak Month Wet Weather Flow peaking factors extracted from historical WWTP flows for City of South San Francisco.
5. Diurnal peaking factor extracted from hydraulic model calibration results for the City of South San Francisco City-Wide Sewer System Master Plan.

master planning cost estimate. Additionally, the table lists the suggested cost allocation between existing and future users for financing purposes.

9.3.3 Construction Triggers

The capacity improvements are identified and categorized based on their urgency to mitigate existing deficiencies and to serve future growth. The construction triggers for each improvement as described as follows:

- **Improvements to Mitigate Existing Deficiencies:** These are considered near-term improvements and are intended to mitigate existing capacity deficiencies. This master plan recommends these improvements be schedule for construction as soon as possible and as fiscal budgets permit.
- **Improvements to Mitigate Buildout Deficiencies:** These are intermediate-term and long-term improvements intended to service future developments within the UGA. This master plan included construction triggers, expressed in equivalent dwelling units (EDUs). These triggers identify the equivalent number of residential single-family units that can be served by the existing collection system prior to requiring upsizing or parallel relief. Other triggers are associated with specific developments or projects that may alter the routing of sewer flows within the collection system.

9.3.3.1 *Prioritization of Capacity and Renewal and Replacement Improvements*

The capacity and Renewal and Replacement (R&R) improvements are prioritized by basins with the highest monitored I&I, in order to focus resources on mitigating infiltration and inflows. The prioritized subbasins are shown on **Figure 7.6**, and were based on the 2017 and 2021 wet weather flow monitoring programs completed by V&A.

9.3.4 Recommended Cost Allocation Analysis

Capacity allocation analysis is needed to identify improvement funding sources, and to establish a nexus between development impact fees and improvements needed to service growth. The capacity allocation analysis, for the proposed improvements, was based on the average dry weather flows from existing customers compared to average dry weather flows from the buildout scenarios flows. In compliance with the provisions of Assembly Bill AB 1600, the analysis differentiates between the project needs of servicing existing users and for those required to service anticipated future developments.

Table 9.2 and **Table 9.3** list each improvement and separates the cost by responsibility between existing and future users. The cost responsibility is based on model parameters for existing and future land use, and may change depending on the nature of development.

Additionally, **Table 9.4** documents the cost sharing for the improvements that collect flows from the neighboring municipalities of Daly City, San Bruno, and the Town of Colma. The capacity allocation analysis, for the proposed improvements, was based on the average dry weather flows

Table 9.4 Capital Improvement Program (East of 101)

City-Wide Sewer System Master Plan
City of South San Francisco

Improv. No.	Improv. Type[1]	Alignment	Limits	Existing Diameter (in)	Priority[2]	Pipeline Improvements: New/Parallel/ Replace	Pipeline Improvements: Diameter (in)	Pipeline Improvements: Length (ft)	Pipeline Improvements: Pipe Unit Cost[3,4] ($/unit)	Infrastructure Costs: Baseline Constr. Costs ($)	Infrastructure Costs: Estimated Constr. Costs[5] ($)	Infrastructure Costs: Capital Improv. Costs[6] ($)	Construction Trigger (gpm)	Suggested Cost Allocation: Existing Users (%)	Suggested Cost Allocation: Future Users (%)	Cost Sharing: Existing Users ($)	Cost Sharing: Future Users ($)
Gravity Main Improvements																	
Priority 1- Existing Deficiencies																	
1-P1	Future-Capacity	Oyster Point Blvd	From 750 ft n/o Lift Station to Lift Station 1	8	3	Replace	12	700	446	312,100	405,800	608,700	914 EDU	16%	84%	99,048	509,652
									Subtotal - Basin 1	**312,100**	**405,800**	**608,700**				**99,048**	**509,652**
Basin 2																	
2-P1	Existing-Capacity	Oyster Point Blvd	From Gull Dr to Eccles Ave	8	1	Replace	12	790	446	352,200	457,900	686,900	-	29%	71%	200,573	486,327
									Subtotal - Basin 2	**352,200**	**457,900**	**686,900**				**200,573**	**486,327**
Priority 2- Future Development																	
4-P1	Future-Capacity	E Grand Ave	From Gateway Blvd o Forbes Blvd	21	3	Replace	24	585	836	488,900	635,600	953,400	3,040 EDU	48%	52%	454,241	499,159
4-P2	Future-Capacity	Harbor Way	From E Grand Ave to 350 ft n/o Harris Ave	27	3	Replace	30	1,105	1,005	1,110,400	1,443,600	2,165,400	7,478 EDU	53%	47%	1,142,066	1,023,334
4-P3	Existing-Slope	Littlefield Ave	From 50 ft ne/o Grand Ave to Littlefield Ave to Grand Ave	8	2	Replace	8	425	334	213,000	276,900	415,400	-	68%	32%	281,039	134,361
4-P4	Existing-Slope	Littlefield Ave	From 100 ft s/o Grand Ave to Grand Ave	30	2	Replace	30	65	1,005	98,100	127,600	191,400	-	53%	47%	100,869	90,531
4-P5	Existing-Slope	E Grand Ave	From Littlefield Ave to 300 ft se/o Littlefield Ave	10	2	Replace	10	315	390	184,350	239,700	359,600	-	99%	1%	354,867	4,733
4-P6	Existing-Slope	Mitchell Ave	From West Harris Ave to 400 ft e/o Harris Ave	6	2	Replace	6	115	271	46,800	60,900	91,400	-	100%	0%	91,400	0
4-P7	Existing-Slope	50 feet n/o Mitchell Ave	From Harbor Way to Lift Station 4	18	2	Replace	18	50	668	50,250	65,400	98,100	-	48%	52%	47,475	50,625
4-P8	Existing-Slope	E Grand Ave	From 250 e/o Kimball Way to Kimball Way	15	2	Replace	15	330	556	275,400	358,100	537,200	-	90%	10%	481,727	55,473
									Subtotal - Basin 4	**2,467,200**	**3,207,800**	**4,811,900**				**2,953,685**	**1,858,215**
									Subtotal - Gravity Main Improvements	**3,131,500**	**4,071,500**	**6,107,500**				**3,253,306**	**2,854,194**
Pump Station Improvements																	
PS-2	Existing-Capacity	955 Gateway Blvd			1	Capacity Upgrade	2 @ 1,850 gpm			5,224,500	6,791,900	10,187,900	-	67%	33%	6,873,701	3,314,199
									Subtotal - Lift Station Improvements	**5,224,500**	**6,791,900**	**10,187,900**				**6,873,701**	**3,314,199**
									Gravity Main Improvement Costs	**3,131,500**	**4,071,500**	**6,107,500**				**3,253,306**	**2,854,194**
									Lift Station Improvement Costs	**5,224,500**	**6,791,900**	**10,187,900**				**6,873,701**	**3,314,199**
									Total Improvement Costs	**8,356,000**	**10,863,400**	**16,295,400**				**10,127,008**	**6,168,392**

6/9/2022

Notes:

1. Improvements are categorized by the type of deficiency they are intended to mitigate.
   - Existing-Slope: This improvement is required to fix an existing pipeline with a slope beneath master plan criteria.
   - Existing-Capacity: This improvement is required to mitigate an existing capacity deficiency as observed in the hydraulic model.
   - Future-Capacity: This improvement is required to mitigate an existing system deficiency caused by buildout flows.
2. Ranking Grouping
   - Rank 1 = Existing Capacity Deficiencies
   - Rank 2 = Existing Slope Deficiencies (City to Review and explore mitigation opportunities)
   - Rank 3: Future Capacity Deficiency Ordered by Construction Trigger (EDUs)
3. For pipeline slope improvements, a 50 percent contingency has been added to the baseline construction cost to account for addition costs such as construction of new manholes.
4. Unit costs based on San Francisco June 2022 ENR CCI of 15,327.
5. Baseline construction costs plus 30% to account for unforeseen events and unknown conditions.
6. Estimated construction cost plus 50 % to cover other costs including: engineering design, project administration (developer and City staff), construction management and inspection, and legal costs.

from each municipality compared against each other and against the average dry weather flow for each municipality from the buildout scenarios.

9.3.5 Recommended Condition and Risk Assessment Improvements

The projects recommended in the Condition and Risk Assessment are intended to replace or refurbish the existing assets that are close to or have exceeded their useful life. The results of this analysis will assist the City in managing and maintaining the existing sanitation infrastructure.

The recommended projects were designated as either condition assessment improvements or operations and maintenance recommendations depending on their specific renewal choice; their costs are summarized on **Table 9.5**. These recommendations were determined as a result of the risk assessment and are intended to mitigate or determine the condition of extreme and high-risk sewer infrastructure within the City's service area. In order to facilitate the prioritization of the projects included in the risk analysis, each project has been prioritized based on its risk score, condition, and sub basin R-Value.

It should be noted that the improvement project prioritization is intended to be used for planning purposes only. Specific on-site conditions, available funds, and other factors should be taken into consideration when preparing to schedule and construct the projects included in the condition and risk assessment.

9.3.6 In-Progress Renewal Projects

Based on planning documents received from City staff, there are several renewal projects that are currently planned for the purpose of rehabilitating existing infrastructure. For ease of reference the pipelines and manholes that the City has identified as in-progress renewal projects are documented below and shown in **Table 9.6**.

- **IP-RP1**: Replace the 10-inch gravity main in kind along Clay Avenue from approximately 120 feet east of Longford Drive to approximately 100 feet west of Newman Drive.
- **IP-BR1**: Conduct pipe bursting on the 6-inch gravity main along El Camino Real from approximately 310 feet west of West Orange Avenue to West Orange Avenue.
- **IP-BR2**: Conduct pipe bursting on the 6-inch gravity main along the right-of-way from approximately 170 feet east of Del Monte Avenue to approximately 180 feet west of Camaritas Avenue.
- **IP-BR3**: Conduct pipe bursting on the 10-inch gravity main along Sister Cities Boulevard from approximately 60 feet south of South San Francisco drive to 260 feet west of Woods Circle.
- **IP-BR4**: Conduct pipe bursting on the 10-inch gravity main along Sister Cities Boulevard from approximately 150 feet east of North Spruce Avenue to approximately 1,500 feet west of Airport Boulevard.

Table 9.5 Condition Assessment Improvements, Cost Estimates

Wastewater Collection System Master Plan
City of South San Francisco

Improv. No.	Type of Improvement	Alignment	Limits	Pipeline Renewal Choice and Priority[1]	I&I Priority[6]	Pipeline Improvements: Diameter (in)	Length (ft)	Unit Cost[2,3] ($/ft)	Infr. Cost ($)	Infrastructure Costs: Baseline Constr. Costs ($)	Estimated Constr. Costs[4] ($)	Capital Improv. Cost[5] ($)
Pipeline Improvements												
Group 1												
P1-RP1	Gravity Main	Duval Drive	from 120' southwest of Arlington Drive to Elkwood Drive	Repair+Full Lining - Priority 2	5	6	92	271/22	18,300	18,400	24,000	36,000
P1-FR2	Gravity Main	Clifden drive	from 290' southwest of Clay Ave to 420' northwest of Dundee Drive	Repair+Full Lining - Priority 2	5	6	546	271/22	28,388	28,400	37,000	55,500
P1-FR3	Gravity Main	Junipero Serra Blvd/Clay Ave	from 170' east of Buxton Ave to Newman Drive	Repair+Full Lining - Priority 2	5	8 / 10	572	390/37	106,961	107,000	139,100	208,700
P1-RP4	Gravity Main	ROW	between Del Monte Ave and Camaritas Ave	Repair+Full Lining - Priority 2	5	6	60	271/22	28,426	28,500	37,100	55,700
P1-FR5	Gravity Main	Camaritas Ave	from 70' south of Alta Loma Drive to 540' north of Del Monte Ave	Repair+Full Lining - Priority 2	5	6	284	271/22	38,822	38,900	50,600	75,900
P1-FR6	Gravity Main	ROW	between Camaritas Ave and McDonell Drive	Repair+Full Lining - Priority 2	5	6	276	271/22	16,970	17,000	22,100	33,200
P1-FR7	Gravity Main	Alta Loma Drive	from McDonell Drive to 125' northwest of Camaritas Circle	Repair+Full Lining - Priority 2	5	6	270	271/22	22,255	22,300	29,000	43,500
P1-FR8	Gravity Main	Camaritas Circle	from eastern corner of Camaritas Circle to Alta Loma Drive	Repair+Full Lining - Priority 2	5	6	232	271/22	37,667	37,700	49,100	73,700
P1-FR9	Gravity Main	ROW	between Mission Road and Colma Creek	Repair+Full Lining - Priority 2	5	15	313	556/56	73,006	73,100	95,100	142,700
									Subtotal - Group 1	**371,300**	**483,100**	**724,900**
Group 2												
P2-FR1	Gravity Main	Newman Drive	from Keoncrest Drive to 270' northwest of Lamonte Ave	Repair+Full Lining - Priority 2	5	6	249	271/22	75,975	76,000	98,800	148,200
P2-FR2	Gravity Main	Romney Ave/Serra Drive	from Keoncrest Drive to 630' northwest of Lacrosse Ave	Repair+Full Lining - Priority 2	3	6	592	271/22	29,410	29,500	38,400	57,600
P2-FR3	Gravity Main	Newman Drive	from King Drive to San Felipe Ave	Repair+Full Lining - Priority 2	5	6	299	271/22	22,900	22,900	29,800	44,700
P2-FR4	Gravity Main	Altamont Drive	from King Drive to 670' northwest of Southcliff Ave	Repair+Full Lining - Priority 2	5	6	330	271/22	18,170	18,200	23,700	35,600
P2-FR5	Gravity Main	Arbor Drive	from 500' northwest of Southcliff Ave to 175' southwest of Newman Drive	Repair+Full Lining - Priority 2	5	6	220	271/22	37,400	37,400	48,700	73,100
P2-FR6	Gravity Main	Arbor Drive	from Southcliff Ave to 250' northwest of Southcliff Ave	Repair+Full Lining - Priority 2	5	6	271	271/22	49,370	49,400	64,300	96,500
P2-RP7	Gravity Main	Serra Drive	from April Ave to Southcliff Ave	Replace - Priority 2	5	6	261	271	70,712	70,800	92,100	138,200
P2-RP8	Gravity Main	Southcliff Ave	from where April Ave becomes Southcliff Ave to 200' northeast of Serra Drive	Replace - Priority 2	5	8	254	334	84,836	84,900	110,400	165,600
P2-FR9	Gravity Main	San Felipe Ave	from Del Monte Ave to 650' northeast of Serra Drive	Repair+Full Lining - Priority 2	3	6	349	271/22	40,266	40,300	52,400	78,600
P2-FR10	Gravity Main	Camaritas Ave	from San Felipe Ave to Clara Ave	Repair+Full Lining - Priority 2	3	6	483	271/22	64,918	65,000	84,500	126,800
P2-FR11	Gravity Main	Camaritas Ave	from Los Flores Ave to 150' northwest of El Campo Drive	Repair+Full Lining - Priority 2	3	6	110	271/22	13,281	13,300	17,300	26,000
P2-FR12	Gravity Main	Clara Ave	from 750' northeast of Carmaritas Ave to Alta Loma Drive	Repair+Full Lining - Priority 2	3	6	275	271/22	27,785	27,800	36,200	54,300
P2-FR13	Gravity Main	ROW	between Camaritas Ave and Carmelo Lane	Repair+Full Lining - Priority 2	3	6	400	271/22	8,888	8,900	11,600	17,400
P2-RP14	Gravity Main	ROW	between Camaritas Ave and Carmelo Lane	Replace - Priority 2	3	6	241	271	65,294	65,300	84,900	127,400
P2-FR15	Gravity Main	ROW	between Carmelo Lane and Del Paso Drive	Repair+Full Lining - Priority 2	3	6	243	271/22	10,818	10,900	14,200	21,300
P2-FR16	Gravity Main	ROW	between Carmelo Lane and Bonita Ave	Repair+Full Lining - Priority 2	3	6	236	271/22	64,849	64,900	84,400	126,600
P2-RP17	Gravity Main	Alta Loma Drive	fom 300' southeast of El Campo Drive to 500' northwest of Del Paso Drive	Replace - Priority 2	3	8	302	334	100,868	100,900	131,200	196,800
P2-FR18	Gravity Main	ROW	between Bonita Ave and Alta Loma Dr	Repair+Full Lining - Priority 2	3	6	231	271/22	32,226	32,300	42,000	63,000
P2-FR19	Gravity Main	ROW	between Del Paso Drive and Hermosa Lane	Repair+Full Lining - Priority 2	3	6	282	271/22	87,545	87,600	113,900	170,900
P2-FR20	Gravity Main	ROW	between Hermosa Lane and Chico Court	Repair+Full Lining - Priority 2	3	6	282	271/22	141,731	141,800	184,400	276,600
P2-RP21	Gravity Main	Alta Mesa Drive	from 110' southwest of Newman Drive to 380' northeast of intersection with Cuestra Drive	Replace - Priority 2	4	6	250	271	67,732	67,800	88,200	132,300
P2-FR22	Gravity Main	Verano Drive	from Alta Mesa Drive to 280' northwest of Tunitas Lane	Repair+Full Lining - Priority 2	4	6	143	271/22	24,852	24,900	32,400	48,600
P2-FR23	Gravity Main	ROW	between Cuestra Dr and Escanyo Dr	Repair+Full Lining - Priority 2	4	6	130	271/22	2,889	2,900	3,800	5,700
P2-FR24	Gravity Main	Alta Mesa Drive	from Escanyo Drive to Arroyo Drive	Repair+Full Lining - Priority 2	4	6	263	271/22	32,937	33,000	42,900	64,400
P2-FR25	Gravity Main	Escanyo Drive	from Casey Drive to 165' west of Berenda Drive	Repair+Full Lining - Priority 2	4	6	160	271/22	19,811	19,900	25,900	38,900
P2-FR26	Gravity Main	Escanyo Drive	from Berenda Drive to 600' northwest of Arroyo Drive	Repair+Full Lining - Priority 2	4	6	213	271/22	86,012	86,100	112,000	168,000
P2-FR27	Gravity Main	ROW	east of Escanyo Drive to 300' northwest of Arroyo Drive	Repair+Full Lining - Priority 2	4	6	300	271/22	28,340	28,400	37,000	55,500
P2-FR28	Gravity Main	Verano Drive	from 145' south of Cuestra Drive to 340' northwest of Arrovo Drive	Repair+Full Lining - Priority 2	4	6	200	271/22	26,118	26,200	34,100	51,200
P2-RP29	Gravity Main	Escanyo Drive	from 340' south of Arroyo Drive to 440' southeast of Berenda Drive	Replace - Priority 2	5	6	310	271	83,988	84,000	109,200	163,800
P2-FR30	Gravity Main	Escanyo Drive	from 440' southeast of Berenda Drive to 390' west of Capay Circle	Repair+Full Lining - Priority 2	5	6	135	271/22	13,837	13,900	18,100	27,200
P2-FR31	Gravity Main	Escanyo Drive	from 190' south of Arroyo Drive to 250' north of Westborough Blvd	Repair+Full Lining - Priority 2	5	6	223	271/22	26,629	26,700	34,800	52,200
P2-FR32	Gravity Main	Jacinto Lane	from 415' south of Arroyo Drive to Verano Drive	Repair+Full Lining - Priority 2	5	6	486	271/22	135,427	135,500	176,200	264,300
P2-FR33	Gravity Main	ROW	between Arroyo Dr and Capay Circle	Repair+Full Lining - Priority 2	5	6	442	271/22	91,100	91,200	118,600	177,900
P2-FR34	Gravity Main	Indio Drive	from 170' east of El Campo Dr to 475' west of Del Paso Dr	Repair+Full Lining - Priority 2	4	8	300	334/30	222,649	222,700	289,600	434,400
									Subtotal - Group 2	**1,911,300**	**2,486,000**	**3,729,600**
Group 4												
P4-RP1	Gravity Main	ROW	between Hillcrest Court and Southwood Drive	Replace - Priority 2	5	6	113	271	30,615	30,700	40,000	60,000
P4-FR2	Gravity Main	ROW	between Hillcrest Ct and Southwood Dr	Repair+Full Lining - Priority 2	5	6	266	271/22	87,190	87,200	113,400	170,100
P4-RP3	Gravity Main	ROW	between Orange Ave and Knoll Circle	Replace - Priority 2	5	6	76	271	20,590	20,600	26,800	40,200
P4-FR4	Gravity Main	ROW	between Orange Ave and Hill Ave	Repair+Full Lining - Priority 2	5	6	370	271/22	29,896	29,900	38,900	58,400
P4-FR5	Gravity Main	ROW	between Knoll Cricle and Orange Avenue	Repair+Full Lining - Priority 2	5	6	307	271/22	115,194	115,200	149,800	224,700
P4-FR6	Gravity Main	1st St	from 130' north of Fairway Drive to 100' west of El Camino Real	Repair+Full Lining - Priority 2	5	8	241	334/30	27,181	27,200	35,400	53,100
P4-FR7	Gravity Main	2nd St/A St	from El Camino Real to 400' northwest of Orange Ave	Repair+Full Lining - Priority 2	5	6	513	271/22	65,585	65,600	85,300	128,000
P4-FR8	Gravity Main	B St	from northernmost point of B St to 2nd street	Repair+Full Lining - Priority 2	5	8	298	334/30	48,910	49,000	63,700	95,600
P4-FR9	Gravity Main	ROW	from 2nd St to C St	Repair+Full Lining - Priority 2	5	8	199	334/30	59,336	59,400	77,300	116,000
P4-RP10	Gravity Main	El Camino Real	from 300' southeast of 2nd St to 90' northwest of Orange Ave	Replace - Priority 2	5	6	281	271	76,131	76,200	99,100	148,700
P4-RP11	Gravity Main	Southwood Center	from Ponderosa Road to 370' east of Hill Ave	Replace - Priority 2	5	6	255	271	69,087	69,100	89,900	134,900
P4-FR12	Gravity Main	Mulberry Ave	from 200' south of Mayfair Ave to Toyon Ave	Repair+Full Lining - Priority 1	1	6	200	271/22	26,118	26,200	34,100	51,200
									Subtotal - Group 4	**656,300**	**853,700**	**1,280,900**
Group 5												
P5-FR1	Gravity Main	Valverde Drive	from 100' south of Yellowstone Drive to Almanor Drive	Repair+Full Lining - Priority 2	5	6	188	271/22	52,945	53,000	68,900	103,400

Table 9.5 Condition Assessment Improvements, Cost Estimates

Wastewater Collection System Master Plan
City of South San Francisco

Improv. No.	Type of Improvement	Alignment	Limits	Pipeline Renewal Choice and Priority[1]	I&I Priority[6]	Pipeline Improvements				Infrastructure Costs		
						Diameter (in)	Length (ft)	Unit Cost[2,3] ($/ft)	Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Costs[4] ($)	Capital Improv. Cost[5] ($)
Pipeline Improvements												
P5-FR2	Gravity Main	Almanor Ave	from 90' east of Tahoe Ct to 160' west of Yosemite Drive	Repair+Full Lining - Priority 2	5	6	179	271/22	52,745	52,800	68,700	103,100
P5-FR3	Gravity Main	Ponderosa Road/Valencia Drive	from Alhambra Road to 270' northwest of Granada Drive	Repair+Full Lining - Priority 2	5	6	334	271/22	77,863	77,900	101,300	152,000
P5-FR4	Gravity Main	ROW	between Cornerwood Court and Ponderosa Road	Repair+Full Lining - Priority 2	5	6	118	271/22	13,459	13,500	17,600	26,400
P5-FR5	Gravity Main	Valencia Drive	from 120' east of Valverde Drive to 410' east of Alhambra Road	Repair+Full Lining - Priority 2	5	6	299	271/22	131,272	131,300	170,700	256,100
P5-FR6	Gravity Main	Valencia Drive	from 135' west of Alhambra Road to 450' west of Ponderosa Road	Repair+Full Lining - Priority 2	5	6	453	271/22	199,717	199,800	259,800	389,700
P5-FR7	Gravity Main	Avalon Drive	from 130' east of Alhambra Road to 540' west of Granada Drive	Repair+Full Lining - Priority 2	5	6	195	271/22	74,775	74,800	97,300	146,000
P5-RP8	Gravity Main	Granada Drive	from Avalon Drive to 530' northeast of Zamora Drive	Replace - Priority 2	5	6	263	271	71,254	71,300	92,700	139,100
P5-RP9	Gravity Main	Granada Drive	from 275' south of Avalon Drive to 250' east of Zamora Drive	Replace - Priority 2	5	6	136	271	36,846	36,900	48,000	72,000
P5-RP10	Gravity Main	Conmur St	from Granada drive to 300' northwest of Alta Vista Drive	Replace - Priority 2	5	6	146	271	39,555	39,600	51,500	77,300
P5-RP11	Gravity Main	Valverde Drive	from Granada Drive to 100' south of Corrido Way	Replace - Priority 2	5	6	342	271	92,657	92,700	120,600	180,900
P5-RP12	Gravity Main	Valverde Drive	from 190' south of Corrido Way to Alta Vista Drive	Replace - Priority 2	5	6	94	271	25,467	25,500	33,200	49,800
P5-RP13	Gravity Main	Alta Vista Drive	from Mira Vista Way to 140' west of De Nardi Way	Replace - Priority 2	5	6	115	271	31,157	31,200	40,600	60,900
P5-RP14	Gravity Main	Northwood Drive	from 250' east of Conmur St to Rosewood Way	Replace - Priority 2	5	6	303	271	82,091	82,100	106,800	160,200
P5-RP15	Gravity Main	Wildwood Drive	from 325' east of Briarwood Drive to 175' west of Rosewood Way	Replace - Priority 2	5	6	344	271	93,199	93,200	121,200	181,800
P5-RP16	Gravity Main	Wildwood Drive	from Rosewood Way to 220' west of Ravenwood Way	Replace - Priority 2	5	8	327	334	109,218	109,300	142,100	213,200
P5-RP17	Gravity Main	Wildwood Drive	from Greenwood Drive to Springwood Way	Replace - Priority 2	5	10	352	390	137,247	137,300	178,500	267,800
P5-FR18	Gravity Main	Rosewood Way	from 200' northeast of Rockwood Drive to 50' north of Rockwood Drive	Repair+Full Lining - Priority 2	5	6	141	271/22	19,389	19,400	25,300	38,000
P5-FR19	Gravity Main	Rockwood Drive	from Sherwood Way to 190' west of Greenwood Drive	Repair+Full Lining - Priority 2	5	6	343	271/22	45,552	45,600	59,300	89,000
P5-FR20	Gravity Main	Greenwood Drive	from 250' southeast of Rosewood Way to 310' southwest of Rockwood Drive	Repair+Full Lining - Priority 2	5	6	632	271/22	79,066	79,100	102,900	154,400
P5-RP21	Gravity Main	Springwood Way	from 100' south of Brentwood Drive to Manor Drive	Replace - Priority 2	5	6	151	271	40,910	41,000	53,300	80,000
P5-RP22	Gravity Main	Manor Drive	from 200' east of Springwood Way to Aptos Way	Replace - Priority 2	5	6	278	271	75,318	75,400	98,100	147,200
P5-RP23	Gravity Main	Brentwood Drive/Rockwood Drive	from 100' east of Mosswood way to Manor Drive	Replace - Priority 2	5	6	583	271	157,951	158,000	205,400	308,100
P5-RP24	Gravity Main	Rockwood Drive	from 170' east of Greenwood Drive to 750' southwest of Pinehurst Way	Replace - Priority 2	5	6	509	271	137,902	138,000	179,400	269,100
P5-RP25	Gravity Main	Rockwood Drive	from 570' east of Pinehurst Way to 120' south of Manor Drive	Replace - Priority 2	5	6	97	271	26,280	26,300	34,200	51,300
P5-RP26	Gravity Main	Hazelwood Drive	from approximately 275' east of Rosewood Way to Ravenwood Way	Replace - Priority 2	5	6	295	271	79,924	80,000	104,000	156,000
									Subtotal - Group 5	**1,985,000**	**2,581,400**	**3,872,800**
Group 6												
P6-FR1	Gravity Main	ROW	between Holly Ave and Evergreen Drive	Repair+Full Lining - Priority 1	3	6	223	271/22	15,792	15,800	20,600	30,900
P6-RP2	Gravity Main	Forest View Drive	from morningside avenue to 235' north of Iris Court	Replace - Priority 1	3	6	97	271	26,280	26,300	34,200	51,300
P6-FR3	Gravity Main	Forest View Drive	from Morningside Ave to Crestwood Drive	Repair+Full Lining - Priority 1	3	6	225	271/22	70,023	70,100	91,200	136,800
P6-FR4	Gravity Main	Hemlock Avenue	from 105' west of Lincoln St to 30' east of Lincoln St	Repair+Full Lining - Priority 1	3	6	140	271/22	46,460	46,500	60,500	90,800
P6-FR5	Gravity Main	Larch Ave	from westernmost point of Larch Ave to 100' east of intersection with Lincoln St	Repair+Full Lining - Priority 1	3	6	218	271/22	15,681	15,700	20,500	30,800
P6-FR6	Gravity Main	Nora Way	from Willow Ave to Susie Way	Repair+Full Lining - Priority 1	3	6	316	271/22	72,045	72,100	93,800	140,700
P6-FR7	Gravity Main	ROW	between Mission Road and Grand Ave	Repair+Full Lining - Priority 1	3	6	172	271/22	30,915	31,000	40,300	60,500
P6-FR8	Gravity Main	ROW	between Grand Avenue and Mission Road	Repair+Full Lining - Priority 2	5	6	110	271/22	94,560	94,600	123,000	184,500
P6-FR9	Gravity Main	ROW	between Oak Avenue and Grand Avenue	Repair+Full Lining - Priority 1	3	6	125	271/22	29,871	29,900	38,900	58,400
P6-FR10	Gravity Main	ROW	300' southwest of Willow Ave to Oak Avenue	Repair+Full Lining - Priority 2	5	10	275	390/37	41,376	41,400	53,900	80,900
P6-FR11	Gravity Main	ROW	from 50' southeast of Oak Ave to 100' northwest of Daly Court	Repair+Full Lining - Priority 2	5	10	300	390/37	50,100	50,100	65,200	97,800
P6-FR12	Gravity Main	Eucalyptus ave	from Park Way to Cottonwood Ave	Repair+Full Lining - Priority 2	5	6	372	271/22	19,103	19,200	25,000	37,500
P6-FR13	Gravity Main	ROW	between Poplar Ave and Magnolia Ave	Repair+Full Lining - Priority 2	5	6	221	271/22	140,376	140,400	182,600	273,900
P6-FR14	Gravity Main	ROW	between Telford Ave and Elm Court	Repair+Full Lining - Priority 1	3	6	400	271/22	35,981	36,000	46,800	70,200
P6-FR15	Gravity Main	4th lane	from Orange Ave to 200' west of Locust Avenue	Repair+Full Lining - Priority 2	5	6	188	271/22	31,270	31,300	40,700	61,100
P6-FR16	Gravity Main	Magnolia Ave	from 4th Lane to Miller Ave	Repair+Full Lining - Priority 2	5	6	190	271/22	42,152	42,200	54,900	82,400
P6-FR17	Gravity Main	Baden Ave	beginning at Chestnut/Baden intersection to Laurel Ave	Repair+Full Lining - Priority 2	5	6	420	271/22	20,170	20,200	26,300	39,500
P6-FR18	Gravity Main	Baden Ave	begins at intersection of Acacia Ave and Baden Ave to Orange Ave	Repair+Full Lining - Priority 2	5	6	478	271/22	37,714	37,800	49,200	73,800
P6-RP19	Gravity Main	3rd Lane	from Magnolia Ave to 750' west of Spruce Ave	Replace - Priority 2	5	6	275	271	74,505	74,600	97,000	145,500
P6-RP20	Gravity Main	ROW	between Commercial Ave and Cicle Court	Replace - Priority 2	5	6	192	271	52,018	52,100	67,800	101,700
P6-FR21	Gravity Main	Railroad Ave	550' east of Orange Ave to 1st Lane	Repair+Full Lining - Priority 2	5	6	163	271/22	25,296	25,300	32,900	49,400
									Subtotal - Group 6	**972,600**	**1,265,300**	**1,898,400**
Group 7												
P7-FR1	Gravity Main	Toyon Ave	from Sycamore Ave to Cherry Ave	Repair+Full Lining - Priority 1	4	6	231	271/22	32,226	32,300	42,000	63,000
P7-RP2	Gravity Main	Cherry Ave	from Toyon Ave to 600' northeast of Myrtle Ave	Replace - Priority 1	4	6	278	271	75,318	75,400	98,100	147,200
P7-FR3	Gravity Main	Mayfair Ave	from S Magnolia Ave to Fir Avenue	Repair+Full Lining - Priority 1	5	8	470	334/30	114,126	114,200	148,500	222,800
P7-RP4	Gravity Main	Magnolia Ave	from 285' south of Mayfair Ave to Redwood Ave	Replace - Priority 1	5	8	282	334	94,188	94,200	122,500	183,800
P7-FR5	Gravity Main	Fir Ave	225' south of Mayfair Ave to 115' north of Redwood Ave	Repair+Full Lining - Priority 1	5	8	239	334/30	53,842	53,900	70,100	105,200
P7-FR6	Gravity Main	Redwood Ave	from Manzanita Ave to Fir Ave	Repair+Full Lining - Priority 1	5	8	237	334/30	33,742	33,800	44,000	66,000
P7-RP7	Gravity Main	Fir Ave	from Redwood Ave to 50' north of Myrtle Ave	Replace - Priority 1	5	8	609	334	203,406	203,500	264,600	396,900
P7-FR8	Gravity Main	S Spruce Ave	from N Canal St to 500' south of Railroad Avenue	Repair+Full Lining - Priority 2	5	18	285	668/66	72,250	72,300	94,000	141,000
									Subtotal - Group 7	**679,600**	**883,800**	**1,325,900**
Group 8												
P8-RP1	Gravity Main	Sister Cities BLVD	from 190' north of Franklin Ave to 180' north of Drake Ave	Replace - Priority 1	5	10	400	390	155,963	156,000	202,800	304,200
P8-FR2	Gravity Main	Randolph Avenue	from 150' north of Damonte Court to 640' northwest of Pecks Lane	Repair+Full Lining - Priority 1	3	6	105	271/22	13,170	13,200	17,200	25,800
P8-RP3	Gravity Main	Randolph Avenue	from Green Ave to Madrone Ave	Replace - Priority 1	4	6	312	271	84,529	84,600	110,000	165,000

Table 9.5 Condition Assessment Improvements, Cost Estimates

Wastewater Collection System Master Plan

City of South San Francisco

Improv. No.	Type of Improvement	Alignment	Limits	Pipeline Renewal Choice and Priority[1]	I&I Priority[6]	Pipeline Improvements: Diameter (in)	Length (ft)	Unit Cost[2,3] ($/ft)	Infr. Cost ($)	Infrastructure Costs: Baseline Constr. Costs ($)	Estimated Constr. Costs[4] ($)	Capital Improv. Cost[5] ($)
Pipeline Improvements												
P8-FR4	Gravity Main	Madrone Ave	from Randolph Ave to 155' northeast of Chapman Ave	Repair+Full Lining - Priority 1	4	6	365	271/22	18,948	19,000	24,700	37,100
P8-FR5	Gravity Main	Randolph Avenue	from Gardiner Ave to Airport Blvd	Repair+Full Lining - Priority 1	4	6	299	271/22	22,900	22,900	29,800	44,700
P8-RP6	Gravity Main	Airport Blvd	from 100' east of Randolph Ave to 230' northeast of Butler Ave	Replace - Priority 1	4	8	297	334	99,198	99,200	129,000	193,500
P8-FR7	Gravity Main	ROW	from Gardiner Ave to 150' east of Pecks Lane	Repair+Full Lining - Priority 1	4	6	108	271/22	13,237	13,300	17,300	26,000
P8-FR8	Gravity Main	Franklin Ave	from 25' west of Larch Ave to Larch Ave	Repair+Full Lining - Priority 1	1	6	73	271/22	12,459	12,500	16,300	24,500
P8-FR9	Gravity Main	Edison Ave	from Hillside Blvd to 290' south of Randolph Ave	Repair+Full Lining - Priority 1	1	6	270	271/22	11,418	11,500	15,000	22,500
P8-FR10	Gravity Main	ROW	between Beech Ave and Hemlock Ave	Repair+Full Lining - Priority 1	2	6	132	271/22	24,607	24,700	32,200	48,300
P8-FR11	Gravity Main	ROW	between Beech Ave and Hemlock Ave	Repair+Full Lining - Priority 1	2	6	285	271/22	33,426	33,500	43,600	65,400
P8-RP12	Gravity Main	ROW	between Spruce Ave and Maple Ave	Replace - Priority 1	2	6	218	271	59,062	59,100	76,900	115,400
P8-FR13	Gravity Main	Rocca Court	from end of Rocca Court cul-de-sac to Rocca Ave	Repair+Full Lining - Priority 1	4	6	173	271/22	9,263	9,300	12,100	18,200
P8-FR14	Gravity Main	Cortesi Ave	from end of the Coresti Ave cul-de-sac to Telford Ave	Repair+Full Lining - Priority 1	4	6	470	271/22	80,885	80,900	105,200	157,800
P8-RP15	Gravity Main	Spruce Avenue	from Park Way to 340' southwest of Cortesi Ave	Replace - Priority 1	4	6	223	271	60,417	60,500	78,700	118,100
P8-RP16	Gravity Main	Maple Avenue	from 120' south of California Ave to Lux Avenue	Replace - Priority 1	3	6	235	271	63,668	63,700	82,900	124,400
P8-RP17	Gravity Main	Linden Ave	from California Avenue to 80' south of Pine Ave	Replace - Priority 1	2	6	253	271	68,545	68,600	89,200	133,800
P8-FR18	Gravity Main	Miller Ave	from 90' east of Maple Ave to Cypress Ave	Repair+Full Lining - Priority 1	4	6	1,189	271/22	80,606	80,700	105,000	157,500
P8-RP19	Gravity Main	3rd Lane	500' east of Spruce Avenue to Maple Avenue	Replace - Priority 1	3	6	405	271	109,726	109,800	142,800	214,200
P8-FR20	Gravity Main	Baden Avenue	from 510' east of Spruce Ave to Maple Ave	Repair+Full Lining - Priority 1	3	6	414	271/22	242,199	242,200	314,900	472,400
									Subtotal - Group 8	**1,265,200**	**1,645,600**	**2,468,800**
Group 9												
P9-RP1	Gravity Main	Poletti Way	from E Grand Ave to 630' west of Gateway Blvd	Replace - Priority 2	5	18	967	668	645,957	646,000	839,800	1,259,700
P9-CA2	Force Main	ROW	between Oyster Point Blvd and Gateway Blvd	Condition Assessment	5	10	759	7	5,057	5,100	6,700	10,100
P9-CA3	Force Main	ROW	between Oyster Point Blvd and Veterans Blvd	Condition Assessment	5	8	548	7	3,653	3,700	4,900	7,400
P9-CA4	Force Main	ROW	from Gull Drive to 200' north of San Francisco Bay Trail	Condition Assessment	5	8	1,406	7	9,370	9,400	12,300	18,500
P9-CA5	Force Main	Forbes Blvd	from Allerton Ave to 2300' northwest of DNA Way	Condition Assessment	5	10	916	7	6,107	6,200	8,100	12,200
P9-CA6	Force Main	Forbes Blvd	from Allerton Ave to 850' northwest of DNA Way	Condition Assessment	5	12	2,690	7	17,930	18,000	23,400	35,100
P9-RP7	Gravity Main	E Harris Ave	from 200' east of Harbor Way to 200' west of Lawrence Ave	Replace - Priority 2	5	8	260	334	86,840	86,900	113,000	169,500
P9-RP8	Gravity Main	ROW	between Littlefield Ave and Swift Avenue	Replace - Priority 2	5	8	377	334	125,918	126,000	163,800	245,700
P9-CA9	Force Main	Kimball Way	from E Grand Ave to 100' north of Swift Ave	Condition Assessment	5	10	378	7	2,519	2,600	3,400	5,100
P9-RP10	Gravity Main	ROW	between E Grand Ave and E Jamie Ct	Replace - Priority 2	5	8	259	334	86,506	86,600	112,600	168,900
									Subtotal - Group 9	**990,500**	**1,288,000**	**1,932,200**
Group 10												
P10-CA1	Force Main	Lowrie Ave	from LS-9 to LS-11	Condition Assessment	5	36	4,087	7	27,248	27,300	35,500	53,300
P10-CA2	Force Main	ROW	from LS-9 to LS-5	Condition Assessment	5	24	4,676	7	31,173	31,200	40,600	60,900
P10-CA3	Force Main	ROW	from LS-11 to LS-5	Condition Assessment	5	28	2,279	7	15,194	15,200	19,800	29,700
P10-FR4	Gravity Main	ROW	between Utah Ave and S Airport Blvd	Repair+Full Lining - Priority 2	5	8	585	334/30	124,214	124,300	161,600	242,400
P10-CA5	Force Main	Utah Ave	from Colma Creek to Harbor Way	Condition Assessment	5	6	559	7	3,727	3,800	5,000	7,500
P10-FR6	Gravity Main	Harbor Way	from Mitchell Ave to 700' north of Littlefield Ave	Repair+Full Lining - Priority 2	5	8	1,204	334/30	229,395	229,400	298,300	447,500
P10-CA7	Force Main	ROW	from 100' east of Mitchell Ave to WQCP	Condition Assessment	5	21	2,663	7	17,749	17,800	23,200	34,800
P10-FR8	Gravity Main	Utah Ave	from 500' east of Harbor Way to Littlefield Ave	Repair+Full Lining - Priority 2	5	8	1,061	334/30	271,917	272,000	353,600	530,400
P10-FR9	Gravity Main	Littlefield Ave	from 270' south of Utah Ave to 900' northeast of Harbor Way	Repair+Full Lining - Priority 2	5	8	546	334/30	129,738	129,800	168,800	253,200
P10-RP10	Gravity Main	Littlefield Ave	from 780' southwest of Utah Ave to 580' east of Harbor Way	Replace - Priority 2	5	10	333	390	129,839	129,900	168,900	253,400
P10-FR11	Gravity Main	Littlefield Ave	from 350' east of Harbor Way to 575' east of Harbor Way	Repair+Full Lining - Priority 2	5	10	219	390/37	70,495	70,500	91,700	137,600
P10-CA12	Force Main	ROW	from Littlefield Ave to WQCP	Condition Assessment	5	8	741	7	4,939	5,000	6,500	9,800
P10-RP13	Gravity Main	S Linden Ave	from 675' northwest of Dollar Ave to 700' south of Victory Ave	Replace - Priority 2	5	8	293	334	97,862	97,900	127,300	191,000
									Subtotal - Group 10	**1,154,100**	**1,500,800**	**2,251,500**
									Total Improvement Costs	**9,985,900**	**12,987,700**	**19,485,000**

AKEL ENGINEERING GROUP, INC.

7/14/2022

1. Project priority for condition assessment improvements was determined by severity of pipeline defects and overall risk score of pipeline.
2. Unit costs for point repair / partial lining are shown as a unit cost for repair and lining.
3. Total costs for point repair / partial lining account for 20 feet of replacement pipe and lining for each rehabilitation.
4. Estimated Construction costs include 30 percent of baseline construction costs to account for unforeseen events and unknown field conditions.
5. Capital Improvement Costs also include an additional 50 percent of the estimated construction costs to account for engineering design, project administration, construction management and inspection, and legal costs.
6. Ranking Grouping:
   - **Rank 1** = R-Value ≥ 75%
   - **Rank 2** = 75% > R-Value ≥ 50%
   - **Rank 3** = 50% > R-Value ≥ 25%
   - **Rank 4** = 25% > R-Value ≥ 10%
   - **Rank 5** = R-Value ≤ 10%

Table 9.6 In-Progress Renewal Projects

City-Wide Sewer System Master Plan
South San Francisco

Improve. No.	Type of Improvement	Alignment	Limits	Pipeline Renewal Choice	Infrastructure Costs Diameter (in)	Length (ft)	Unit Cost ($)	Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Costs[1] ($)	Capital Improv. Cost[2,3] ($)
Pipeline Replacement											
IP-RP1	Gravity Main	Clay Ave	From approx 120' e/o Longford Dr to approx 100' w/o Newman Dr	Replacement	10	180	390	70,183	70,183	91,238	136,857
					Subtotal - Pipeline Replacement				**70,183**	**91,238**	**136,857**
Pipeline Bursting											
IP-BR1	Gravity Main	EL Camino Real	From approx. 310' w/o W Orange Ave to W Orange Ave	Pipe Burst	6	84	107	8,959	8,959	11,647	17,471
IP-BR2	Gravity Main	ROW	From approx. 170' e/o Del Monte Ave to approx 180' w/o Camaritas Ave	Pipe Burst	6	150	107	15,999	15,999	20,799	31,198
IP-BR3	Gravity Main	Sister Cities Blvd	From Mandalay Pl to Airport Blvd	Pipe Burst	10	1,263	167	210,486	210,486	273,632	410,448
					Subtotal - Pipeline Bursting				**235,445**	**306,078**	**459,117**
Pipeline Lining											
IP-L1	Gravity Main	EL Camino Real	From approx. 310' w/o W Orange Ave to W Orange Ave	Full Lining	6	84	22	1,867	1,867	2,427	3,640
IP-L2	Gravity Main	ROW	From approx. 170' e/o Del Monte Ave to approx 180' w/o Camaritas Ave	Full Lining	6	150	22	3,333	3,333	4,333	6,500
IP-L3	Gravity Main	Sister Cities Blvd	From Mandalay Pl to Airport Blvd	Full Lining	10	1,263	37	46,775	46,775	60,807	91,211
IP-L4	Gravity Main	ROW	From Escanyo Dr to Westborough Blvd	Full Lining	6	150	22	3,333	3,333	4,333	6,500
IP-L5	Gravity Main	ROW	Approx 90' s/o Grand Ave	Full Lining	6	200	22	4,444	4,444	5,777	8,666
IP-L6	Gravity Main	ROW	From El Camino Real to McDonnel Dr	Full Lining	6	625	22	13,888	13,888	18,054	27,082
					Subtotal - Pipeline Lining				**73,640**	**95,732**	**143,597**
Manhole Rehabilitation											
IP-MRH1	Manhole	Granada Dr	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH2	Manhole	Granada Dr	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH3	Manhole	Granada Dr	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH4	Manhole	Haven Ave	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH5	Manhole	W Orange Ave	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH6	Manhole	Arroyo Dr	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH7	Manhole	Railroad Ave	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH8	Manhole	Orange Ave	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
IP-MRH9	Manhole	Orange Ave	-	Rehabilitation	-	-	4,300	4,300	4,300	5,590	8,385
					Subtotal - Manhole Rehabilitation				**38,700**	**50,310**	**75,465**

Table 9.6 In-Progress Renewal Projects

City-Wide Sewer System Master Plan
South San Francisco

Improve. No.	Type of Improvement	Alignment	Limits	Pipeline Renewal Choice	Infrastructure Costs: Diameter (in)	Length (ft)	Unit Cost ($)	Infr. Cost ($)	Baseline Constr. Costs ($)	Estimated Constr. Costs[1] ($)	Capital Improv. Cost[2,3] ($)
Manhole Replacement											
IP-MRP1	Manhole	EL Camino Real	-	Replacement	-	-	32,600	32,600	32,600	42,380	63,570
IP-MRP2	Manhole	Victory Ave	-	Replacement	-	-	32,600	32,600	32,600	42,380	63,570
					Subtotal - Manhole Replacement				**65,200**	**84,760**	**127,140**
Total											
					Subtotal - Pipeline Replacement				**70,183**	**91,238**	**136,857**
					Subtotal - Pipeline Bursting				**235,445**	**306,078**	**459,117**
					Subtotal - Pipeline Lining				**73,640**	**95,732**	**143,597**
					Subtotal - Manhole Rehabilitation				**38,700**	**50,310**	**75,465**
					Subtotal - Manhole Replacement				**65,200**	**84,760**	**127,140**
					Total Improvement Costs				**483,167**	**628,118**	**942,176**

AKEL ENGINEERING GROUP, INC.

7/10/2022

Notes:
1. Estimated Construction costs include 30 percent of baseline construction costs to account for unforeseen events and unknown field conditions.
2. Capital Improvement Costs also include an additional 50 percent of the estimated construction costs to account for engineering design, project administration, construction management and inspection, and legal costs.
3. Capital Improvement Costs are shown for planning purposes only and may be superseded by more recent cost estimates at the discretion of City staff.

- **IP-L1**: Conduct full lining replacement on the 6-inch gravity main along El Camino Real from approximately 310 feet west of West Orange Avenue to West Orange Avenue.
- **IP-L2**: Conduct full lining replacement on the 6-inch gravity main along the right-of-way from approximately 170 feet east of Del Monte Avenue to approximately 180 feet west of Camaritas Avenue.
- **IP-L3**: Conduct full lining replacement on the 10-inch gravity main along Sister Cities Boulevard from approximately 60 feet south of South San Francisco Drive to approximately 260 feet west of Woods Circle.
- **IP-L4**: Conduct full lining replacement on the 10-inch gravity main along Sister Cities Boulevard from approximately 150 feet east of North Spruce Avenue to approximately 1,500 feet west of Airport Boulevard.
- **IP-L5**: Conduct full lining replacement on the 6-inch gravity main along the right-of-way from Escanyo Drive to Westborough Boulevard.
- **IP-L6**: Conduct full lining replacement on the 6-inch gravity main along the right-of-way from approximately 90 feet south of Grand Avenue.
- **IP-L7**: Conduct full lining replacement on the 6-inch gravity main along the right-of-way from El Camino Real to McDonell Drive.
- **IP-MRH1**: Conduct rehabilitation of the manhole located on Granada Drive.
- **IP-MRH2**: Conduct rehabilitation of the manhole located on Granada Drive.
- **IP-MRH3**: Conduct rehabilitation of the manhole located on Granada Drive.
- **IP-MRH4**: Conduct rehabilitation of the manhole located on Haven Avenue.
- **IP-MRH5**: Conduct rehabilitation of the manhole located on West Orange Avenue.
- **IP-MRH6**: Conduct rehabilitation of the manhole located on Arroyo Drive.
- **IP-MRH7**: Conduct rehabilitation of the manhole located on Railroad Avenue.
- **IP-MRH8**: Conduct rehabilitation of the manhole located on Orange Avenue.
- **IP-MRH9**: Conduct rehabilitation of the manhole located on Orange Avenue.
- **IP-MRP1**: Replace manhole in-kind located on El Camino Real.
- **IP-MRP2**: Replace manhole in-kind located on Victory Avenue.

APPENDICES