Collection System Master Plan Update

FINAL REPORT | AUGUST 2021



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COLLECTION SYSTEM MASTER PLAN

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0011180.01
City of Pacifica, CA
August 2021

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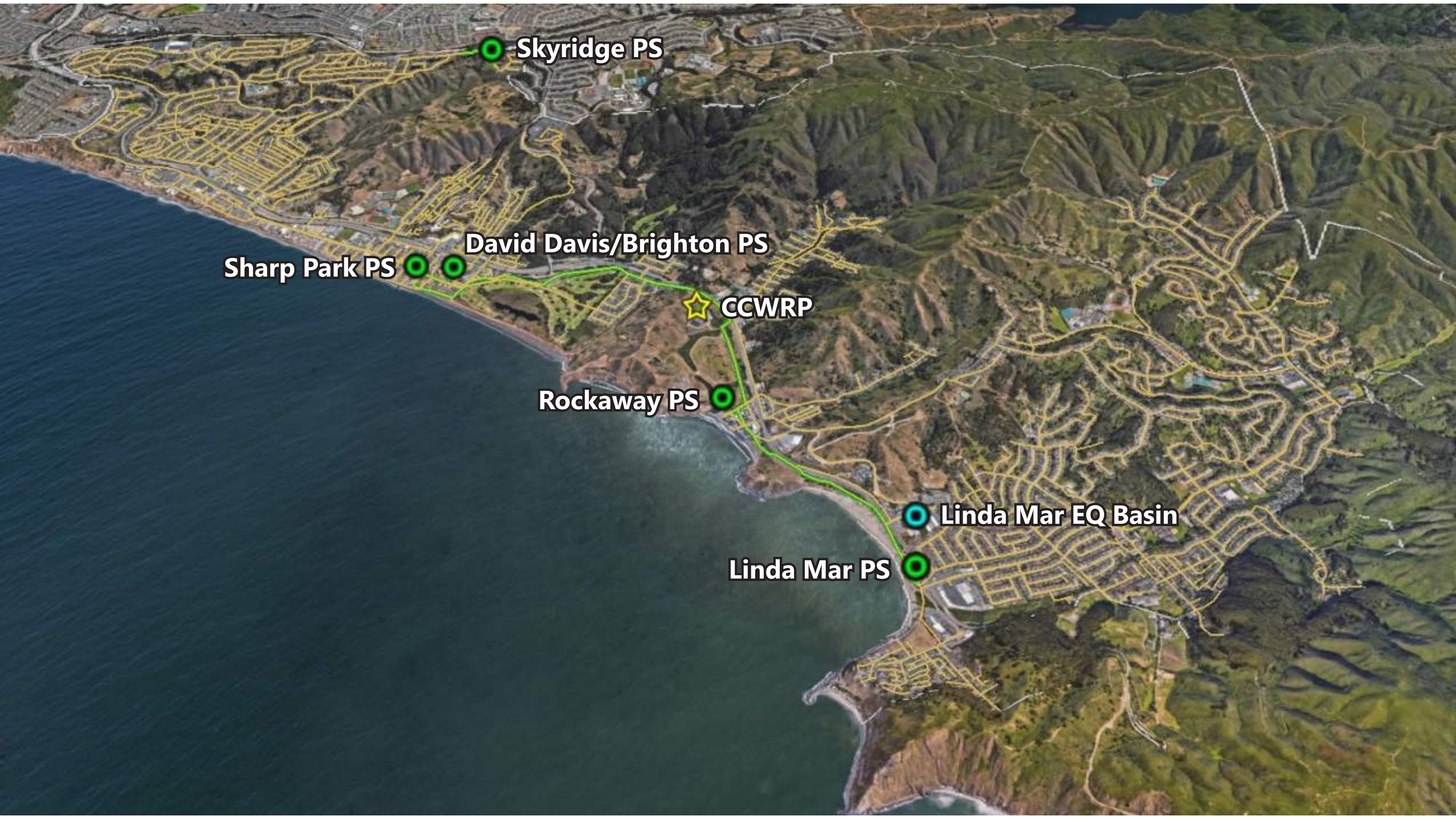
LIST OF ABBREVIATIONS

ACP	Asbestos Cement Pipe
ADWF	Average Dry Weather Flow
APN	Assessor Parcel Number
BWF	Base Wastewater Flow
CCTV	Closed-Circuit Television
CCWRP	Calera Creek Water Recycling Plant
CDO	Cease and Desist Order
CIP	Capital Improvement Program or Capital Improvement Plan
CIPP	Cured-in-Place Pipe
City	City of Pacifica
DEM	Digital Elevation Model
DU	Dwelling Unit
DWF	Dry Weather Flow
ENR CCI	Engineering News Record Construction Cost Index
fps	Feet per second
FY	Fiscal Year
GIS	Geographic Information System
gpd	Gallons per day
gpcd	Gallons per capita per day
GWI	Groundwater Infiltration
HDPE	High Density Polyethylene (Pipe)
I&I	Infiltration and Inflow
MFR	Multi-Family Residential
MG	Million Gallons
mgd	Million Gallons per Day
MH	Manhole
PDWF	Peak Dry Weather Flow
PS	Pump Station
PVC	Polyvinyl Chloride (Pipe)
PWWF	Peak Wet Weather Flow
RDI&I	Rainfall Dependent Infiltration and Inflow
R&R	Rehabilitation and Replacement
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SECAP	System Evaluation and Capacity Assurance Plan
SFR	Single Family Residential
SSMP	Sewer System Management Plan
VCP	Vitrified Clay Pipe
WWF	Wet Weather Flow
WWPF	Wet Weather Peaking Factor

Executive Summary



EXECUTIVE SUMMARY

This report presents the results and recommendations of the Collection System Master Plan Phase 2 Update (Master Plan) for the City of Pacifica (City). The objective of this plan is to update the portions of the City's 2011 Sewer Collection Master Plan (2011 Master Plan) report that address sewer system hydraulic capacity and needed capacity improvements. The report was prepared by Woodard & Curran under an agreement with the City dated August 12, 2019.

The City is subject to infiltration and inflow (I&I) of extraneous groundwater and stormwater into the collection system, resulting in high wet weather flows during storm events. As a result, sanitary sewer overflows (SSOs) have occurred at several locations in the system during large storms. In 2011, the City was issued a Cease and Desist Order (CDO) by the San Francisco Bay Regional Water Quality Control Board (RWQCB) and also entered into a Consent Decree with Our Children's Earth Foundation, a non-governmental organization, both of which required the City to implement a number of measures targeted at reducing SSOs, which are discussed in the 2011 Master Plan report. The 2011 Master Plan report also served to satisfy specific requirements of the CDO and Consent Decree related to the sewer system including: a condition assessment, preparation of the System Evaluation and Capacity Assurance Plan (SECAP) as required by the Statewide General Wastewater Discharge Requirements for Sanitary Sewer Systems, and development of a long-range Capital Improvement Program (CIP) for the wastewater collection system.

Since 2011, the City has completed many of the recommendations identified in the 2011 Master Plan including the Pedro Point Sewer Rehabilitation Project, which reduced peak wet weather flows (PWWFs) by half through improvement of approximately 15,000 linear feet (LF) of sewer mains, and the Linda Mar Flow Equalization Basin Project, which provides the City with flexibility in addressing and reducing PWWFs to the City's Calera Creek Water Recycling Plant (CCWRP). In addition, the City has also completed a number of other rehabilitation and repair programs expected to reduce I&I. The current Master Plan is therefore intended to incorporate the system changes, reassess projected flows, and identify any remaining capacity improvement projects needed.

The City has also embarked on several assessments to address sea level rise and climate change topics. A supplementary Technical Memorandum (TM) was prepared to summarize the risks identified by those studies associated with the City's collection system assets and is provided as **Attachment F**. The City has recently finalized other supporting documents such as the Certification Draft Local Coastal Land Use Plan (LCLUP) and the Beach Boulevard Infrastructure Resiliency Project (BBIRP) reports. These supporting documents also identify areas of vulnerable sewer collection system infrastructure and provide a roadmap of policies for sections of Pacifica's coastline. The BBIRP Multi Hazard Risk Assessment provides a conceptual relocation plan along with estimated relocation cost of the sewer infrastructure in the West Sharp Park neighborhood noting the cost to be about forty million dollars (with specific details of the cost included in the report). The report identifies both a critical mainline along Beach Boulevard and the Sharp Park Pump Station as vulnerable assets without completion of a protection project. The City should continue to move forward with the BBIRP final project construction to protect the City's important sewer infrastructure in this area. The Certification Draft LCLUP has policies that support protecting existing vulnerable infrastructure through means of shoreline protection devices and beach nourishment throughout the City, which the City should undertake as soon as possible. The Public Works Wastewater Division should assist the City-led efforts in planning and protecting vital wastewater infrastructure through the support of these projects. This is a cost-effective way to protect the City's sewer infrastructure while dealing with the uncertainty of sea level rise and climate change.

Existing Sewer System and Service Area

The City's wastewater collection system serves a population of about 40,000 within the City of Pacifica city limits. The system includes approximately 97 miles of gravity sewer mains, 4 miles of pressure (force) mains, and 5 sewage pump stations. All wastewater is pumped via the three largest pump stations (Sharp Park, Linda Mar, and Rockaway) to the CCWRP. **Figure ES-1** shows the existing collection system.

The primary sewer pipe material in the collection system is vitrified clay pipe (VCP) with some areas of asbestos cement pipe (ACP), and plastic materials used for newer sewer construction and rehabilitation. A large portion of the system was constructed in the 1940s and 1950s, with some newer areas (e.g., Park Pacifica and Fairmont) developed in the 1960s. There has been relatively little new sewer construction since that time, although the City has continued to rehabilitate and replace aging pipes in poor structural condition.

The collection system also includes approximately 12,000 private sewer laterals. The Property Owner is responsible for the maintenance and repair of the lateral. Some of the original laterals used Orangeburg pipe for lateral construction. The City has been replacing these laterals, as well as other VCP laterals, as part of ongoing improvements.

The 2011 Master Plan proposed a number of capacity related improvements, including a new Linda Mar Equalization Basin (EQ Basin) and several pipeline upsizing projects. Most of those improvements have been completed, although the EQ Basin is not yet operational during wet weather. In addition, the City has also undertaken a number of rehabilitation and replacement (R&R) projects and, since their implementation, a significant reduction in I&I rates has been observed by operations staff. The purpose of this Master Plan is to assess the effectiveness of those R&R projects at reducing I&I and to identify whether any additional capacity improvement projects are needed.

Capacity Assessment

The capacity of the collection system was assessed using a hydraulic model. The assessment focused on the trunk sewer network, the system of pipes that convey flow generated throughout the system to the major pump stations and CCWRP. The modeled network includes all gravity sewers 10 inches in diameter and larger and additional 6- and 8-inch pipes, totaling about 30 percent of the length of sewers in the collection system, plus four of the system's pump stations and their associated force mains. The modeled network is shown in **Figure ES-1**.

Flow loads to the model were developed from customer water use data provided by the City, estimates of additional flows from potential future development (fairly minimal for Pacifica, as the city is largely built out), and from a flow monitoring program conducted for this study. Winter water use data typically provides a very accurate estimate of base wastewater flow (BWF), as outside water use is minimal during that time of year.

Flow monitoring was conducted at 21 sites in the collection system during the winter 2019/20, with rainfall data also collected by three temporary rain gauges. The purpose of the monitoring was to obtain data to confirm base wastewater flows and to quantify the I&I response of the system to rainfall. The flow monitoring data was used to estimate the amount of groundwater infiltration (GWI) and rainfall-dependent I&I (RDI&I) for various areas of the system and to confirm, through model calibration, that the hydraulic model reasonably simulates the actual performance of the system during both dry and wet weather conditions. **Table ES-1** summarizes the existing and future average BWF for the City's sewer system.

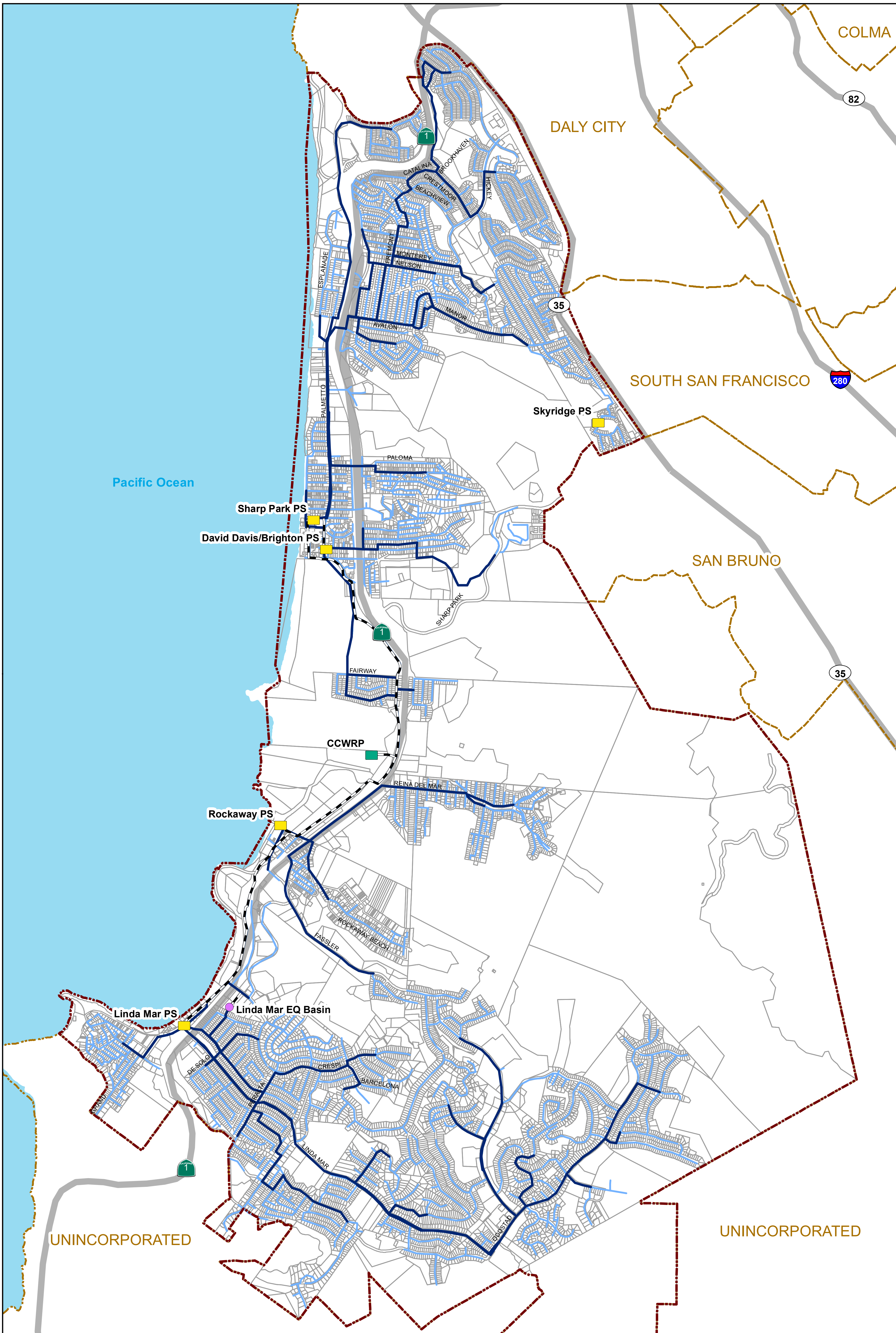


Figure ES-1
Existing Wastewater Collection System

Wastewater Collection System Master Plan

Legend

- Force Main
- Modeled Sewers
- Unmodeled Sewers
- Parcels

Facilities

- Pump Station
- Water Recycling Plant
- Equalization Basin

- Pacifica City Limits
- Other City Boundaries

0 0.125 0.25 0.5 Miles

N

Project #: 0011180.01
Map Created: August 2021

Table ES-1: City of Pacifica Dry Weather Flow Summary

Type of Development	Estimated BWF (mgd)		
	Existing	Existing Plus Opportunity Sites[1]	Buildout[2]
Residential	1.75	1.79	2.02
Non-Residential	0.21	0.52	0.54
Total	**1.96**	**2.31**	**2.56**

1. The City has identified a total of 318 opportunity sites as well as the Hengli Higgins Way Subdivision, which is planned to include approximately 60 very low-density residential lots.
2. Includes other parcels identified as vacant and potentially developable.

Existing per capita residential wastewater flow was estimated as 46 gallons per capita per day (gpcd) based on Department of Finance population data for January 1, 2021, compared to approximately 54 gpcd in the 2011 Master Plan (calculated based on the reported average residential dry weather flow (DWF) and the Census 2010 population).

Design Storm

The capacity of the system was assessed with respect to a design rainfall event. This Master Plan uses the same design rainfall event as the 2011 Master Plan, which selected a 10-year recurrence frequency, 24-hour duration storm using an "SCS Type 1A" temporal distribution. The storm has a total 24-hour rainfall of 3.74 inches with a peak intensity of 0.59 inches per hour. The design storm is comparable in size to notable large rainfall events that have occurred in the San Francisco Bay Area since 2000, including the storms of December 31, 2005, January 25, 2008, and February 13-14, 2019.

Capacity Analysis Results

The hydraulic model was run with the 10-year design storm to identify areas of the collection system that would not have adequate capacity to convey the peak wet weather flows generated by that event. Wastewater collection system flows are summarized in **Table ES-2**.

Table ES-2: Summary of Wastewater Collection System Flows

Model Scenario[1]	Flow to CCWRP (mgd)
Existing Average Dry Weather Flow	2.5
Existing Peak Dry Weather Flow	4.6
Existing Peak Wet Weather Flow	19.7
Future Average Dry Weather Flow	3.1
Future Peak Dry Weather Flow	5.7
Future Peak Wet Weather Flow	20.0

1. Model scenarios are based on the existing trunk sewer network with no improvements considered. Implementation of the recommended capacity improvements is not expected to have a significant impact on projected PWWFs; however, the proposed improvements are consistent with the City's long-term goal of addressing wet weather capacity issues. Capacity improvements are further discussed in **Section 4.1**.

Consistent with the 2011 Master Plan, sewer capacity in this Master Plan was considered inadequate whenever the model predicted that the peak flows would result in surcharge (flow above the crown of sewer pipes) to within 4 feet of manhole rims or overflows from the system. Pump station capacity was considered inadequate if the peak flows exceeded the station's firm capacity (capacity with the largest pump not in operation).

The modeling indicated gravity pipeline capacity deficiencies in four locations in the collection system. Based on the model results, four improvement projects to address the predicted capacity deficiencies were developed as shown in

Table ES-3 and **Figure ES-2**. All four projects involve replacing existing deficient (undersized) sewers with larger diameter pipes. Proposed sewer improvements were tested in the model to confirm that they would eliminate the identified capacity deficiencies and to confirm that sewers and pump stations downstream of the upsized pipes could handle the higher peak flows. No pump station deficiencies were identified. Discussions with the City indicated that aging pumps and outdated electrical systems are being replaced and/or updated as needed to maintain and improve overall pump station reliability.

Costs for capacity improvement projects were estimated based on Woodard & Curran's experience with similar projects in the greater San Francisco Bay Area. These cost estimates are planning or conceptual level estimates and are considered to have an estimated accuracy range of -30 to +50 percent. This level of accuracy corresponds to an "order of magnitude" or "Class 5" cost estimate as defined by the American Association of Cost Estimators. These estimates are suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed into the design and construction phases. All costs are presented in current dollars based on an Engineering News Record Construction Cost Index (ENR-CCI) for the San Francisco Bay Area of 13,169 in December 2020.

Table ES-3:Recommended Capacity Improvement Projects

Project ID	Project Name	Deficiency Type	Description[2]	Estimated Construction Cost	Estimated Project Cost[1]
1	Crespi Drive	Predicted overflow	Upsize 474 LF of 6" to 8" pipe and upsize 1,054 LF of 8" to 12" pipe on Crespi Dr. from Peralta Rd. to Barcelona Dr.	$792,000	$1,069,000
2	Linda Mar Boulevard	Inadequate freeboard	Upsize 307 LF of 20" to 27" pipe on Linda Mar Blvd. between De Solo Dr. and Peralta Rd.	$335,000	$453,000
3	Fremont Avenue	Inadequate freeboard	Upsize 278 LF of 12" to 15" pipe on Fremont Ave. between Nelson Ave. and Monterey Rd.	$154,000	$207,000
4	Catalina Avenue	Predicted overflow	Upsize 940 LF of 10" to 12" pipe on Catalina Ave. and Beachview Ave. from Brookhaven Ct. to Crestmoor Cir.	$547,000	$739,000

1. Includes construction costs (pipe installation, lateral reconnection, bypass pumping, traffic control, mobilization/demobilization, and contingencies) plus engineering, administration, and legal fees (estimated as 35 percent of construction costs).
2. Proposed pipe sizes are based on standard sewer pipe diameters. If pipe bursting with HDPE, a pipe with an equivalent inside diameter would be used.

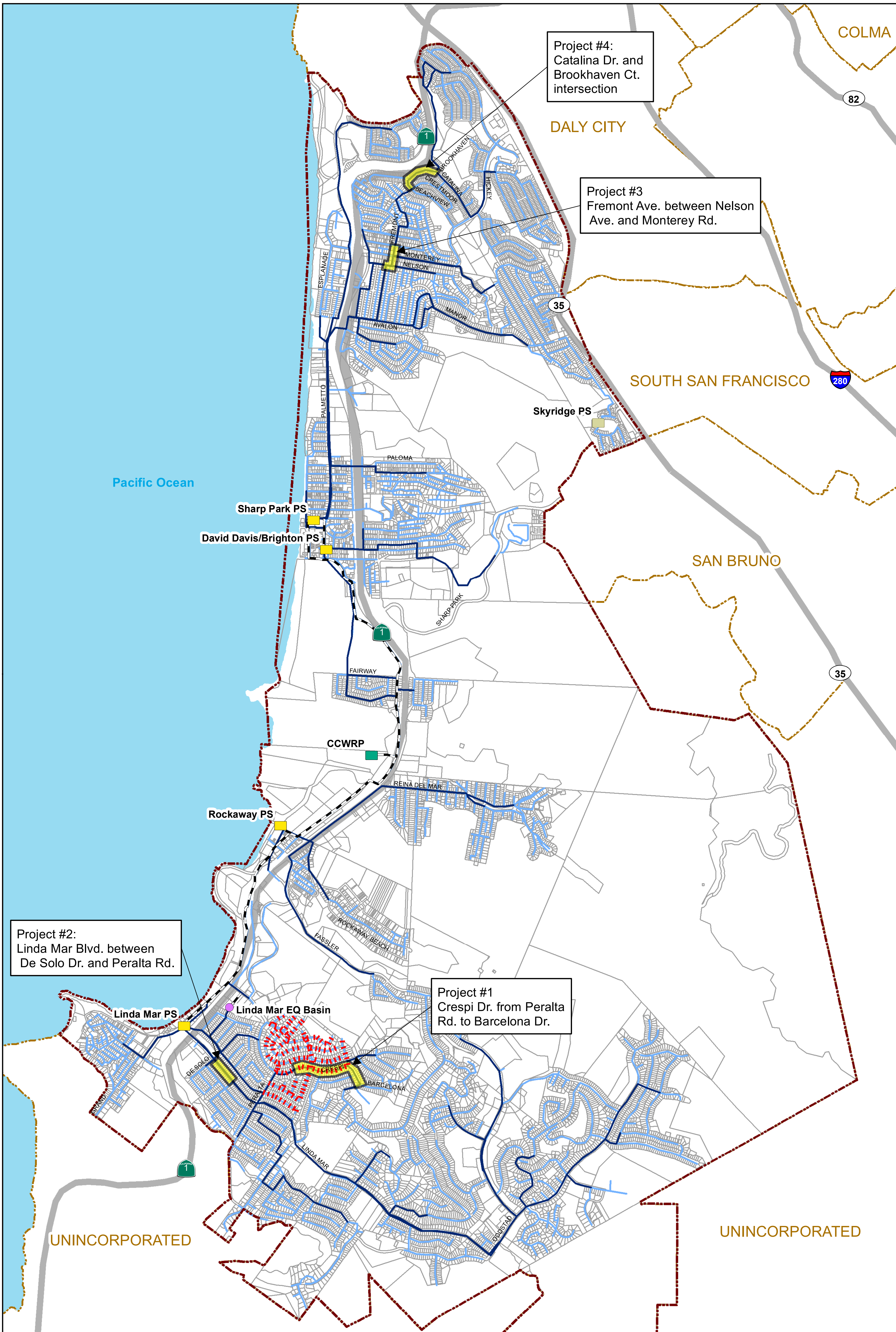


Figure ES-2
Recommended Capacity Improvement Projects
Wastewater Collection System Master Plan

Legend

- Project Area
- Modeled Sewers
- Force Main
- Unmodeled Sewers
- Equalization Basin

Facilities

- Pump Station
- Water Recycling Plant
- Pump Station (unmodeled)
- Future City Rehabilitation and Replacement (R&R) Project
- Pacifica City Limits
- Other City Boundaries

0 0.125 0.25 0.5 Miles

N

City of Pacifica
WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

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Project Implementation Recommendations

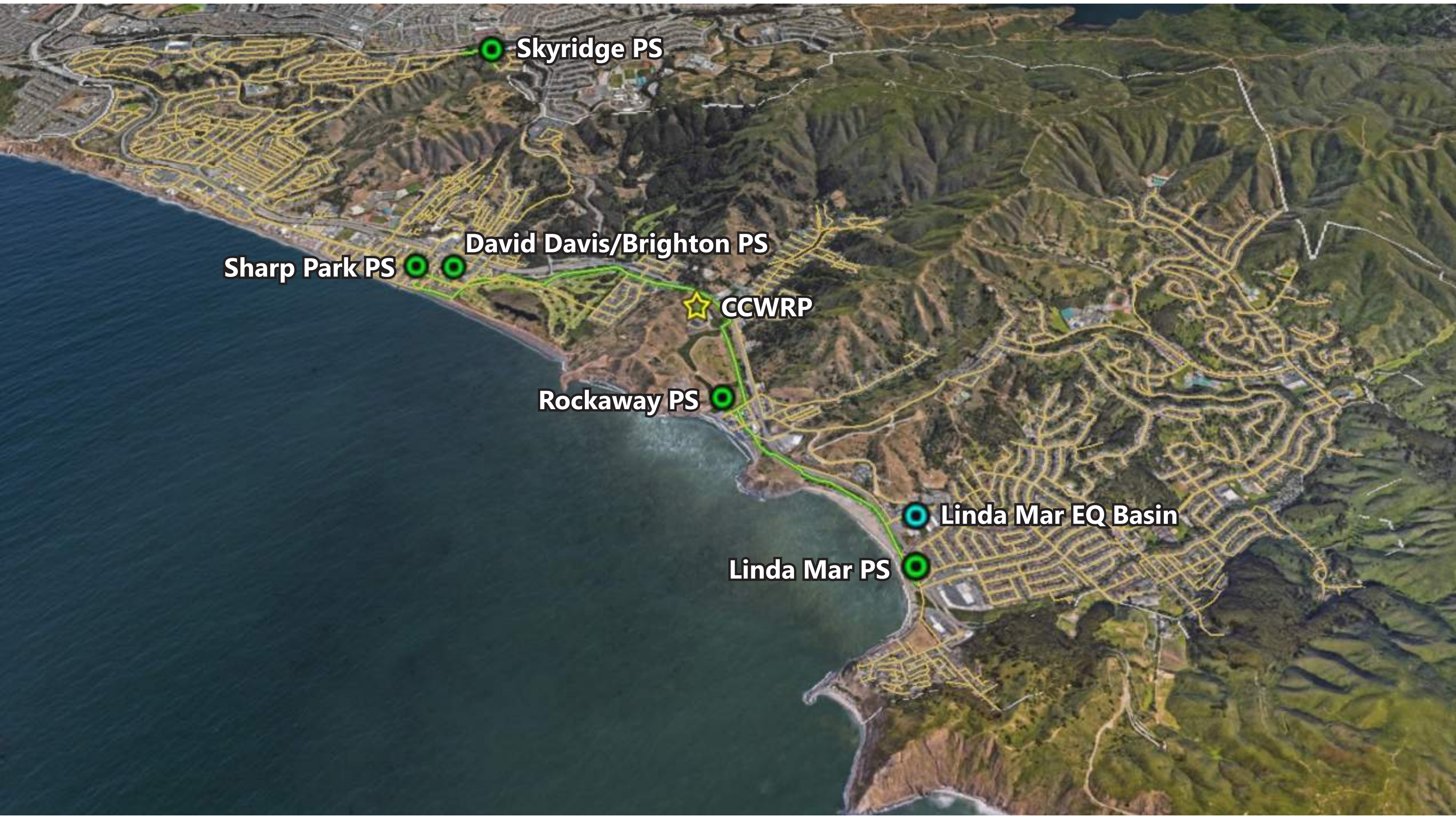
The City should begin implementation of the capacity improvements recommended in this Master Plan. This plan does not specify an implementation schedule, as the City will need to balance the timing of sewer capacity improvements with the need for other capital projects, such as sewer rehabilitation and pump station upgrades. The following items should be considered in project scheduling and design, and in future updates of the Master Plan:

- The alignments and sizes of all recommended projects should be verified with detailed predesign analyses, including topographic surveys, geotechnical investigations, utility research, and constructability reviews;
- The projects recommended in this report are based on pipe replacement. The decision to parallel or replace existing sewers should consider the physical condition and remaining useful life of the existing pipelines; the availability of pipeline corridors for new sewer construction; and operation and maintenance concerns;
- Only standard pipe diameters (e.g., 8, 10, 12, 15, 18 inches, etc.) were modeled; appropriate pipe sizes for HDPE pipe should be considered as part of design;
- The hydraulic model has been developed to assist the City in performing capacity analyses and updating the Master Plan in the future. The model should be kept up-to-date with any changes to existing sewer connections, development plans, and sewer system facilities;
- The City should continue with its sewer inspection and condition assessment program, identifying sewers that should be replaced due to poor condition. To the extent possible, these improvements should be coordinated with the recommended capacity-related improvements;
- In addition to the project implementation recommendations listed above, the City should continue to address I&I through continued CCTV inspection and rehabilitation of sewer mains and lower laterals. Additional flow monitoring and field investigations should be conducted in high I&I areas to identify possible opportunities for I&I reduction, and the resulting elimination or downsizing of some of the CIP projects presented herein;
- Growth projections assumed herein should be updated as needed to reflect the City's General Plan and Sharp Park Specific Plan updates, which are currently ongoing, and need to meeting regional housing needs. Based on the Draft Regional Housing Needs Allocation (RHNA) Plan for the San Francisco Bay Area, prepared in May 2021, the City must plan to accommodate a total of 1,892 new households between 2023-2031 to meet regional housing needs;
- The City should assess its connection fees and sewer rates and evaluate financial alternatives to fund the recommended capacity improvement projects, including methods for allocating costs to future development; and
- Although this recommended project is not a capacity-related improvement, the City should consider re-routing the 12-inch sewer line that runs underneath the San Francisco RV park main building to an alignment along Palmetto Avenue.

This Master Plan is intended to be a working document to be refined and updated as additional data and new planning information becomes available. The Master Plan should be updated whenever there are major changes in planning assumptions and conditions or, at a minimum, every 5 to 10 years.

CHAPTER 1

Introduction



1. INTRODUCTION

This report presents the results and recommendations of the Collection System Master Plan Phase 2 Update (Master Plan) for the City of Pacifica (City). The report was prepared by Woodard & Curran under an agreement with the City dated August 12, 2019. This introductory chapter provides background information on the objectives and scope of the Master Plan, the City's sewer system and service area, and the contents and organization of the Master Plan report.

1.1 Background and Study Objectives

Prior to this study, the City last conducted a comprehensive assessment of its wastewater collection system in its 2011 Collection System Master Plan (2011 Master Plan). The 2011 Master Plan proposed a number of capacity related improvements, including a new Linda Mar Equalization Basin (EQ Basin) and several pipeline upsizing projects such as the Pedro Point Sewer Rehabilitation Project. Most of those improvements have been completed, although the EQ Basin is not yet operational during wet weather. In addition, the City has also undertaken a number of rehabilitation and repair (R&R) projects and, since their implementation, a significant reduction in I&I rates has been observed by operations staff. The purpose of this Master Plan is to assess the effectiveness of those R&R projects at reducing I&I and to identify whether any additional capacity improvement projects are needed.

1.2 Study Area

The study area for this Master Plan consists of the City of Pacifica. The collection system serves a population of about 40,000 within the city limits and does not convey any flows from outside the city. **Figure 1-1** shows the study area. The city is bounded on the north by the City of Daly City, on the northeast by the Cities of South San Francisco and San Bruno, on the south and southeast by unincorporated portions of San Mateo County, and on the west by the Pacific Ocean. The city is divided into several individual communities or districts (e.g., Edgemar, Pacific Manor, Sharp Park, Fairway Park, Vallemar, Rockaway Beach, Linda Mar, Park Pacifica, Pedro Point), largely delineated by ridges and valleys. Three major creeks (Milagra, Calera, and San Pedro Creeks) drain in an east-to-west direction across the city and discharge into the Pacific Ocean. The city is largely built out with significant areas of open space, including portions of the Golden Gate National Recreation Area. There are only a few areas of projected future development.

1.3 Existing Sewer System

The City's wastewater collection system includes approximately 97 miles of gravity sewer mains, 4 miles of pressure (force) mains, and five sewage pump stations. All sewage is pumped via the three largest pump stations (Sharp Park, Linda Mar, and Rockaway) to the Calera Creek Water Recycling Plant (CCWRP), which is located centrally in the system just west of Highway 1 opposite Reina Del Mar in the Vallemar area. The other two pump stations serve smaller areas within the collection system. **Figure 1-2** shows the existing collection system layout and **Figure 1-3** shows the existing connected parcels. **Table 1-1** summarizes the footage of pipe by diameter. As noted in the table, nearly 60 percent of the gravity sewer mains are 6 inches in diameter, and over 85 percent are less than 10 inches. Since the 2011 Master Plan, about 7 percent of the 6-inch sewers have been replaced by 8-inch or larger sewers.

Table 1-1: Collection System Inventory

Pipe Size (in.)	Length (feet)	Length (miles)	Percent of Total
Gravity Sewer Mains			
<6 or unknown	561	0.1	0.1%
6	296,693	56.2	57.7%
8	141,531	26.8	27.5%
10	23,879	4.5	4.6%
12	23,192	4.4	4.5%
15	14,402	2.7	2.8%
18	8,920	1.7	1.7%
20-21	3,019	0.6	0.6%
24-30	2,068	0.4	0.4%
Total	**514,264**	**97.4**	**100%**
Force Mains			
6-12	14,475	2.8	66%
20-26	6,891	1.3	31%
36	649	0.1	3%
Total	**22,016**	**4.2**	**100%**

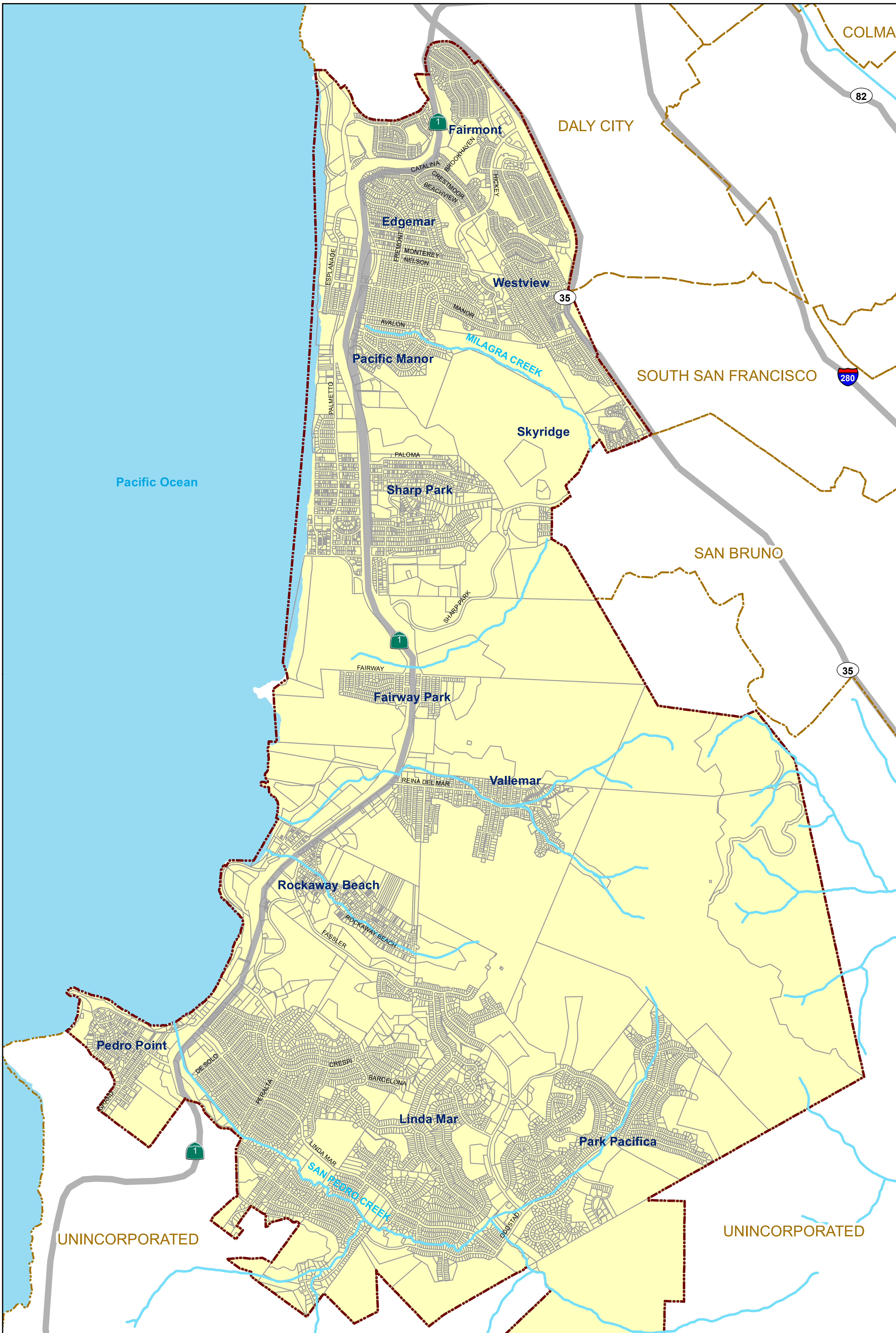


Figure 1-1
Study Area

Wastewater Collection System
Master Plan

Legend

- Pacifica City Limits
- Other City Boundaries
- Parcels

0 0.125 0.25 0.5
Miles

N

City of Pacifica

WOODARD & CURRAN

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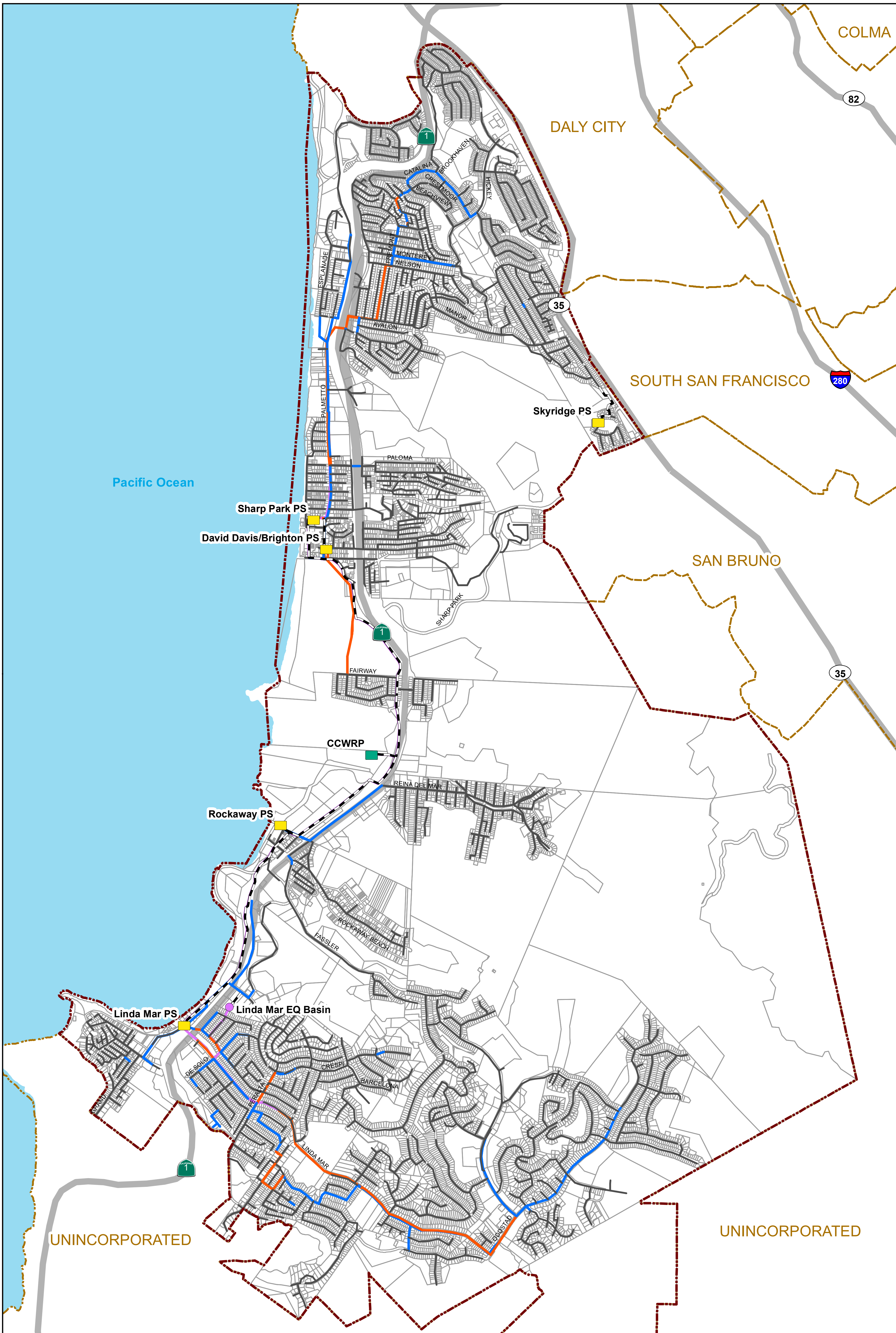

Figure 1-2
Existing Collection System

Wastewater Collection System
Master Plan

Legend

Pipe Diameter
- 4" - 8"
- 10" - 12"
- 15" - 18"
- > 18"

- Forcemain
- Parcels
- Pacifica City Limits
- Other City Boundaries

Facilities
- Pump Station
- Water Recycling Plant
- Equalization Basin

0 0.1 0.2 0.4 Miles

N

City of Pacifica
WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

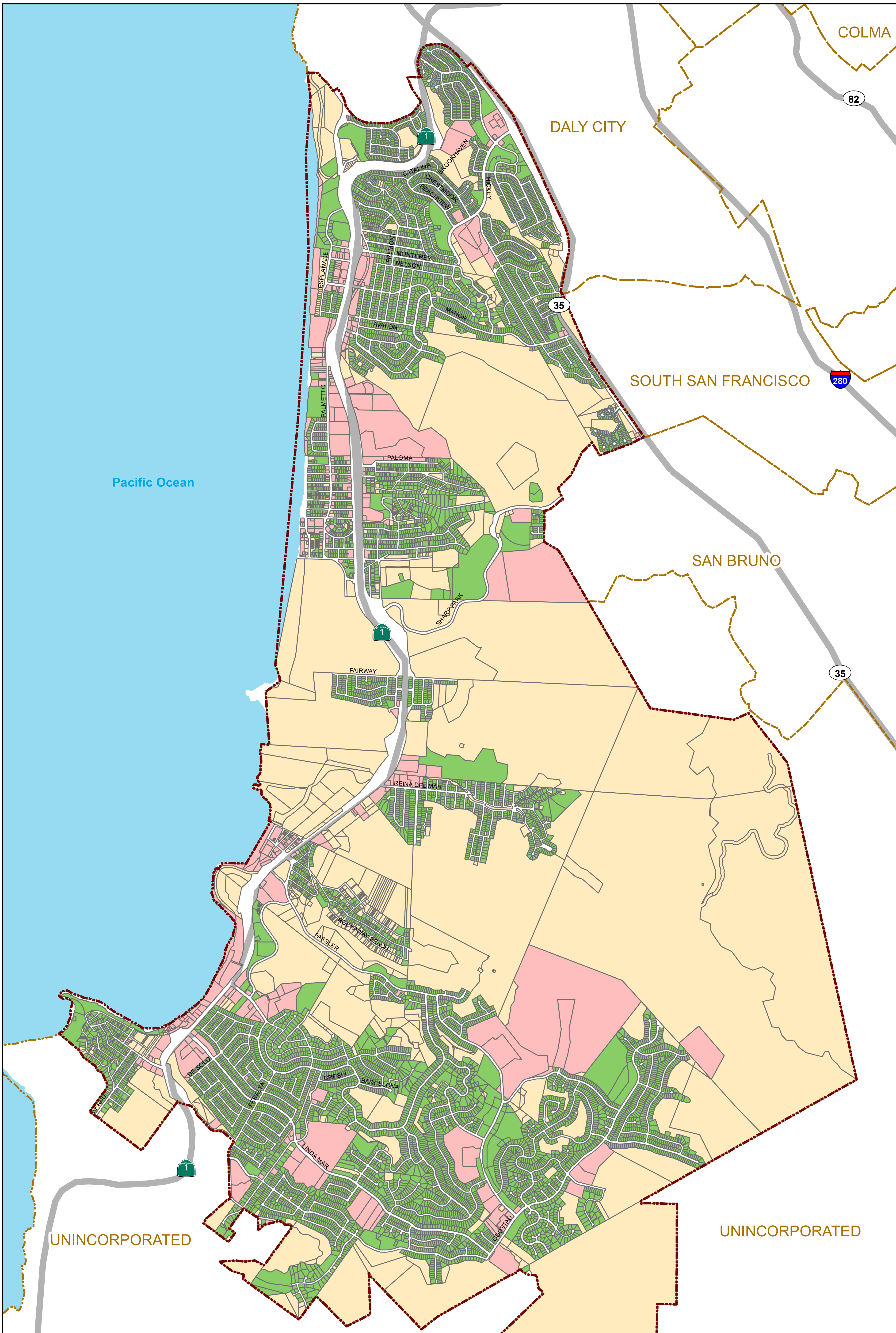

Figure 1-3
Existing Connected Parcels

Wastewater Collection System
Master Plan

Legend

Parcels

- Non-Residential
- Residential
- Vacant, Undeveloped, or Unconnected
- Pacifica City Limits
- Other City Boundaries

N

0 0.125 0.25 0.5 Miles

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

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1.4 Scope of Study

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

- **Task 1 – Project Management and Coordination.** Periodic progress meetings and teleconferences were held with City staff to review project status and discuss project issues, and monthly status reports were prepared to document the work completed.
- **Task 2 – Data Collection and Review.** This task involved assembling, organizing, and reviewing maps, documents, and data related to the collection system, including GIS files, maps and drawings of collection system facilities and recent sewer improvement projects; pump curves and operating data; pump station and treatment plant SCADA data; water use and customer account data; the City's General Plan and other relevant planning information; and sewer design standards and specifications.
- **Task 3 – Flow Monitoring.** A plan for flow and rainfall monitoring in the collection system during the 2019/20 wet weather season was developed. The program included 21 flow meters and three rain gauges installed for a period of approximately three and a half months. The monitoring was conducted by Woodard & Curran's subconsultant, ADS Environmental Services.
- **Task 4 – Hydraulic Model Update and Calibration.** A hydraulic model of the City's trunk sewer system was developed using InfoWorks™ CS software for the 2011 Master Plan and was updated in 2018 using InfoWorks ICM™ software. Sewersheds were delineated to define areas loading to the model based on a GIS process that associates each parcel in the City's sewer service area to a sewer pipe in the existing collection system, and then aggregating the parcels by tracing downstream from the connecting pipes to the first downstream manhole in the modeled trunk network. Existing and future flow loads to the model were compiled using water use and land use data and flow factors representing unit base wastewater flow (BWF) rates, diurnal BWF patterns, and I&I. The model was calibrated for dry and wet weather conditions using the flow monitoring data collected under Task 3.
- **Task 5 – System Performance Evaluation and Improvement Needs.** The model was used to determine collection system capacity requirements and identify capacity deficiencies under peak wet weather flow conditions, defined based on a design storm and system performance criteria. Areas of the system with high rates of I&I were identified, and the potential effectiveness of reducing peak flows by reduction of I&I through sewer system rehabilitation was assessed. Potential solutions to capacity deficiencies were identified and tested in the model, and capacity improvement projects and associated costs were developed based on these analyses. I&I rates were compared between the 2019/2020 and 2009/2010 flow monitoring programs to assess the effectiveness of the City's R&R projects on reducing I&I.
- **Task 6 – Master Plan Preparation.** This updated report was prepared to present the results and recommendations of the study.

1.5 Report Organization

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

Executive Summary

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

Chapter 1- Introduction

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

Chapter 2 – Hydraulic Model Update and Calibration

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

Chapter 3 – Capacity and I&I Assessment

This chapter defines the basis for the capacity assessment of the system, including the selected design storm and performance criteria and describes the identified capacity deficiencies based on the model results. The chapter also identifies areas of the system with high I&I and evaluates how I&I has changed throughout the system since the 2009/2010 flow monitoring program.

Chapter 4 – Recommended Capacity Improvement Plan

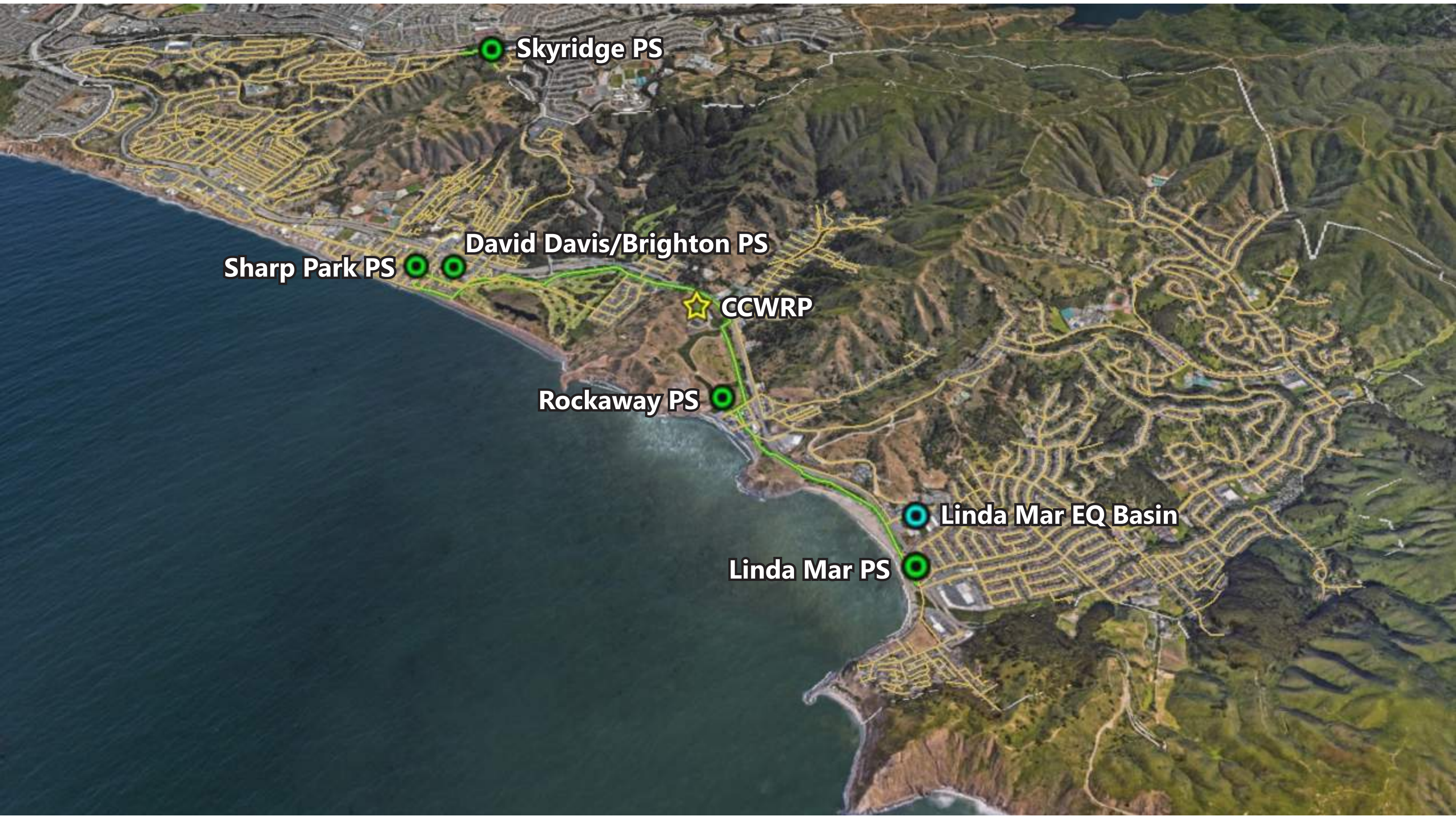
This chapter presents the recommended capacity improvement projects. Each project is documented with a general description, planning level capital cost estimate, and relative priority rating.

Appendices

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

CHAPTER 2

Hydraulic Model Update and Calibration



2. HYDRAULIC MODEL UPDATE AND CALIBRATION

This chapter documents the development of the updated hydraulic model that was used to assess the capacity of the City's sewer system. The chapter provides an overview of the model development process, including descriptions of the modeled sewer network and sewersheds, the flow monitoring program conducted for this study and the basis for estimating wastewater flows, and the calibration of the model. A summary of flows in the system is also presented.

The modeling utilized InfoWorks™ ICM, a fully dynamic hydraulic modeling software supported by a GIS-based modeling interface.

2.1 Modeling Terminology

Key modeling terminology are defined below.

- **Network** refers to the representation of the physical facilities being modeled. The primary components of the modeled network are pipes, manholes, and pump stations.
- **Nodes** are primarily manholes, but also include pump station wet wells, outfalls (discharge points from the modeled system) and breaks (changes in slope or diameter without a structure). The primary data associated with nodes are manhole ground elevations and pump station wet well elevations and cross-sectional areas.
- **Pipes** or **conduits** are connections between nodes and include both gravity sewers and force mains. The primary data associated with pipes are upstream and downstream node IDs, pipe length, diameter, roughness factor, and upstream and downstream invert elevations.
- **Pumps** are modeled individually, connecting pump station wet wells with the upstream node of associated force mains. Data associated with pumps include type (e.g., fixed or variable speed), on and off levels, pump capacities, and pump discharge curves.
- **Subcatchments** (also called sewersheds) are areas that contribute flow to the modeled sewer network and represent the unmodeled sewers in the collection system. Data associated with subcatchments include sanitary flow (computed based on population, water use, or other available data), type of diurnal sanitary flow profile (which is a function of land use), I&I parameters, and the node at which the flow from the subcatchment enters the modeled system.
- **Model loads** are the flows associated with subcatchments. Components of model loads are residential and commercial sanitary or base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall dependent I&I (RDI&I). As a sum, they represent the total wastewater flow applied to the model.
- **Models** are the combination of a modeled network, its associated subcatchments and loads, and other data files (e.g., rainfall, diurnal profiles, inflows from other areas, etc.) that comprise a specific model scenario.

2.2 Modeled System

The modeled network includes pipes 10 inches and larger in diameter and additional 6- and 8-inch lines that were either part of a flow split and could potentially carry flows from a larger diameter pipe or were considered important because of a significant contributing sewershed. In total, the network includes about 30 miles of pipelines, or about 30 percent of total length of sewers in the system, including about 15 miles of 6- and 8-inch sewers. The model includes the four largest of the five system pump stations. The network has one model outfall at the Calera Creek Water Reclamation Plant (CCWRP). The model network is shown in **Figure 2-1**.

The City's sewered area was divided into 500 sewersheds, called "subcatchments" in the modeling software (InfoWorks ICM, Version 10.5), with an overall average size of 15 acres per subcatchment. Each subcatchment "loads" to a manhole in the modeled network.

2.2.1 Network Data and Data Validation

The original model was developed as part of the 2011 Master Plan, which utilized data from the City's AutoCAD sewer map, record drawings, and the San Mateo County Digital Elevation Model (DEM) to define the model network and associated attributes. The model network has been updated to reflect projects completed since 2011, as indicated on **Figure 2-1**.

The network updates also include the recently constructed Linda Mar EQ Basin, which receives excess flow backing up from the Linda Mar Pump Station during large events. When flows to Linda Mar Pump Station recede, pumps in the EQ Basin discharge water from the EQ Basin into the City's gravity sewer on Crespi Drive. The Linda Mar EQ Basin pumps were evaluated in a separate TM, which is included as **Appendix E**.

The updated network was used as the basis for the nodes and conduits in the model. Model loading nodes were assigned to individual parcels using GIS processes, which were used as the basis for delineating subcatchments. All parcels loading to the same model node were dissolved into the same subcatchment.

2.3 Flow Monitoring Program

As part of the Master Plan, 21 temporary meters and 3 recording rain gauges were installed by ADS, subcontractor to Woodard & Curran, from January 5, 2020 to April 22, 2020. **Figure 2-2** shows the locations of the flow meters and rain gauges. The figure also shows the associated tributary area of each flow meter. Areas designated by "(I)" indicate that the area represents the incremental tributary area between the flow meter and other upstream flow meters. **Table 2-1** lists the flow meter locations, pipe diameters, and upstream meters. **Figure 2-3** shows a schematic of the flow meters that were installed as part of the monitoring program.

Table 2-1: Flow Meter Locations

Meter ID[2]	Location	Manhole ID	Pipe Dia. (in.)	Upstream Meters
3	505 Linda Mar Blvd. (east of CA-1)	LLD36	15 HDPE	-
4	Peralta Rd. at Linda Mar Blvd. (east)	LL7	21	24
5A	Peralta Rd. at Linda Mar Blvd. (south)	LL7	15 HDPE	-
6	Parallel to San Pedro Ave. extension	PT11	12 HDPE	-
7[1]	5400 CA-1 (northeast of Linda Mar Blvd.)	LLZ3	12	25
8A	Parallel to Coast Hwy. north of San Marlo Way	V29	12	17,18
9	2412 Palmetto Ave. (south of Brighton Rd.)	SPQ6A1	15	-
10	423 Del Mar Ave. (between Nelson Ave. and Manor Dr.)	F38	15	-
13	Palmetto Ave. at San Jose Ave.	F56	21	10,20,21
14	121 Bright Rd. (at David Davis/Brighton PS)	SP34	8	-
15	Palmetto Ave. and Montecito Ave.	FW52	12	10,20,21
16	De Solo Dr. at Linda Mar Blvd.	LLM14	10	-
17	200 Reina del Mar Ave. (east inlet)	V14	8	-
18	200 Reina del Mar Ave. (south inlet)	V14	6	-
19	447 Harvey Way	R19	8	-
20	Milagra Dr. and Oceana Blvd.	F45	18	10
21	866 Palmetto Dr.	FW38	12	-
22A	Rockaway Beach Ave. and Fassler Ave.	RK26	8	-
23	Peralta Rd. at Linda Mar Blvd. (north)	LLD25A	15	-
24	734 Oddstad Blvd. (south of Terra Nova Blvd.)	PP28	15 HDPE	-
25	Balboa Way and Anza Dr.	EQ03	24	-

1. Includes flow discharged from the Linda Mar EQ Basin.
2. Meters 3 through 15 were located in the same sites as in the 2010/2011 flow monitoring program.

All of the meters were area-velocity type gravity flow meters, which record flow depth and velocity and compute flow rate based on average flow velocity and the cross-sectional area of flow (a function of flow depth and pipe diameter).

The purpose of the flow monitoring program was to quantify the flows in the system to provide data with which to calibrate the hydraulic model (discussed later in this chapter), and to quantify the I&I response to storm events in various areas of the system. Approximately 4 inches of rain fell during the flow monitoring period, with about one third of that amount during the January 16, 2020 storm event. **Figure 2-4** shows a typical plot of measured flow for one flow meter and the hourly rainfall for one of the rain gauges. **Appendix A** includes plots of the rainfall and flow data for all of the rain gauges and meters.

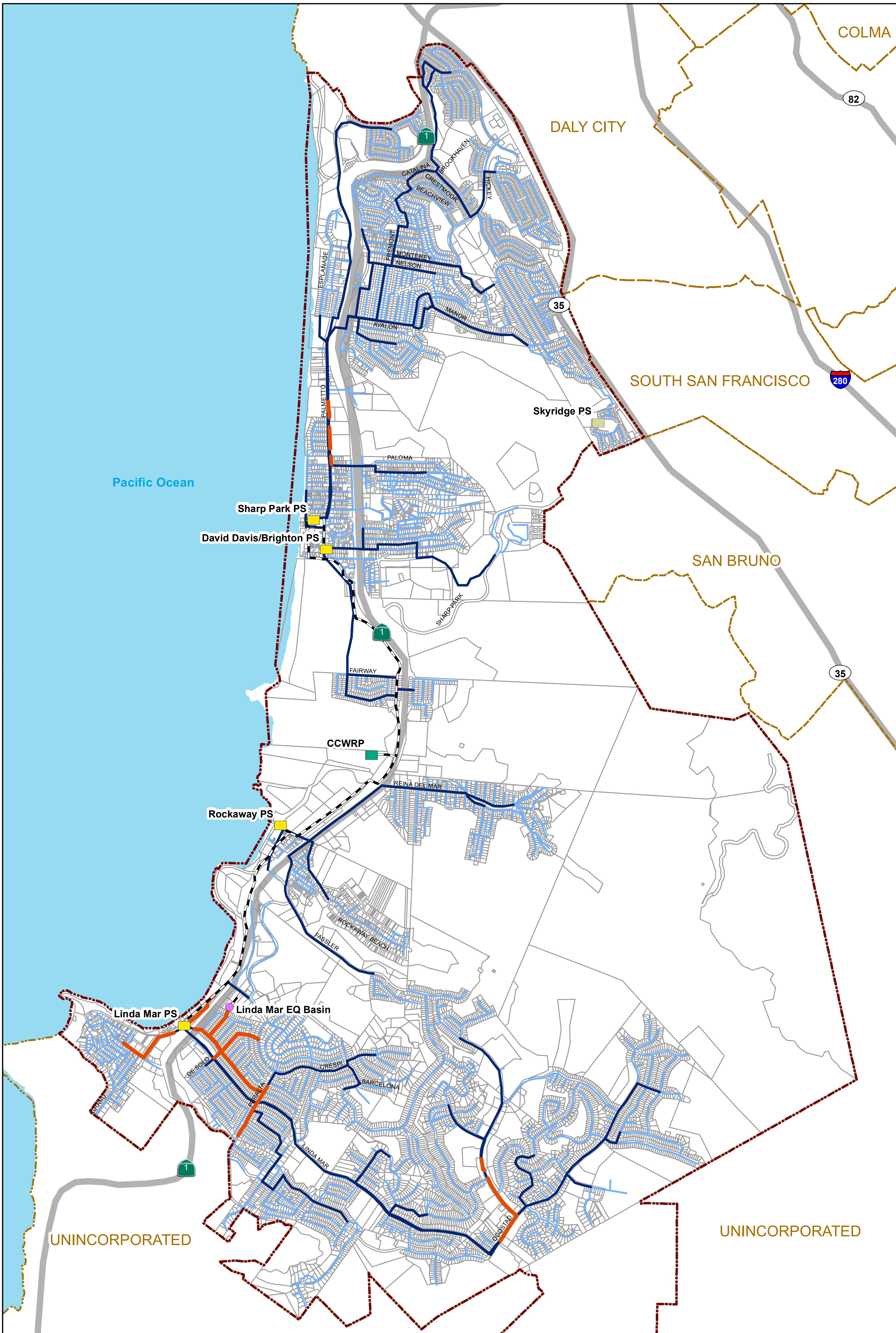


Figure 2-1
Modeled Sewer Network

Wastewater Collection System
Master Plan

Legend

- Modeled Sewers
- Modeled Sewers Replaced After 2011
- Unmodeled Sewers
- Force Main

Facilities

- Pump Station
- Water Recycling Plant
- Pump Station (unmodeled)
- Equalization Basin
- Pacifica City Limits
- Other City Boundaries
- Parcels

0 0.125 0.25 0.5 Miles

N

CITY OF PACIFICA
WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

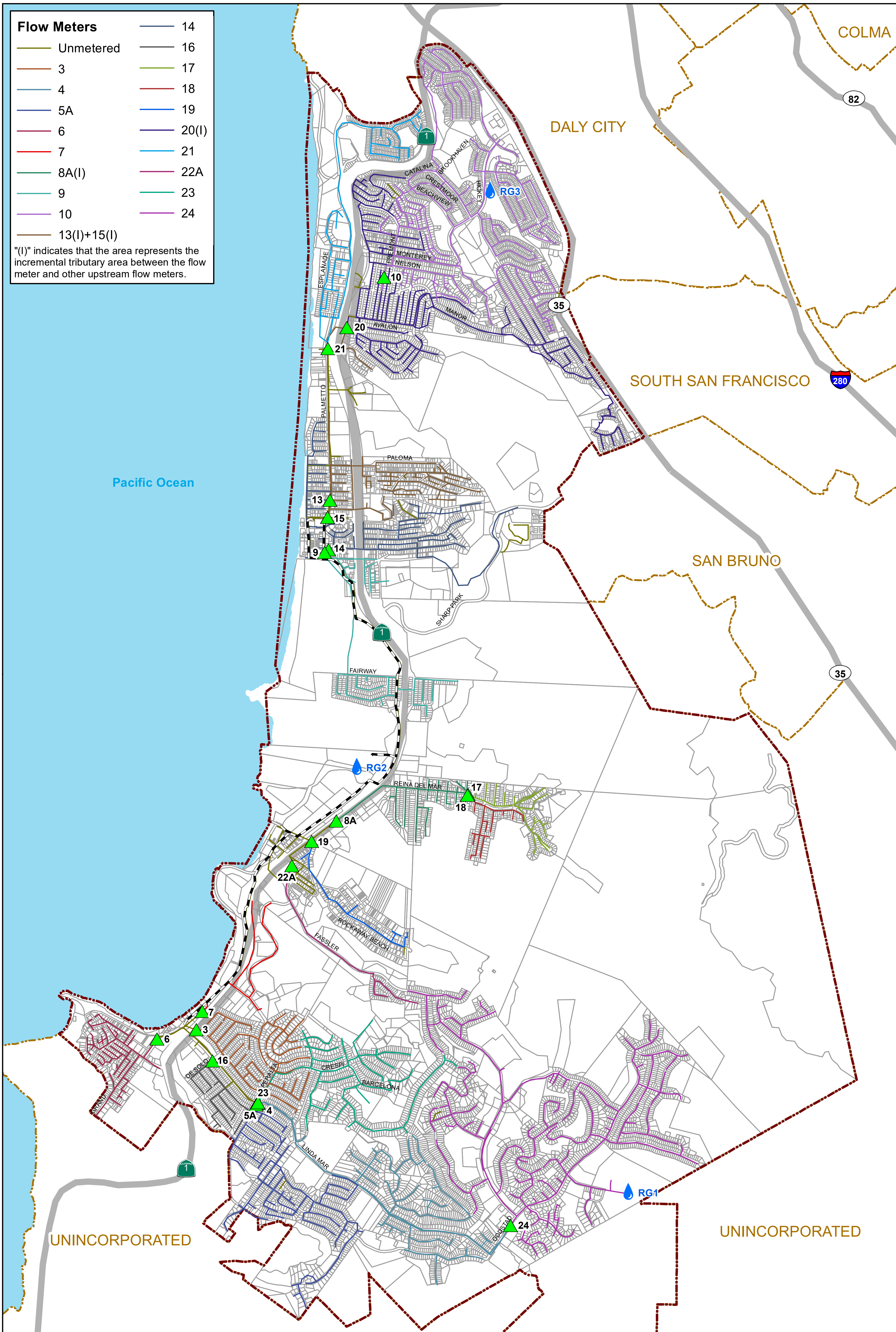


Figure 2-2
Flow Meters and Rain Gauges

Wastewater Collection System
Master Plan

Legend

- Rain Gauge
- Flow Meter
- Parcels
- Pacifica City Limits
- Other City Boundaries

0 0.1 0.2 0.4 Miles

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CITY OF PACIFICA

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Project #: 0011180.01
Map Created: August 2021

Figure 2-3: Flow Monitoring Schematic

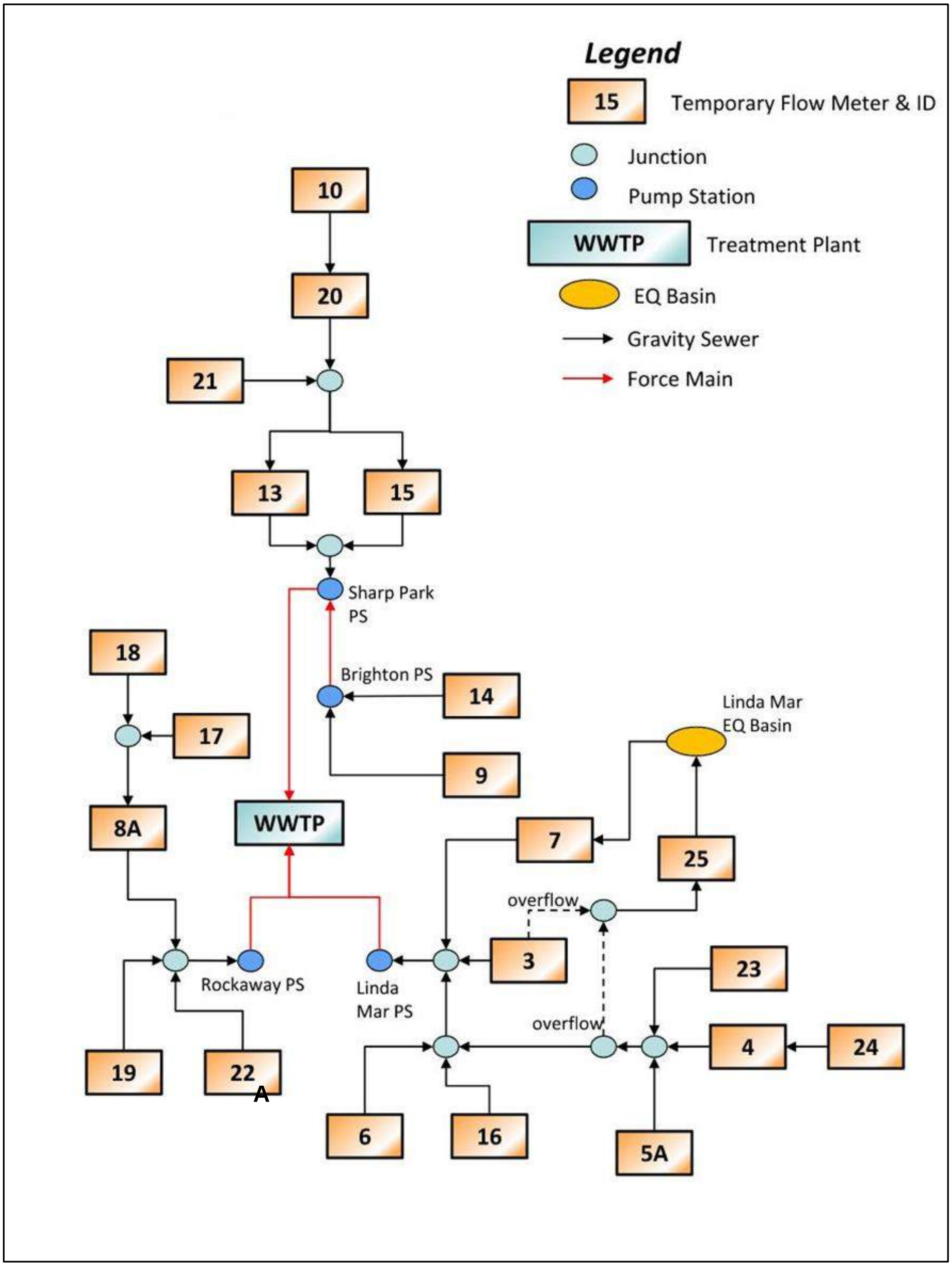
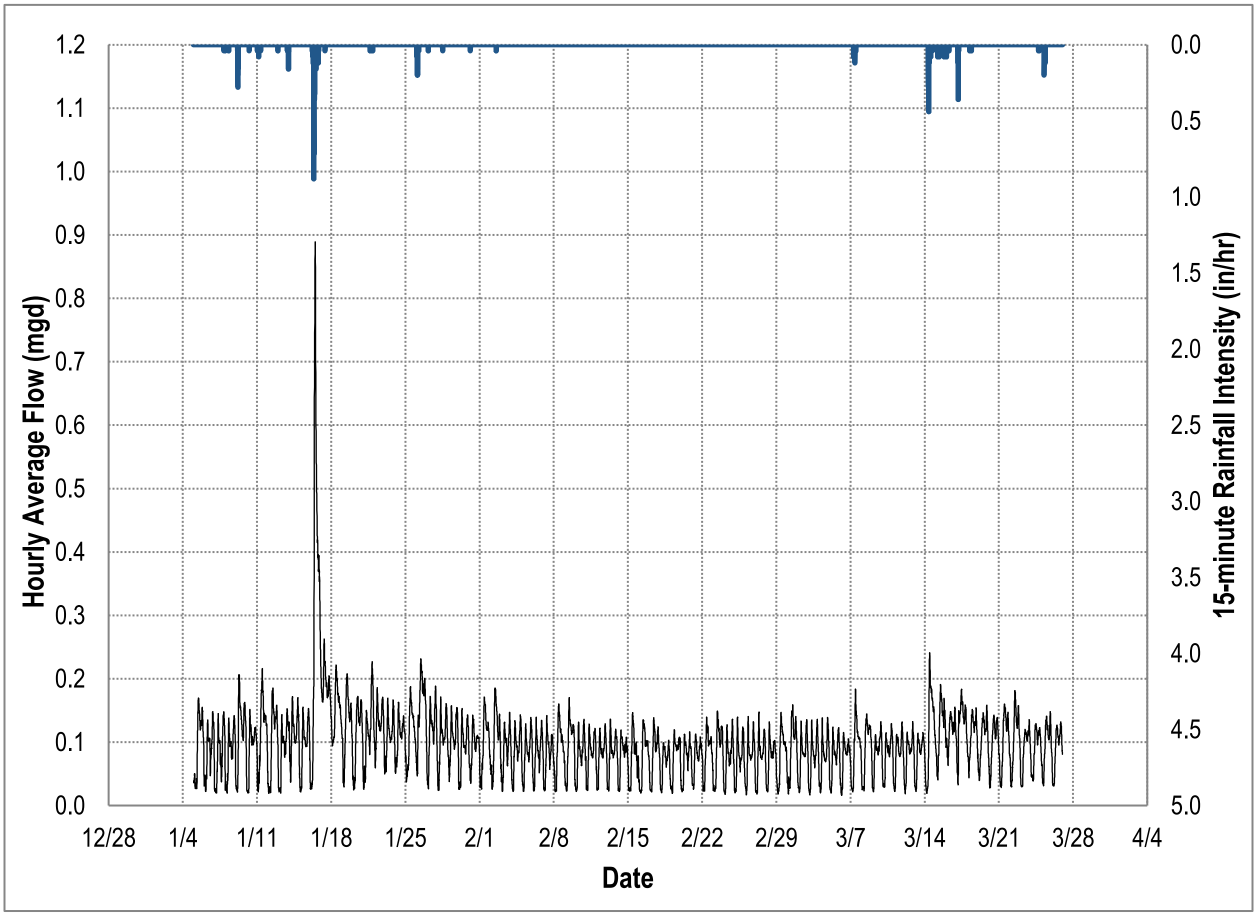


Figure 2-4: Plot of Typical Data for Flow Monitoring Period (Meter 3, Rain Gauge 2)



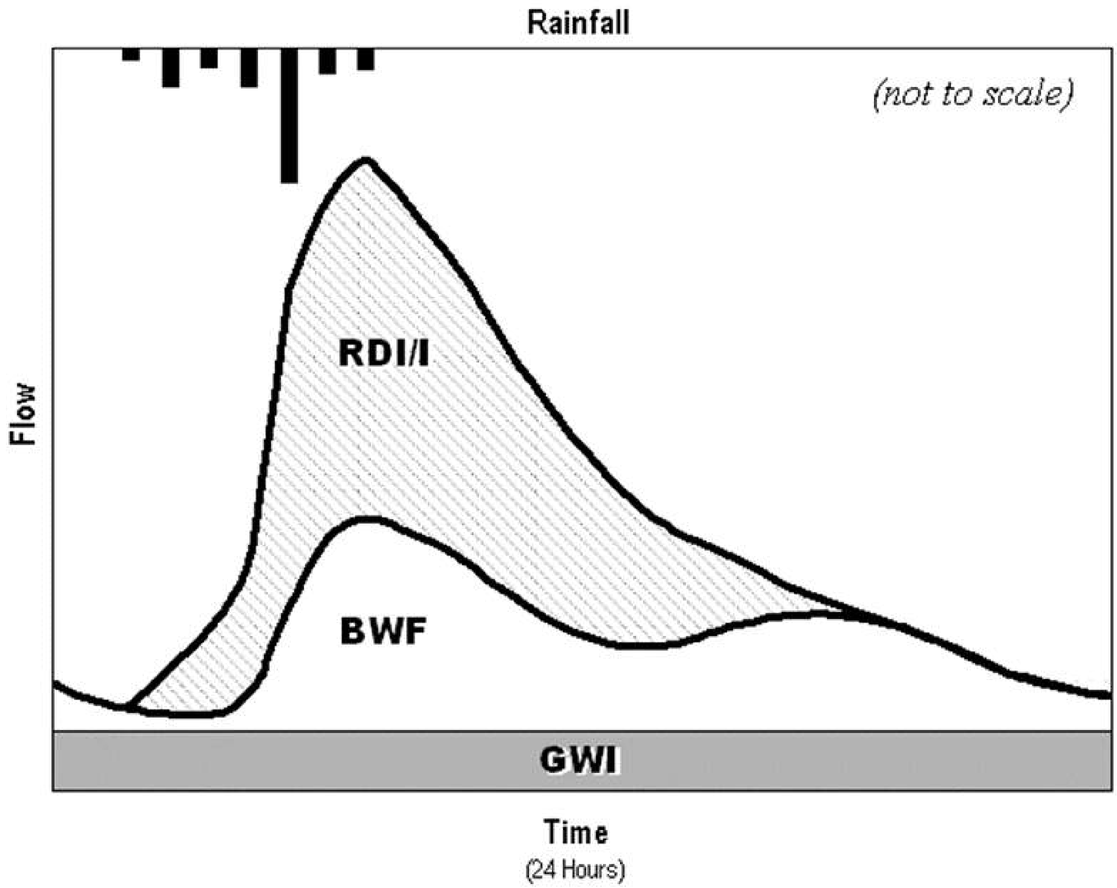
2.4 Flow Estimating Methodology

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

2.4.1 Wastewater Flow Components

Wastewater flows typically include three components: base wastewater flow (BWF), groundwater infiltration (GWI), and rainfall-dependent infiltration/inflow (RDI&I). BWF represents the sanitary and process flow contributions from residential, commercial, institutional, and industrial users of the system. GWI is groundwater that infiltrates into the sewer through defects in pipes and manholes. GWI is typically seasonal in nature and remains relatively constant during specific periods of the year. RDI&I is storm water inflow and infiltration that enter the system in direct response to rainfall events. RDI&I can occur through direct connections such as holes in manhole covers or illegally connected roof leaders or area drains (called “direct inflow”), or through defects in sewer pipes, manholes, and service laterals. RDI&I typically results in short term peak flows that recede quickly after the rainfall ends. These three flow components are illustrated conceptually in **Figure 2-5**. Dry weather flow (DWF) consists of BWF plus GWI, while wet weather flow (WWF) adds the RDI&I component.

Figure 2-5: Wastewater Flow Components



2.4.2 Base Wastewater Flow

Existing residential and non-residential base wastewater flows were estimated using information compiled at the parcel level (approximately 12,200 parcels) and then aggregated into the 500 model subcatchments. The total residential and non-residential BWF for each model subcatchment were calculated by summing the BWF for all parcels within that subcatchment.

2.4.2.1 Existing Flows

Existing BWF was determined based on water billing data provided by the City. Metered water use during the winter months most closely approximates wastewater generation since outdoor water use is at a minimum. Therefore, meter readings taken in the winter of 2016-2019 (January through April) were used as the basis for estimating residential and non-residential BWF. A sewer return rate of 100 percent (i.e., BWF equal to 100 percent of winter water use) was assumed, based on comparison of water use to wastewater flow rates during the model calibration.

All water billing records were geocoded to a water meter shapefile using GIS processes according to assessor parcel number (APN), or address if APN was not available or did not match. Billing records were assigned a land use type based on City planning data (parcels shapefile). Parcels were designated as either residential or non-residential based on the land use type. A parcel-by-parcel visual assessment of the City using aerial photos confirmed that data were available for all developed parcels.

2.4.2.2 Future Flows

Although the City is largely built out, there are a number of vacant, developable parcels, as well near-term developments, and opportunity sites. **Figure 2-6** shows the location of planned developments or opportunity sites and currently vacant, potentially developable parcels, which are classified by land use type (residential/open space/agriculture, other residential, or non-residential).

Future flows were based on a land use dataset provided by the City indicating potential vacant/undeveloped and non-residential underutilized opportunity sites, along with an associated development density. For this Master Plan, other parcels identified in the General Plan as existing vacant developable parcels were also included in the Buildout scenario, based on the allowable density in the General Plan. Parcels identified as residential/open space/agriculture are included as potentially developable parcels, but have a very low density (0.15 units per acre), and are assumed to result in no increase in I&I. For developed parcels which have no plan for redevelopment, the current flow based on water billing data was assumed to characterize their BWF in the future.

The flow factors presented in **Table 2-2** and the buildout criteria presented in **Table 2-3** were used to calculate BWF from these developments. Flow factors are based on factors commonly used at the master planning level for similar communities or confirmed by water use data for similar developments (e.g., single family residential) in Pacifica. These residential design flow factors are higher compared to the existing flow factors (~122 gpd per dwelling unit [DU]) but are conservative for master planning. Buildout criteria for residential development is based on the "Projected Density" by land use classification as defined in Table 4-2 of the City's General Plan. Buildout criteria for non-residential development is based on the "Projected Non-Residential FAR" by land use classification as defined in Table 4-3 of the City's General Plan.

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

Development Type	Unit	BWF Factor (gpd/unit)
Single Family Residential (SFR)	Dwelling Units	220
Multi-Family Residential (MFR)	Dwelling Units	170
Non-Residential (NR)	Square feet	0.1

DU = dwelling unit
Sq. ft. = square footage of building floor space

Table 2-3: Buildout Criteria for Future Development

Land Use	Development Type	Residential Density (DU/acre)	Non-Residential Intensity (FAR)
Residential/Open Space/Agriculture	SFR	0.15	-
Very Low Density Residential	SFR	1.5	-
Low Density Residential	SFR	6.5	-
High Density Residential	MFR	25	-
Mixed Use Neighborhood	MFR	25	0.25
Low-Intensity Visitor-Serving Commercial	NR	-	0.05
Visitor-Serving Commercial	NR	-	0.35
Public/Institutional	NR	-	0.35

DU = housing unit; FAR = floor area ratio

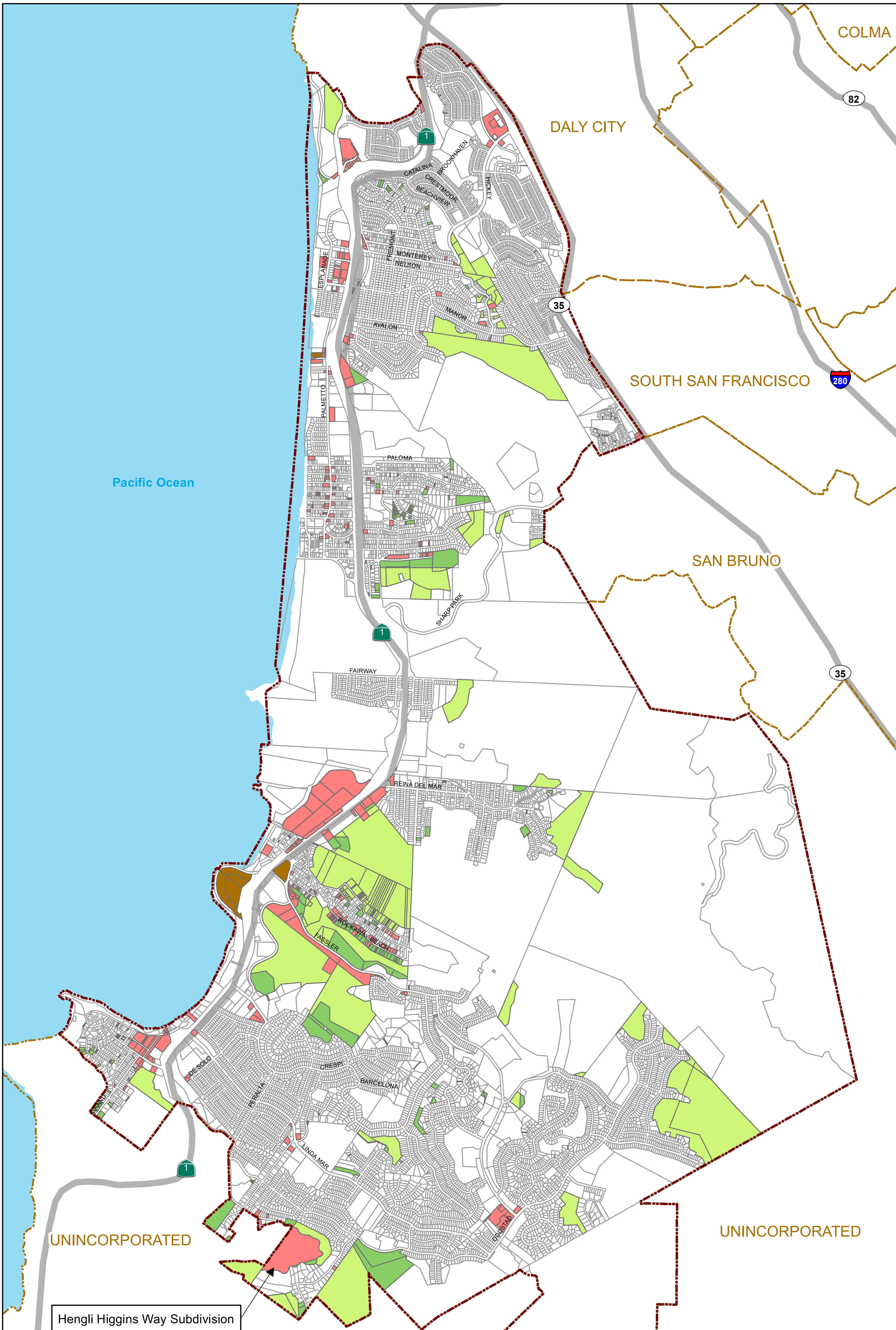


Figure 2-6
Planned Development and Vacant Developable Land

Wastewater Collection System
Master Plan

Legend

- Planned Developments (Opportunity Sites)
- Other Vacant Residential Parcels
- Vacant Non-Residential Parcels
- Vacant Residential/Open Space/Agriculture Parcels (0.15 DU/acre)
- Parcels (No Planned Development)
- Pacifica City Limits
- Other City Boundaries

0 0.125 0.25 0.5 Miles

N

City of Pacifica

WOODARD & CURRAN

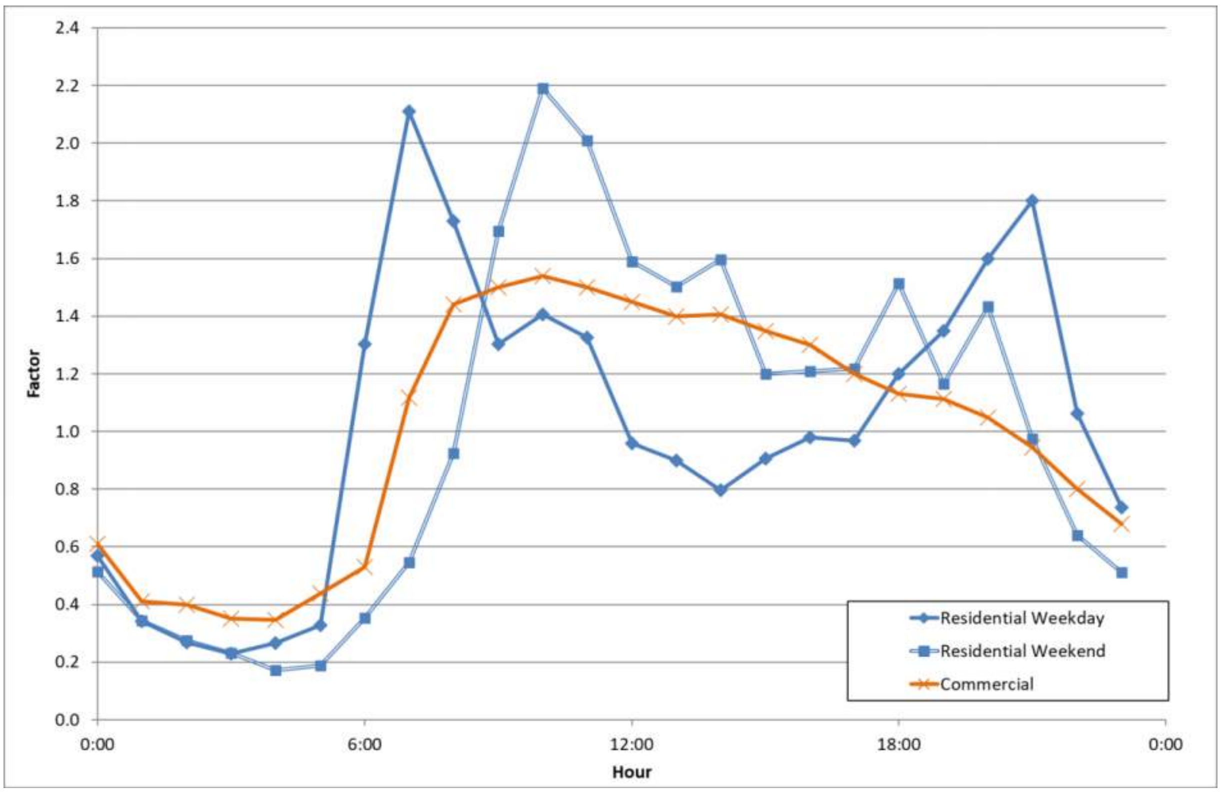
Project #: 0011180.01
Map Created: August 2021

2.4.2.3 BWF Diurnal Profiles

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

The variations in BWF on a typical day are represented by diurnal profiles. Diurnal profiles are defined by a set of hourly factors that are applied to the average BWF for each subcatchment. For Pacifica, the 2011 Master Plan defined separate sets of diurnal profiles for weekdays and weekends and for residential and non-residential development. The same profiles were used for the current Master Plan, which are shown in **Figure 2-7**.

Figure 2-7: Diurnal Profiles



The flow monitoring period ended in March of 2020 and therefore did not capture impacts to wastewater flow patterns under coronavirus (COVID-19) stay-at-home orders. Based on impacts observed by surrounding communities, diurnal patterns are anticipated to have slightly changed in response to stay-at-home orders and work from home (e.g., residential weekday morning peak is lower and occurs later in the morning). San Jose and Bay Area Clean Water Agencies (BACWA) performed extensive studies on COVID impacts to wastewater flows and observed a later and flatter peak and a decrease in overall flow because of reduced commercial use. However, Pacifica's operations staff has not noticed a change in volume of dry weather flow at the plant, so although diurnal patterns have changed, Pacifica residents are likely still using water at rates comparable to pre-COVID-19 volumes. Changes in residential diurnal patterns are anticipated to have the greatest impact on the Pacifica's system because most of the City's base wastewater flows (nearly 90 percent as shown in **Table 2-4** below) come from residential land uses rather than non-residential.

2.4.2.4 BWF Projections

Table 2-4 summarizes the existing and future BWF for residential and non-residential land use categories. Based on these estimates, BWF in Pacifica could increase by about 30 percent due to potential future development and redevelopment. As the additional flow for the Buildout scenario is not significantly larger than the future flows identified for the Opportunity Sites, only the Buildout scenario has been modeled.

Table 2-4: Base Wastewater Flow Projections

Type of Development	Estimated BWF (mgd)		
	Existing	Existing Plus Opportunity Sites[1]	Buildout[2]
Residential	1.75	1.79	2.02
Non-Residential	0.21	0.52	0.54
Total	**1.96**	**2.31**	**2.56**

1. The City has identified a total of 318 opportunity sites as well as the Hengli Higgins Way Subdivision, which is planned to include approximately 60 very low-density residential lots.
2. Includes other parcels identified as vacant and potentially developable.

Existing per capita residential wastewater flow was estimated as 46 gallons per capita per day (gpcd) based on Department of Finance population data for January 1, 2021, compared to approximately 54 gpcd in the 2011 Master Plan (calculated based on the reported average residential dry weather flow (DWF) and the Census 2010 population).

2.4.3 Groundwater Infiltration

GWI is typically applied in the model as a constant load in addition to the BWF. The amount of GWI in any particular area is determined during model calibration by comparing the modeled flows to actual observed dry weather flows at points in the system where flow meter data are available. Where modeled BWF is less than monitored dry weather flow, the difference is assumed to represent GWI. The GWI determined at the monitoring location is then distributed to the meter tributary area on a per-acre basis. GWI was identified in ten of the meter areas in Pacifica with rates ranging from about 70 to 4,300 gpd/acre. Note that because GWI is seasonal in nature, the modeled GWI represents a typical GWI rate during the wet weather season rather than a dry season (summertime) GWI. The distribution of GWI throughout the City's service area is discussed further in **Section 3.3**.

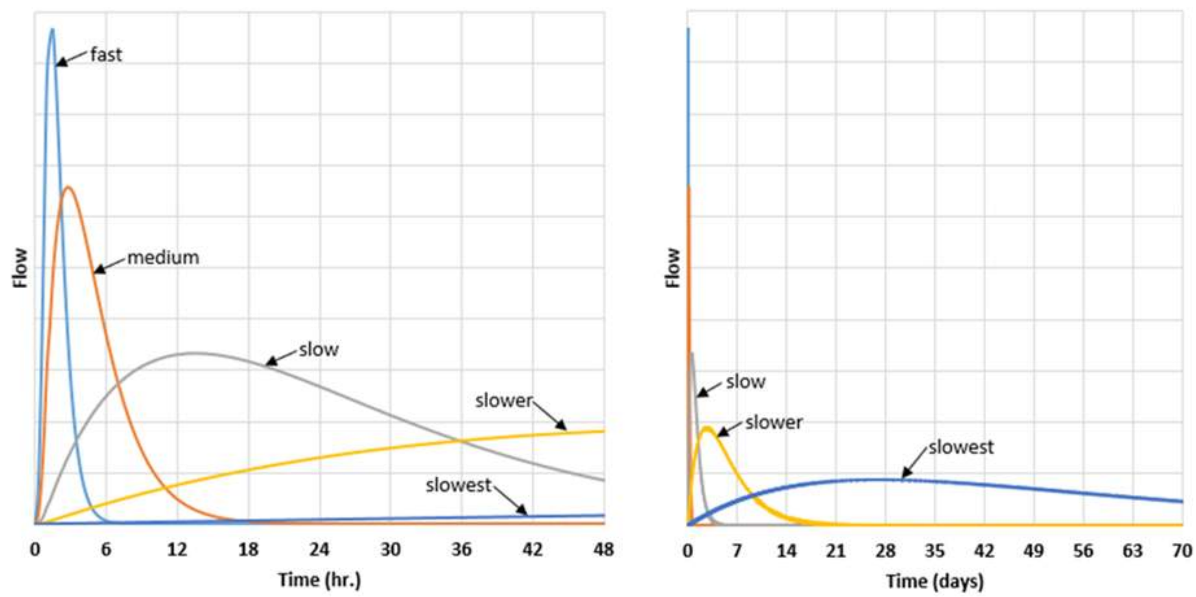
2.4.4 Rainfall-Dependent I&I

RDI&I flows result from rainfall events that produce infiltration and inflow of storm water runoff into the sewer system. RDI&I can be quantified as the difference between the total flow during and immediately following a storm event and the non-rainfall "base flow" (BWF plus GWI) that is estimated to have occurred during the storm period. The magnitude of the resulting RDI&I response is typically described by the percentage of the rainfall volume (called the "R value") represented by the volume of the RDI&I hydrograph. The R value can vary from storm to storm, depending on such factors as the degree of soil saturation (due to antecedent rainfall) prior to the storm event.

The shape of the RDI&I hydrograph is also important in determining the peak RDI&I response. The RDI&I hydrograph shape is often defined by separating the total RDI&I hydrograph volume into components, representing different response times to rainfall. Up to three or more response patterns may be used, as illustrated in **Figure 2-8**. The slowest component may result in a wet weather response several weeks or even months after the rainfall. Alternately, this component could be considered to be a gradual increase in GWI as a result of increased soil saturation and higher groundwater levels after storm events.

Summing all of the component hydrographs for the duration of the rainfall events results in the total RDI&I hydrograph for that area. In most sewer systems, the "fast" component of the hydrograph usually has the biggest impact on the magnitude of the peak wet weather flow response, while the slower components can contribute significantly to the total volume of the RDI&I response. These parameters, when applied to a different rainfall pattern, can be used to estimate the RDI&I response to that particular rainfall event.

Figure 2-8: RDI&I Hydrograph Components



The model parameters defining the RDI&I flows to the system within a given meter area are determined by comparing modeled wastewater flow at the meter location to the measured wastewater flow during one or more rainfall events, as discussed in the model calibration section below. The same calibrated parameters are generally applied to all subcatchments within each meter area.

2.5 Model Calibration

Model calibration is the process of comparing the model-computed (predicted) flows to the observed (monitored/measured/metered) flows and adjusting various model parameters until the model is accurately simulating flows in the sewer system. The model was calibrated for both dry and wet weather conditions as discussed in **Section 2.5.1** and **Section 2.5.2**, respectively.

2.5.1 Dry Weather Calibration

The 14-day dry period from February 21 to March 6, 2020, was used as the dry weather calibration period for comparing flow data to the model results for most of the meters. This period was selected because it was not impacted by previous rainfall and a majority of the meters showed consistent readings.

The primary focus of the dry weather calibration was to confirm that the calculated average BWF based on winter water consumption was consistent with the measured flows at the meter locations. The dry weather calibration confirmed that the overall sewer return rate is about 100 percent, indicating that consumptive and outdoor water use is minimal during the winter. The second objective of the dry weather calibration was to confirm the diurnal profiles used to represent the hourly variations in BWF. The curves shown in **Figure 2-7** were developed based on the calibration. Finally, GWI was added when the observed (metered) dry weather hydrographs were greater than the model-simulated hydrographs by a relatively constant value throughout the day. The additional flow seen at the meters was distributed to upstream subcatchments on an area-weighted basis.

The dry weather model calibration resulted in a reasonable match between modeled and metered average flow at most meters, as summarized in **Table 2-5**. Most of the meters with larger percentage differences (greater than 10%), are on pipelines with very low flows, where reduced accuracy is expected. Due to upstream flow splits, two of the 20 meters were reviewed as a pair (13 and 15) where the sum of modeled flow was compared to the sum of metered flow. A similar match for peak dry weather flow (PDWF) was also achieved.

Table 2-5: Dry Weather Flow Calibration Results

Meter	Contributing Area (acres)[1]	GWI (gpd/acre)[1]	GWI (mgd)[1]	Meter Avg. Flow (mgd)	Model Avg. Flow (mgd)	Difference (mgd)[2]	Difference (%)[2]
3	67	298	0.02	0.08	0.07	-0.01	-13%
4	167	600	0.10	0.54	0.50	-0.05	-9%
5A[3]	132	--	--	0.15	0.15	< 0.01	0%
6	55	--	--	0.04	0.03	-0.01	-17%
7[4]	32	--	--	0.04	0.04	0.00	-7%
8A	54	1,666	0.09	0.21	0.23	0.02	10%
9	61	988	0.06	0.12	0.11	-0.01	-9%
10	308	--	--	0.52	0.48	-0.04	-7%
13+15	112	--	--	0.96	0.87	-0.09	-9%
14	123	162	0.02	0.15	0.13	-0.02	-13%
16	34	296	0.01	0.04	0.04	< -0.01	-4%
17	272	221	0.06	0.07	0.08	0.01	18%
18[5]	1	4,262	0.006	0.01	0.01	< -0.01	-9%
19[3]	28	--	--	0.13	0.14	0.01	4%
20	175	--	--	0.52	0.61	0.09	17%
21	89	225	0.02	0.19	0.15	-0.04	-19%
22A[5]	21	--	--	0.02	0.01	-0.01	-27%
23	151	1,324	0.20	0.26	0.23	-0.02	-8%
24	403	--	--	0.31	0.28	-0.03	-10%
CCWRP	--	--	--	2.14	2.63	0.49	23%

1. Represents flow meter incremental contributing area and GWI (not including areas tributary to upstream meters).
2. Predicted (model) minus observed (meter) flows.
3. BWF was added to the Meters 5A and 19 where the initial difference in predicted and observed flows exceeded 20 percent.
4. Discharge from the EQ Basin affected observed flows at Meter 7 through much of the flow monitoring period. Observed and predicted flows were based on the period from January 19, 2020 through January 26, 2020, which was more characteristic of typical dry weather flow at this site.
5. Dry weather flows are very small and difficult to calibrate against.

Total modeled flow into the CCWRP was approximately 2.6 mgd during both the winter 2009/2010 and winter 2019/2020 temporary flow monitoring programs. Total metered flow into the CCWRP, based on data from the City's CCWRP meter, was 3.0 mgd in winter 2009/2010 and 2.1 mgd in winter 2019/2020. Therefore, during the 2009/2010 monitoring period, total modeled flow to the CCWRP was about 13 percent (0.4 mgd) lower than measured flow compared to 23 percent (0.5 mgd) higher than measured flow during the 2019/2020 dry weather calibration period. However, modeled and metered flows matched reasonably well for the individual flow meter areas during the 2019/2020 dry weather calibration period. The larger percent difference in the CCWRP flow may be due in part to cumulative inaccuracies from each or some of the flow meters, or inaccuracies in the CCWRP flow meter data. Overall, it was considered better for the model be high (conservative) for purposes of collection system planning than risk the predicted flow at any location in the system being too low. The City has a planned capital improvement project to look into the accuracy of its CCWRP flow meter. **Appendix B** includes plots of modeled vs. metered dry weather flow for all of the meters.

2.5.2 Wet Weather Calibration

During wet weather calibration, parameters are adjusted to accurately simulate the volume and timing of RDI&I for monitored storm events. Only two significant storm events occurred during the monitoring period, on January 16, 2020 and March 14, 2020. The rest of the monitoring period was relatively dry. Wet weather calibration was based on the largest storm observed during the flow monitoring period (January 16, 2020), which was in the range of a 2-year storm event. Soils were likely moderately wet during the January 16, 2020 storm event, whereas very dry antecedent conditions were present during the smaller March 14, 2020 storm event considering there was no rainfall after February 1, 2020 with the exception of a small event on March 7, 2020. Therefore, calibrating to the larger, wetter January 16, 2020 storm resulted in modeled flows being overpredicted during the March 14, 2020 storm. The March 14, 2020 storm was only used to calibrate meters that did not have data available during the January storm (meters 18 and 22A). Moreover, no other meters were located upstream of these meters; and therefore, accuracy of calibration at these meters would not significantly impact overall calibration results. The total amount of rainfall that fell during the monitoring period was around 4 inches, approximately 30 percent of which fell during the January 16, 2020 storm. Rainfall was assigned to subcatchments using data from the closest of three rain gages maintained by ADS during the monitoring period.

Rainfall data from the northernmost gauge located at 630 Hickey Boulevard (RG3) were not available during the January 16, 2020 storm event and data from RG2 were utilized in place of the missing RG3 data. This assumption may have led to a slight overprediction or underprediction of RDI&I at flow meters in the northern portion of the City (10, 20, 21). If less rain actually fell at RG3 than at RG2, then the RG3 rainfall data would need to be associated with a higher runoff response to achieve the same total flow. For example, RG2 recorded approximately 1.2 inches of rain during the January 16, 2020 storm that the wet weather calibration was based on; however, if 1.5 inches of rain actually fell at RG3 but the RDI&I factors were determined assuming 1.2 inches of rain, the actual runoff response would be somewhat overpredicted.

Overall, the wet weather calibration resulted in a good match between modeled and metered peak flows as shown in **Table 2-6**. Due to upstream flow splits, two of the 20 meters were reviewed as a pair (13 and 15) where the sum of peak modeled flow was compared to the sum of peak metered flow.

Table 2-6: Wet Weather Flow Calibration Results

Meter	Meter Peak Flow (mgd)	Model Peak Flow (mgd)	Difference (mgd)[1]	Difference (%)[1]
3	0.93	0.94	0.01	1%
4	3.18	3.30	0.13	4%
5A	1.33	1.43	0.10	8%
6	0.30	0.31	0.01	2%
7	0.11	0.10	-0.01	-6%
8A	0.71	0.73	0.02	2%
9	0.64	0.62	-0.02	-3%
10	2.18	2.18	0.00	0%
13+15	4.20	3.92	-0.28	-7%
14	0.70	0.75	0.05	7%
16	0.25	0.24	-0.01	-5%
17[2]	0.33	0.30	-0.03	-9%
18[3]	0.013	0.01	0.00	-15%
19	0.35	0.38	0.03	9%
20	2.92	2.87	-0.06	-2%
21	0.42	0.38	-0.05	-11%
22A[4]	0.06	0.06	0.01	13%
23	1.49	1.48	-0.01	-1%
24	1.82	1.87	0.05	3%
CCWRP	12.9	14.4	1.5	11%

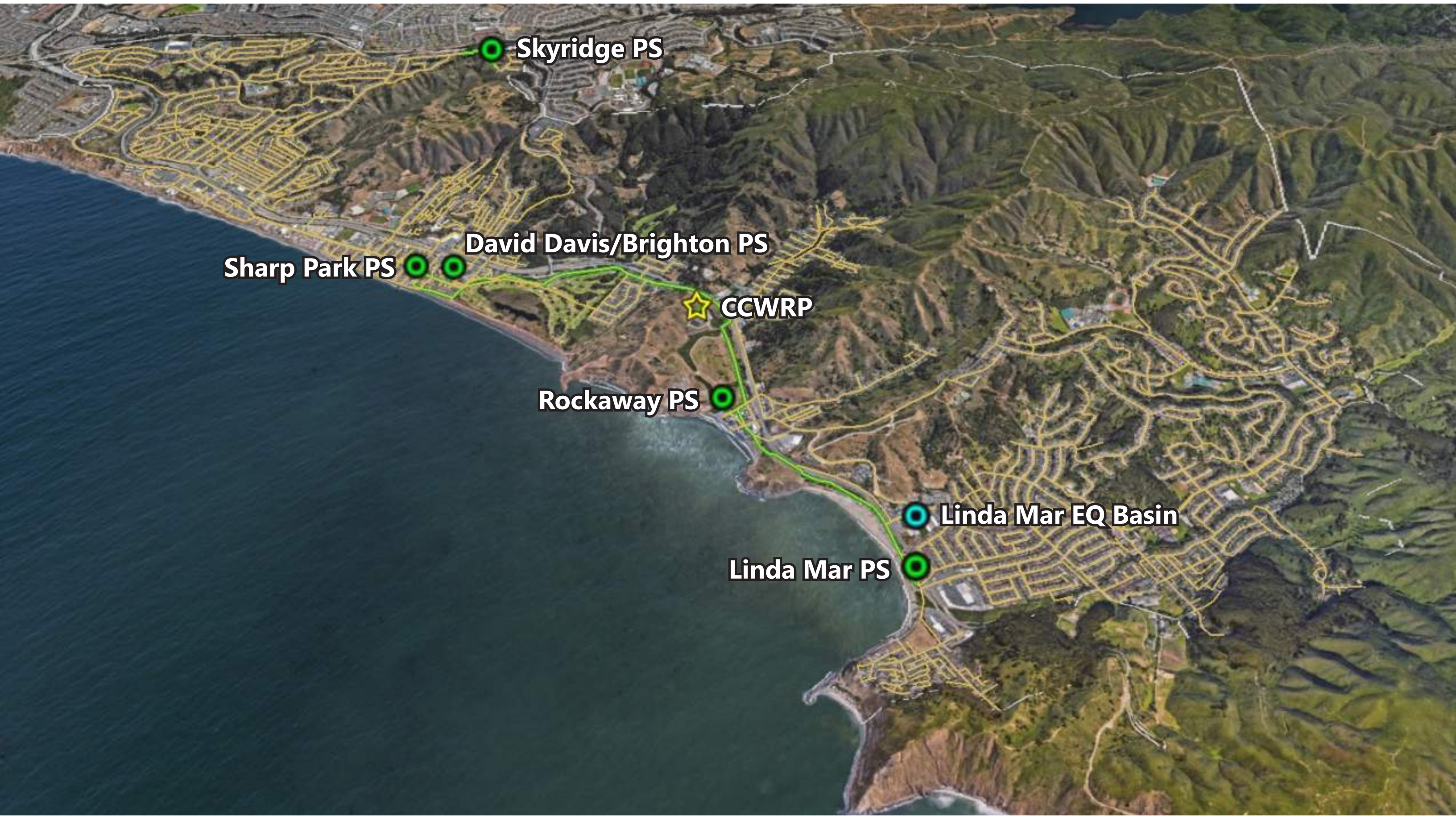
1. Predicted minus observed flows.
2. Runoff response was added to Meter 17 to better calibrate to the slow response observed after the storm event, which suggests that groundwater is draining into the area from further upslope.
3. Flows at Meter 18 were too small for adequate calibration and did not have a clear relationship to rainfall for the March 14 event, which was the only event with available data. Therefore, runoff response has been assumed based on the response of nearby meters (Meter 17).
4. Data were not available at meter for the January 16, 2020 storm; therefore, meter was calibrated to the smaller March 14, 2020 storm.

Plots of model vs. metered flow, shown in **Appendix C**, illustrate that the volumetric match is also very good. Peak modeled flow to the CCWRP was about 11 percent (1.5 mgd) higher than the measured peak flow at the plant for the wet weather calibration period, which means that overall GWI entering the system may be slightly overpredicted; however, modeled and metered flows matched reasonably well for the individual flow meter areas.

Results of the wet weather calibration and distribution of I&I throughout the service area are discussed further in **Section 3.3**.

CHAPTER 3

Capacity and I&I Assessment



3. CAPACITY AND I&I ASSESSMENT

The capacity performance of the system and need for capacity improvements were evaluated using the calibrated hydraulic model described in **Section 2**. This chapter discusses the criteria on which the capacity assessment was based and presents the model results and proposed capacity improvement projects. The I&I reduction benefits achieved from the R&R programs implemented since 2011 are also discussed.

3.1 Design Flow and Performance Criteria

Sewer system capacity is assessed with respect to the system's performance under a design flow condition. The subsections below define the design flow criteria used for the capacity assessment and the criteria for assessing system performance and identifying system capacity deficiencies. Criteria used for this Master Plan are consistent with the criteria used for the 2011 Master Plan.

3.1.1 Design Storm Condition

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

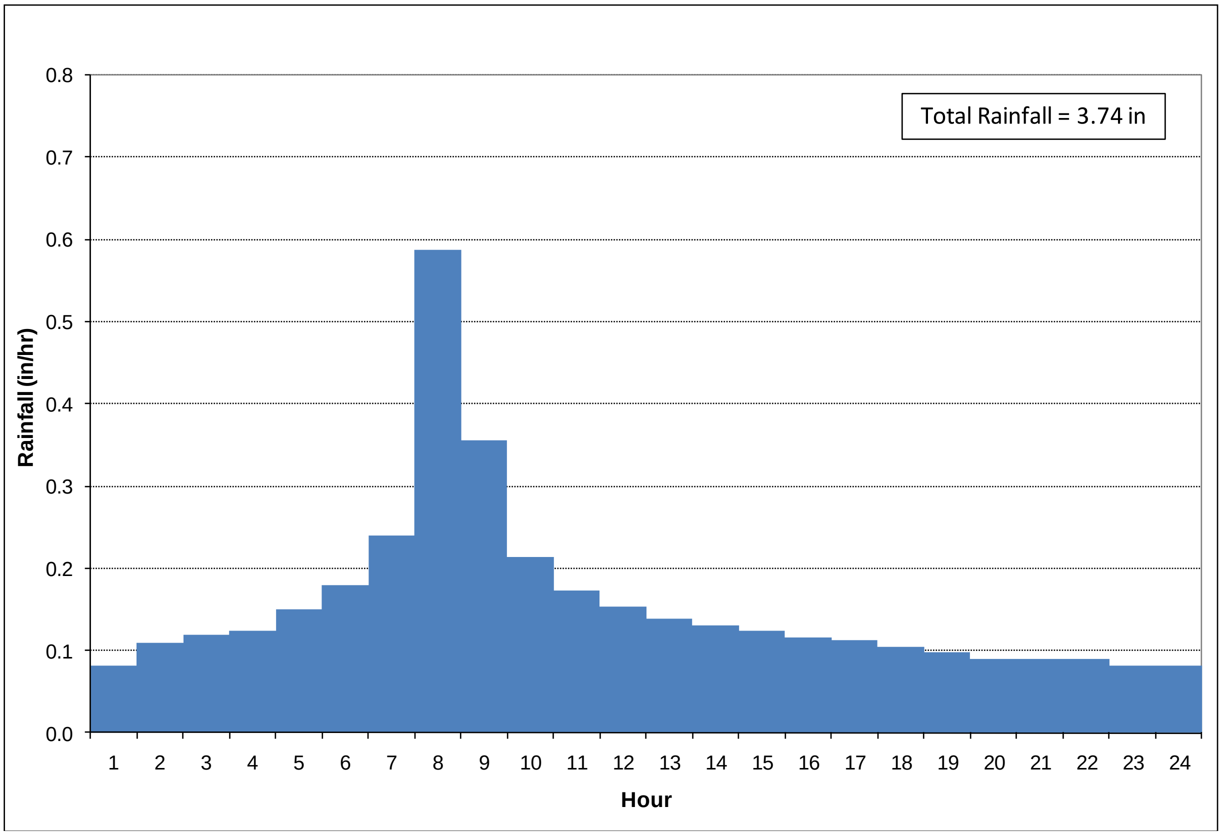
Selection of a design rainfall event is typically based on an allowable level of risk, often expressed as the return period. It is recognized that while wet weather overflows are highly undesirable, it is not cost-effective to provide capacity for the largest possible storm event. Regulatory agencies have not adopted standard criteria for return periods, so each agency must choose a target return period based on desired level of service, potential impacts of overflows, and cost. The City has adopted a 10-year return period for analysis of wet weather capacity.

As in the 2011 Master Plan, the 10-year design storm for Pacifica was developed using an SCS Type 1A synthetic 24-hour rainfall distribution. The 24-hour rainfall amount for Pacifica was determined based on Rainfall Runoff Data for San Mateo County published by the San Mateo County Department of Public Works. The 10-year, 24-hour SCS Type 1A design storm for Pacifica has the following characteristics:

- Total rainfall 3.74 inches
- Peak hour intensity 0.59 inches/hr.

The design storm is comparable in size to other notable large rainfall events that have occurred since 2000, such as the storms of December 31, 2005, January 25, 2008, and February 13-14, 2019. **Figure 3-1** shows the design storm rainfall hyetograph.

Figure 3-1: Design Rainfall Event



The timing of the design storm also affects the resultant peak wet weather flows. If the design storm is timed such that the peak RDI&I occurs at the same time as the peak BWF ("peak-on-peak"), the total PWWF will be higher than if the design storm occurs under average or minimum BWF conditions. Timing the storm to produce peak-on-peak results is generally thought to create a return period of the peak wastewater flow that is greater than the return period of the design rainfall event. As in the 2011 Master Plan, this Master Plan sets the timing of the design storm rainfall such that the peak RDI&I resulting from the design storm occurs at or near the time of peak BWF for most areas of the system.

Future scenarios were modeled conservatively under the assumption that the sewer system's response to rainfall would remain the same as existing conditions. This assumption implies that any increase in I&I due to deterioration of existing sewers will be offset by a decrease due to sewer rehabilitation or replacement, and that new sewers and laterals will contribute minimal I&I flows. However, if confirmed by flow monitoring, future R&R programs and additional lateral rehabilitation or replacement could be incorporated into the rainfall response assumptions.

3.1.2 Capacity Deficiency Criteria

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

For Pacifica, since the design storm PWWF represents an infrequent, 10-year return period event coinciding with a conservative BWF condition, the 2011 Master Plan considered it acceptable to allow surcharging over the pipe crown, provided the hydraulic grade line (water level) remains at least 4 feet below the ground surface. Under peak dry weather conditions, however, sewers should be able to convey the peak flow without surcharge. The current Master Plan uses the same criteria.

Performance criteria for pump stations are based on their firm capacity, defined as pumping capacity with the largest pumping unit out of service. Force mains are considered to be capacity deficient if maximum velocity exceeds 8 feet per second (fps) under design peak wet weather flow or 6 fps under normal PDWF.

3.2 Capacity Analysis Results

The calibrated model was run for existing and future conditions to identify areas of the system that fail to meet the specified performance criteria under design storm peak wet weather flows. No capacity deficiencies in the system were identified for dry weather conditions. Wastewater collection system flows are summarized in **Table 3-1.**

Table 3-1: Summary of Wastewater Collection System Flows

Model Scenario[1]	Flow to CCWRP (mgd)
Existing Average Dry Weather Flow	2.5
Existing Peak Dry Weather Flow	4.6
Existing Peak Wet Weather Flow	19.7
Future Average Dry Weather Flow	3.1
Future Peak Dry Weather Flow	5.7
Future Peak Wet Weather Flow	20.0

1. Model scenarios are based on the existing trunk sewer network with no improvements considered. Implementation of the recommended capacity improvements is not expected to have a significant impact on projected PWWFs; however, the proposed improvements are consistent with the City's long-term goal of addressing wet weather capacity issues. Capacity improvements are further discussed in **Section 4.1**.

3.2.1 Gravity Sewer System Deficiencies

The model results show that under existing design storm PWWF conditions, there are four areas of capacity deficiencies in the gravity sewer system. These locations are identified in **Figure 3-2** and include pipes that are surcharged due to insufficient capacity as well as upstream segments that are surcharged due to backwater, where the deficiency results in either predicted overflows or surcharge to within less than 4 feet of the manhole rims. Under buildout flow conditions, there are no additional deficiencies predicted.

As noted above, predicted surcharge in a particular pipe does not necessarily indicate a capacity deficiency at that particular location, as flows can back up due to a downstream capacity deficiency and cause extensive surcharging or even overflows upstream due to backwater effects. Relieving upstream deficiencies can also create additional or more severe capacity deficiencies downstream of the relieved pipe; however, none of the deficiencies identified in this Master Plan would result in downstream deficiencies if relieved. The four locations of model predicted capacity deficiencies are described in **Table 3-2**.

Table 3-2: Model-Predicted Capacity Deficiencies

Deficiency	Location	Contributing Sewershed Area	US MH	DS MH	Model-Predicted Worst-Case Condition Resulting from Deficiency[1]	Proposed Improvement[2]	Recommendation[3]
1	Crespi Dr. from Peralta Rd. to Barcelona Dr.	Meter 23	LLD14	LLD22	Overflows at MH LLD20 on 6" main and at MHs LLD14 and LLD18 on 8" HDPE main	Upsize existing pipes. See Improvement Project 1.	During planned R&R project, upsize pipes as described in Project 1 (refer to **Section 4.1**).
2	Linda Mar Blvd. between De Solo Dr. and Peralta Rd.	Meters 4, 5A, 23	LL10	LL11	Inadequate freeboard (3.73') at MH LL10 on northern 20" main	Upsize existing pipe. See Improvement Project 2.	Perform additional flow monitoring after planned R&R project is implemented to confirm deficiency.
3	Fremont Ave. between Nelson Ave. and Monterey Rd.	Meter 10	F35	F36	Inadequate freeboard (2.96') at MH F35 on 12" main	Upsize existing pipe. See Improvement Project 3.	Perform additional flow monitoring to isolate I&I in Meter 10 sewershed area.
4	Catalina Ave. and Brookhaven Ct. intersection	Meter 10	F15	F19	Overflow at MH F15 where 8" and 10" mains meet and discharge to one 10" main	Upsize existing pipes. See Improvement Project 4.	Perform additional flow monitoring to isolate I&I in Meter 10 sewershed area.

1. To date, the City has not reported SSOs in the locations associated with Deficiencies #1 and #4; however, the City plans to add these locations to its list of areas to manually inspect during heavy rain flows.
2. Detailed capacity improvement projects are presented in **Section 4.1**.
3. If capacity deficiencies are still present after recommendations are implemented, construct the proposed improvement project.

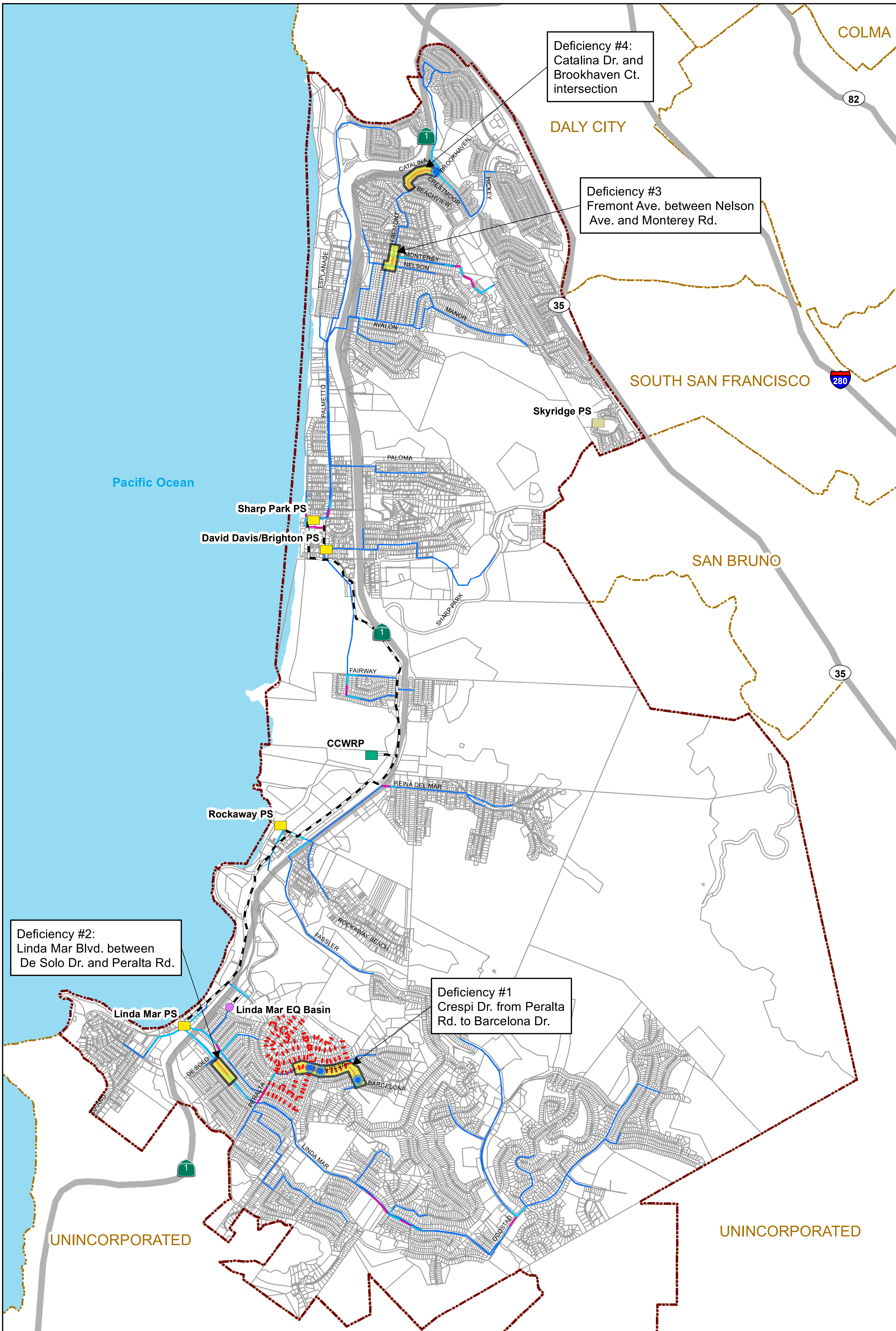


Figure 3-2
Model Results for
Design Storm PWWF

Wastewater Collection System
Master Plan

Legend

Modeled Sewer
- Not Surcharged
- Backwater Surcharge
- Throttle Surcharge
- Model Predicted Overflow
- Unmodeled Sewers

- Force Main
- Capacity Deficiency Area
- Pacifica City Limits
- Other City Boundaries
- Future City Rehabilitation and Replacement (R&R) Project

Facilities
- Pump Station
- Water Recycling Plant
- Pump Station (unmodeled)
- Equalization Basin

0 0.1 0.2 0.4 Miles

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WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

A sensitivity analysis was performed to assess the potential impacts of a more intense storm event with higher peak rainfall on the collection system. The model was run with an adjusted design storm in which rainfall amounts were inflated by 25% at each timestep. The adjusted design storm resulted in two additional predicted overflows along Crespi Drive just upstream of the Deficiency #3 area (refer to **Table 3-2**) and one additional predicted overflow along Monterey Road east of Norfolk Drive. The adjusted design storm also resulted in approximately 1,400 LF of additional capacity deficiencies, the majority of which are located near the existing deficiency areas and are caused by the larger storm exacerbating these capacity issues. Areas where the larger storm predicts new capacity deficiencies include 6-inch sewers along Monterey Road east of Norfolk Drive and Marina Way and Seaside Drive west of Seaforth Court.

3.2.2 Pump Stations

The City operates five sewer pump stations, four of which (Linda Mar, Rockaway, Sharp Park, and David Davis/Brighton) are included in the modeled network. These four pump stations were evaluated to determine if they had adequate capacity to convey buildout design peak wet weather flows. The fifth pump station, Skyridge, serves a small, relatively new residential development and was not included in the hydraulic model. Flows from Skyridge PS were included as part of the meter 10 subarea.

The firm capacities of each pump station were determined as part of the 2011 Master Plan. Firm capacity is defined as the flow at the intersection of the system curve with the summed pump curves, assuming that one pump is out of service (when all pumps have the same capacity) or the largest pump is out of service (when not all pumps have the same capacity).

Table 3-3 compares the total and firm capacity of each modeled pump station to the modeled flows under existing and future flow conditions. The table indicates that Rockaway, David Davis/Brighton, and Sharp Park Pump Stations have sufficient capacity to convey buildout design storm peak wet weather flows. Linda Mar Pump Station does not have firm or total capacity for the potential inflow; however, any sewer flows exceeding station capacity would be diverted into the Linda Mar EQ Basin. Modeling indicates that the flow diverted into storage would be significantly less than EQ Basin capacity (0.2 MG if Linda Mar PS is operating all three pumps [using total capacity] or 1.3 MG if the Linda Mar PS is operating without its largest pump [using firm capacity], compared to basin storage capacity of 2.1 MG). It should be noted that sequential storms could increase the storage used. Wastewater stored in the Linda Mar EQ Basin is pumped out via the EQ Basin effluent pumps and discharged to a gravity sewer in Crespi Drive, from where the flow is conveyed back to the Linda Mar PS. The Linda Mar EQ Basin pumps were evaluated in a separate TM, which is included as **Appendix E**.

Table 3-3: Pump Station Capacity Results

Pump Station	No. of Pumps	Total Capacity (mgd)	Firm Capacity (mgd)	Existing PWWF Constricted[1] (mgd)	Existing PWWF Relieved[2] (mgd)	Buildout PWWF Relieved[2] (mgd)
Linda Mar	3[3]	9.2	7.0	9.4[4]	9.5[4]	9.5[4]
Rockaway	3	5.0	4.1[4,5]	1.9	2.0	2.1
David Davis/ Brighton	3	3.7	3.4	1.9	2.0	2.0
Sharp Park	3	13	12.1	8.1	8.6	8.8

1. Constricted system - existing system without capacity relief projects.
2. Relieved system - capacity improvement projects constructed to relieve upstream bottlenecks.
3. The Linda Mar PS is equipped with two electric pumps and one larger natural gas engine-driven pump. Firm capacity is based on operation of the two electric pumps. The City identified a Capital Improvements Project to replace the two electric driven pumps with slightly larger pumps to increase firm capacity.
4. Total potential flow to Rockway PS (i.e., assumes no flow diversion to the Linda Mar EQ Basin).
5. Based on system curve assuming Linda Mar PS discharging 9.2 mgd. Note that Rockaway PS and Linda Mar PS discharge to a common force main.

3.3 Infiltration & Inflow Analysis

The Pacifica wastewater collection system is subject to significant amounts of I&I, resulting in high peak flows during wet weather events. Wet weather peaking factors (ratio of PWWF to average BWF) based on the model-predicted flow for the 10-year design storm range from about 3 to 16. The highest peak RDI&I rates occur in the lower Linda Mar area (meter area 23), with other areas of relatively high I&I in the Vallemar area (meter area 17) and in the Fairmont and Westview areas in the northern portion of the City (meter area 10). Most of the capacity deficiencies in the system were found in these areas. Although Pacifica's overall wet weather peaking factor (WWPF) of 7.7 is high compared to some other Bay Area systems, it is still within the range observed for similar older systems. Some other Bay Area systems (e.g., in southern Marin County) have higher WWPFs, whereas relatively newer systems typically have lower WWPFs (closer to 3).

Between the 2009/2010 and the 2019/2020 flow monitoring programs, the City has implemented a number of rehabilitation and replacement (R&R) projects to address the condition of sewer mains throughout the system, and since 2011 approximately 3,000 private laterals, or about 25-percent of the laterals in the system have also been replaced as part of the City's Sewer Lateral Replacement Program. This program requires homeowners to replace the upper portion of the lateral extending from the residence or building to the property line (upper lateral) when replacing the lower portion of the lateral extending from the property line to the sewer main (lower lateral), in accordance with the City's sewer maintenance ordinance. Of the 3,000 laterals replaced, approximately 90-percent were upper and lower lateral replacements, and the remaining 10-percent were only lower lateral replacements (typically because the upper laterals had already been replaced). Laterals were also replaced as part of the 2012/2013 R&R program in Linda Mar, and lateral replacement was offered as an option to homeowners as part of the 2017/2018 R&R program in Pedro Point. The City anticipated that these activities would reduce the observed I&I rates.

Section 3.3.1 provides a comparison of inflow and infiltration (I&I) rates estimated based on the 2019/2020 flow monitoring program versus the 2009/2010 flow monitoring program, which was used to assess the effectiveness of the City's R&R projects on reducing I&I.

3.3.1 I&I Reduction Analysis

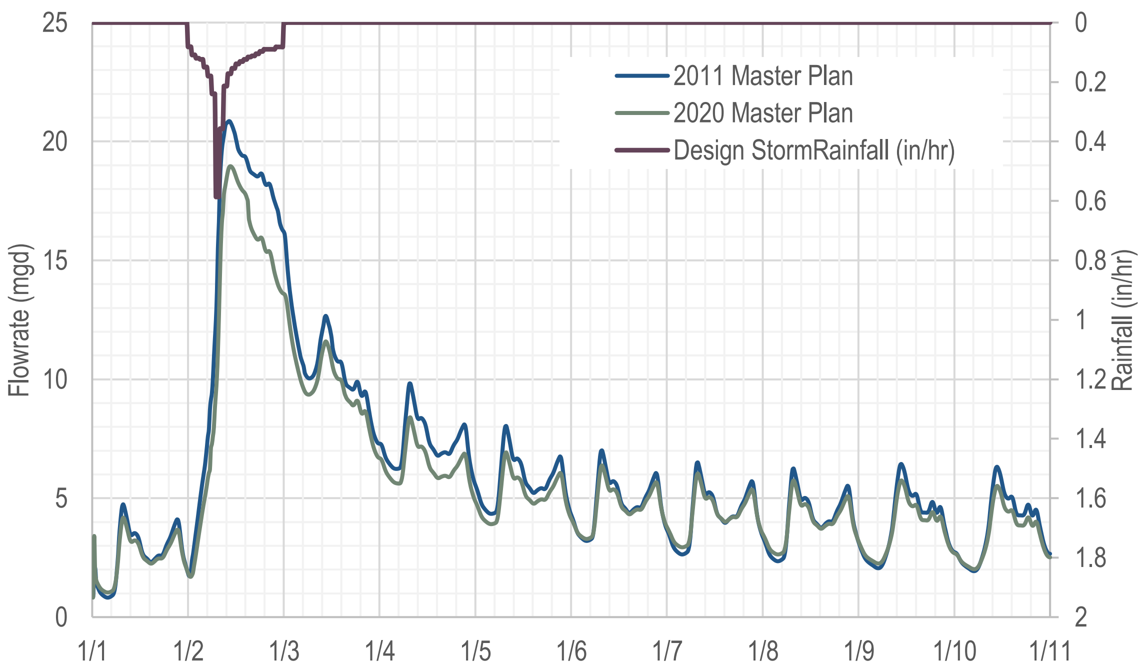
To perform the analysis, the calibrated models from 2020 and 2011 were run under design storm conditions, and the resulting flows were compared for each meter sewershed. Several metrics have been considered; the results are summarized in **Table 3-4**. **Figure 3-3** and **Figure 3-4** show the modeled design storm results to the CCWRP and to Linda Mar Pump Station, respectively, with both the 2020 and the 2011 master plan model under existing land use conditions. (Note that the hydrographs for the Linda Mar Pump Station are presented for comparison of the total flow from the pump station tributary area and do not reflect the peak flow reduction that would occur through use of the new wet weather equalization basin.) **Figure 2-2** showed the flow monitoring program and the sewers draining to each flow meter. **Figure 3-5** shows the modeled peak design storm I&I rates for each sewershed on a per linear foot of sewer basis based on total linear feet of sanitary sewer (modeled and unmodeled) in the sewershed. **Figure 3-6** compares the current I&I rates against the I&I rates estimated for the 2011 master plan. **Figure 3-7** and **Table 3-5** show the range of wet weather peaking factors by area. The following observations were made based on this information:

- Based on the predicted design storm flow to the CCWRP, the wet weather flow volume in the system appears to have been reduced by about 15 percent overall, which indicates that overall, the City's R&R program has been effective at achieving significant reductions in I&I.
- The reduction is slightly more significant in the sewershed tributary to the Linda Mar Pump Station, where there has been an 18 percent reduction in I&I volume, likely due in large part to the R&R projects that have been completed since 2011. This may reduce the frequency that the Linda Mar Equalization Basin gets used, reduce the volume needed to store the design storm peak flow, and/or allow for handling of larger, consecutive storm events.
- The 2019/2020 wet weather season had substantially less rainfall than the 2009/2010 season, which likely impacted the calibration and projections of I&I for some areas.
- The highest I&I rates occur upstream of Meter 23 (which includes many of the sewers on Crespi Drive) and upstream of Meter 17 (which includes the upstream sewers on Reina del Mar adjacent to Calera Creek), with moderate rates of I&I upstream of Meter 3 (in the vicinity of Arguello Boulevard), Meter 4 (Linda Mar Blvd. upstream of Peralta Road), and Meter 5A (Peralta Road south of Linda Mar Blvd.). Other basins had relatively lower peak I&I rates.
- Most basins that have been rehabilitated as part of the City's annual R&R programs have seen an overall reduction of I&I. The exception was for the FY 2012/2013 project (Meter 3), which saw no appreciable change in I&I. The FY 2014/2015 (Meter 16) and FY 2015/2016 (Meter 23) projects did not have an equivalent meter in 2010 to compare with, so while the change in I&I has been estimated, the change is likely partially due to the calibration assumptions used for these areas in the 2011 Master Plan.
- Much of the I&I through Meter 17 (Vallemar) has a very slow response, suggesting that groundwater is draining into the area from further upslope. The City has performed CCTV inspections of main lines in this area during the spring and has observed high infiltration. Low I&I was observed at the adjacent Meter 18 (Vallemar) which suggests that the majority of I&I enters the system via sewers within the Meter 17 watershed. However, Meter 18 had difficult hydraulic conditions (very low flow depths and velocities) and had to be calibrated using data from the March 2020 storm event because the data for the January event was poor (ADS subsequently installed a different velocity sensor on February 7, 2020 in an attempt to improve data quality); therefore, there is significant uncertainty in the I&I estimates for Meter 18.
- Meter 10 (which includes the northernmost part of the City) is the only meter present in 2009/2010 that showed a significant increase in I&I. The source of this additional I&I is unclear. As the model predicts two potential capacity deficiencies upstream of this meter (near Catalina Avenue and Beachview Avenue; on Fremont Avenue near Monterey Road; and on Monterey Road upstream of Hickey Blvd) due to the greater I&I, it is

recommended that the City perform additional flow monitoring to better isolate the source of the I&I and confirm the capacity deficiency. The pipes on Catalina Avenue and Fremont Avenue could also be upsized to alleviate the model-predicted capacity deficiencies (Deficiency #3 and #4) if sufficient I&I reductions cannot be achieved.

- Meter 23 (primarily sewers tributary to the main on Crespi Drive near Escalero Avenue) had a fairly significant I&I response, and the model predicts that this area could experience an overflow during a design storm. This area was not specifically monitored in 2009/2010 (and sewer configuration has changed somewhat), so it is likely that significant I&I was also present during that calibration period and just not identified. A R&R project to rehabilitate the sewers in this area has already been planned and designed by the City but has not yet been implemented. Since a portion of this sewershed would be part of the planned R&R program, it is recommended that the City perform additional flow monitoring to assess I&I after the R&R project is completed. The pipes on Crespi Drive could also be upsized to eliminate the predicted capacity deficiency (Deficiency #1) if sufficient I&I reductions cannot be achieved.
- The future R&R project area identified includes portions of Meter 3 and Meter 23, both of which had relatively high rates of I&I. This area is suspected to have many laterals constructed using Orangeburg pipe material, which is known to have high rates of defects and may be a significant source of I&I.

Figure 3-3: Modeled Design Storm Results (Flow into CCWRP)[1]



1. Approximately 1.7 MG was stored in the Linda Mar EQ Basin in the 2011 Master Plan model run, versus about 0.2 MG in the 2020 Master Plan model run.

Figure 3-4: Modeled Design Storm Results (Flow into Linda Mar PS)[1]

1. Total potential inflow into Linda Mar PS (e.g., flow diverted into Linda Mar EQ Basin is included).

Table 3-4: RDI&I Rates by Flow Meter Area

Flowmeter ID[1]	Community	US Meter	Sewershed Rehab/Repair Projects	Approx. Sewer Length (mi.)	2011 Peak I&I (gpd/ft)[2]	2020 Peak I&I (gpd/ft)[2]	Change in Peak I&I per ft [2]	2011 I&I Volume (MG)[2]	2020 I&I Volume (MG)[2]	Change in I&I Volume[2]	2011 Model PWWF (mgd)[2]	2020 Model PWWF (mgd)[2]	Change in PWWF[2]	Comments
6	Pedro Point		FY 2017/2018	3.1	59	28	-52%	1.1	0.6	-41%	1.1	0.5	-50%	Pedro Point. Calibration and data were good for both 2009/2010 and 2019/2020. Significant reduction in I&I.
3	Linda Mar		Most of the area was included in the FY 2012-2013 project	4.2	56	61	9%	1.8	1.9	4%	1.4	1.4	6%	Not a significant change in I&I. Calibration and data were good for both 2009/2010 and 2019/2020.
4	Linda Mar	24	none	6.7	27	51	84%	1.8	1.8	-1%	1.2	2	63%	This is an incremental meter area, so some uncertainty in calibrated I&I is expected. Overall metered peak flows at Meter 4 are not substantially changed, but upstream Meter 24 area shows reduced I&I, requiring an increase for the Meter 4 incremental area. Runoff volumes do appear to have decreased for this meter area.
5A	Linda Mar		A small part of this area was included in the FY2014-2015 Phase 1 project	6.1	61	53	-14%	2.8	2.6	-5%	2.3	1.9	-18%	Moderate reduction in I&I. 2010 and 2020 calibrations were reasonable.
7	Linda Mar	EQ	None	1.5	25	11	-57%	0.1	0.2	160%	0.2	0.1	-43%	Very small area and flows were impacted by operation of the EQ basin. Poor data quality for both in 2009/2010 and 2019/2020, so data is inconclusive.
16	Linda Mar		FY2014-15 Phase 1	1.5	485	35	-93%	3.3	0.7	-80%	3.9	0.3	-92%	Flows in 2011 Model for this area were based on a Meter 5B on the 27-inch trunk just upstream of Linda Mar PS and downstream of 5A. Current metering program was better able to isolate this area and indicates a significant reduction in I&I.
23	Linda Mar		None; Future R&R project will include about half this area	4.6	69	94	36%	2.1	3.7	71%	1.8	2.5	35%	Flows in 2011 Model were based on a Meter 5B on the 27-inch trunk just upstream of Linda Mar PS and downstream of 5A. Current metering program was better able to isolate this area. The apparent increase in I&I may be primarily due to how the I&I for the 5B meter area in 2010 was distributed, rather than an actual increase.
24	Park Pacifica		None	13.9	51	31	-40%	4.6	3.5	-24%	4.4	2.8	-37%	Formerly 2009/10 Meter 1 and Meter 2. Calibration and data were good for both 2009/2010 and 2019/2020. Moderate apparent decrease in I&I.
22A	Rockaway Beach (Fassler Ave)		None	1.2	48	33	-32%	1	0.3	-73%	0.3	0.2	-30%	Flows in 2011 Model for this area were based on Rockaway Pump Station incremental area. 2020 model has better isolation of flow from this area: however, this meter had to be moved and had unusable data for the 1/16/2020 calibration storm so results are not reliable.
19	Rockaway Beach		None	1.1	61	40	-36%	1.2	1.1	-6%	0.5	0.5	-3%	Flows in 2011 Model for this area were based on incremental Rockaway Pump Station area. 2020 model has better isolation of flow from this area. This meter had an unexplained apparent base wastewater flow in the 2019/2020 flowmeter data, which was added to the 2020 model.
8A	Vallemar	17, 18	None	2.3	50	41	-19%	2.1	1.5	-27%	0.7	0.6	-19%	This is an incremental meter area for the 2020 calibration, which isolated part of the upstream basins. A significant part of the I&I in this area is coming from meter 17, therefore the apparent “reduction” is mainly due to redistribution of the overall flow, not necessarily a reduction in the incremental area’s I&I.

Flowmeter ID[1]	Community	US Meter	Sewershed Rehab/Repair Projects	Approx. Sewer Length (mi.)	2011 Peak I&I (gpd/ft)[2]	2020 Peak I&I (gpd/ft)[2]	Change in Peak I&I per ft [2]	2011 I&I Volume (MG)[2]	2020 I&I Volume (MG)[2]	Change in I&I Volume[2]	2011 Model PWWF (mgd)[2]	2020 Model PWWF (mgd)[2]	Change in PWWF[2]	Comments
17	Vallemar		None	1.1	51	88	73%	1.1	2.4	123%	0.3	0.6	71%	2020 model has better isolation of the I&I flow going through 8A meter, and I&I appears to be primarily coming from the meter 17 sewershed. The apparent "increase" is mainly due to redistribution of the overall flow in the Vallemar basin, not necessarily an increase in this subarea's I&I.
18	Vallemar		None	1.8	16	13	-16%	0.5	0.3	-45%	0.2	0.2	-9%	2020 model has better isolation of the I&I flow going through 8A meter, and I&I appears to be primarily coming from the meter 17 sewershed. The apparent "reduction" is mainly due to redistribution of the overall flow in the Vallemar basin, not necessarily a decrease in this subarea's I&I.
14	Fairway Park		None	6.4	29	24	-17%	2	1.6	-21%	1.1	1	-12%	I&I response in both 2009/2010 and 2019/2020 data was relatively slow (not a significant peak response). Reduction could be due to antecedent conditions and change in character of the design storm.
9	Sharp Park		None	3.6	52	45	-13%	1.7	0.8	-51%	1.1	0.9	-13%	Small apparent reduction in peak I&I. More significant reduction in I&I volume, but overall flows are relatively small, and reduction could be due to antecedent conditions and change in character of the design storm.
13 & 15	Sharp Park	20, 21	None	5.9	67	32	-53%	1.5	1.2	-19%	2.3	1.2	-48%	These meters are on parallel trunk sewers carrying flow from the north part of Pacifica. Apparent moderate decrease in overall I&I in this incremental sewershed.
20	Edgemar, Pacific Manor	10	None	11.1	49	17	-64%	3	0.6	-80%	3.3	1.3	-60%	Flows in 2011 Model were based on 2009/10 Meter 12 (on Avalon Drive near Edgemar Avenue), which had a very significant I&I response. Meter 20 is at a downstream location and includes Meter 10. 2019/2020 data showed significantly less I&I. Reduction in I&I could be due to projects completed since the 2011 Master Plan (Milagra Drive from Bruce Street to Edgemar Avenue, Avalon Drive to Del Mar Avenue), which included replacement of a section of pipe that crossed a creek on Edgemar.
21	Edgemar		None	4.2	8	12	50%	0.4	0.4	8%	0.4	0.5	18%	Flows in 2011 Model were based on Meter 15. 2020 model has better isolation of flow from this area. Overall, I&I rates in this were low in 2009/2010 and remain low in 2019/2020.
10	Fairmont, Westview		None	14.3	23	34	51%	3.3	5.6	69%	2.2	3.5	55%	Calibration and data were good for both 2009/2010 and 2019/2020. Apparent increase in I&I.
Linda Mar Sewershed[3]				41.9	73	47	-35%	18.8	15.4	-18%	17.8	11.8	-34%	2020 Model results indicate that significant reductions in both I&I volume and peak I&I were achieved in the Linda Mar sewershed area since the 2011 Master Plan.
Overall[4]				104.5	49	33	-31%	37.9	32.3	-15%	30.8	22.4	-27%	Overall, the 2020 Model results indicate that a significant reduction in both I&I volume and peak I&I were observed systemwide since the 2011 Master Plan.

1. Incremental I&I flows for meters with upstream flow meters.
2. For 10-year design event. Based on sum of individual model subcatchments loads (does not reflect flow attenuation in trunk sewer system). Runoff volumes are based on a 10-day design storm simulation.
3. Includes all subcatchments upstream of the Linda Mar Pump Station.
4. Includes all subcatchments.

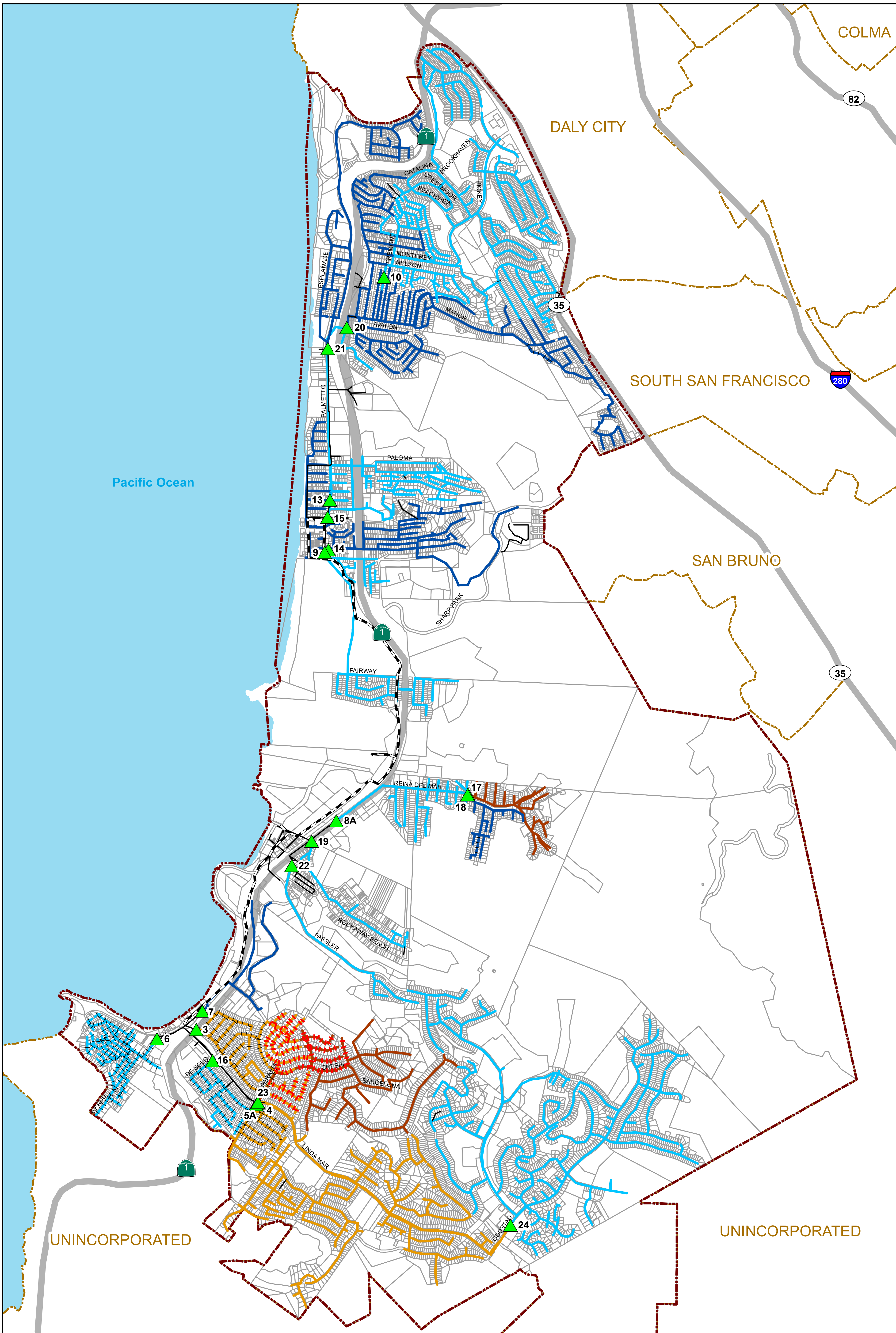


Figure 3-5
2020 Inflow & Infiltration Rates

Wastewater Collection System
Master Plan

Legend

GPD per linear foot of sewer

- <25
- 25 - 50
- 50 - 75
- >75
- City Rehabilitation and Replacement Project (2012-2018)
- Future City Rehabilitation and Replacement Project
- Flow Meter
- Force Main
- Not Metered
- Pacifica City Limits
- Other City

0 0.1 0.2 0.4 Miles

N

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

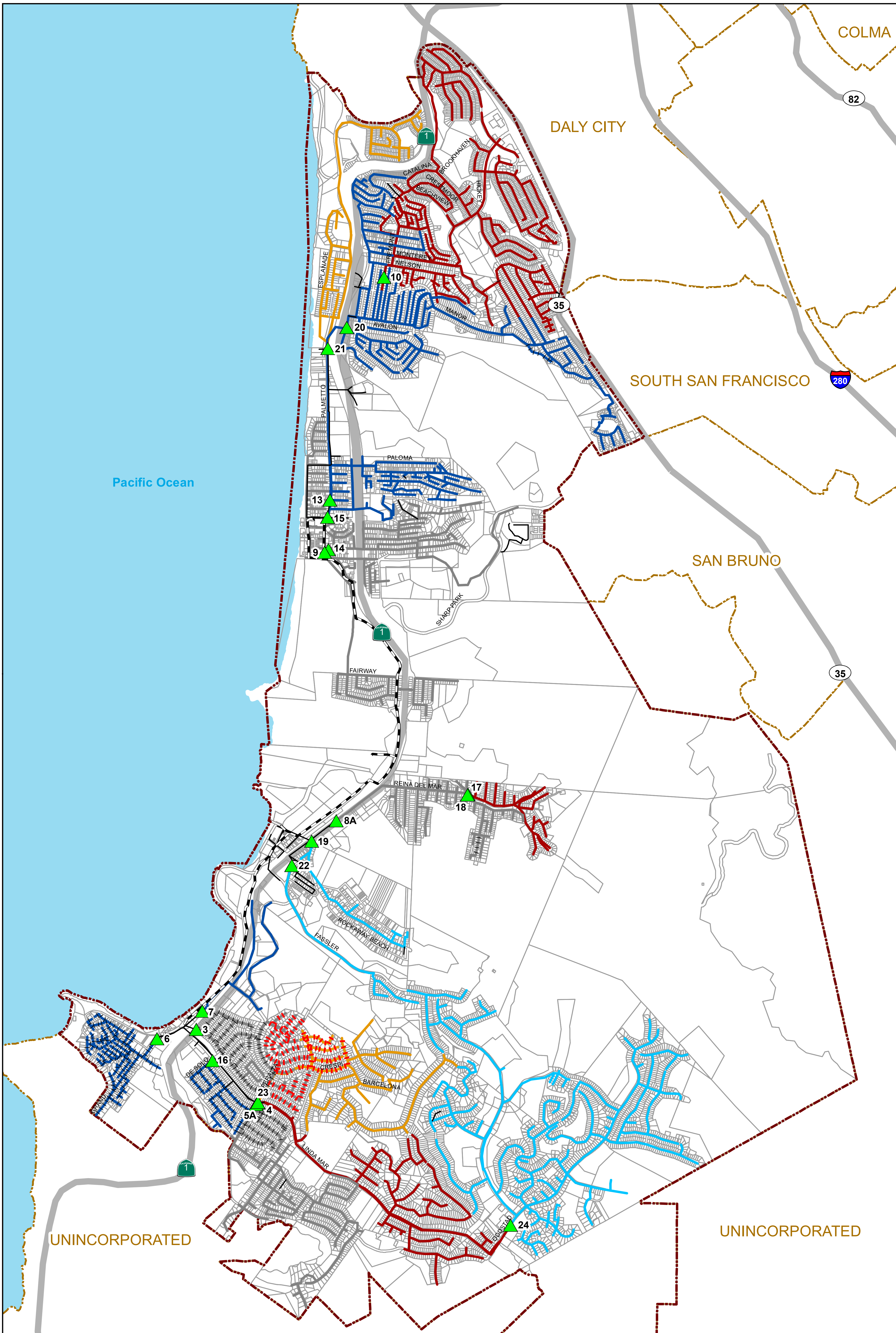


Figure 3-6
2020 vs. 2011 Inflow & Infiltration Comparison

Wastewater Collection System Master Plan

Legend

GPD per linear foot of sewer (change vs 2011 model)

- <-50%
- -20% to -50%
- -20% to +20%
- +20% to +50%
- >+50%
- City Rehabilitation and Replacement Project (2012-2018)
- Future City Rehabilitation and Replacement Project
- Flow Meter
- Not Metered
- Force Main
- Pacifica City Limits
- Other City Boundaries

0 0.1 0.2 0.4 Miles

N

City of Pacifica

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

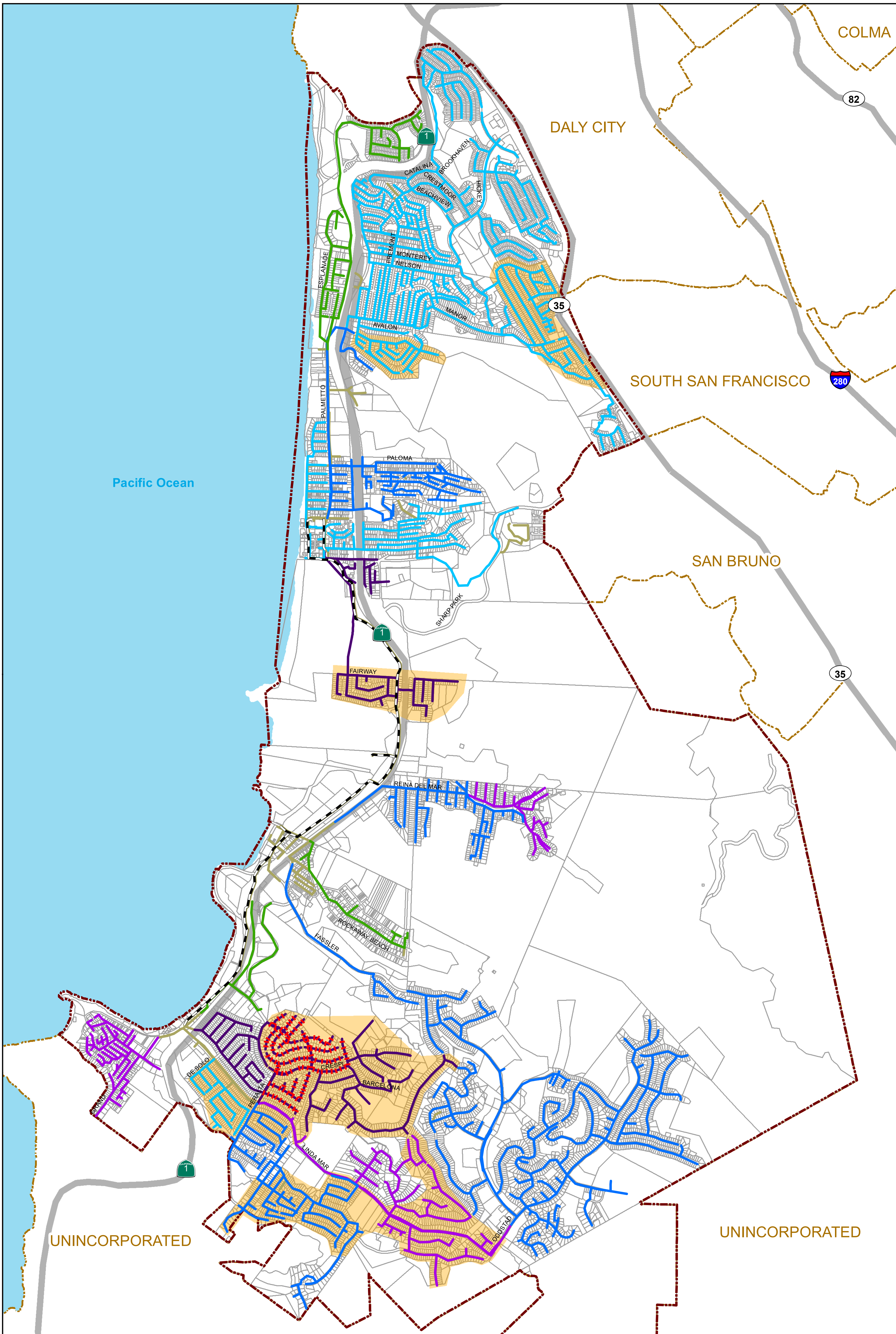


Figure 3-7
Wet Weather Peaking Factors

Wastewater Collection System
Master Plan

Legend

WWPF	
< 5	
5-10	
10-15	
15-20	
20-30	

- Force Main
- Unmetered Sewer
- Future City Rehabilitation and Replacement (R&R) Project
- Areas with Known Orangeburg Laterals Identified by City Staff
- Pacifica City Limits
- Other City Boundaries
- Highways
- Parcels

0 0.125 0.25 0.5 Miles

N

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

Table 3-5: Wet Weather Peaking Factors by Flow Meter Area

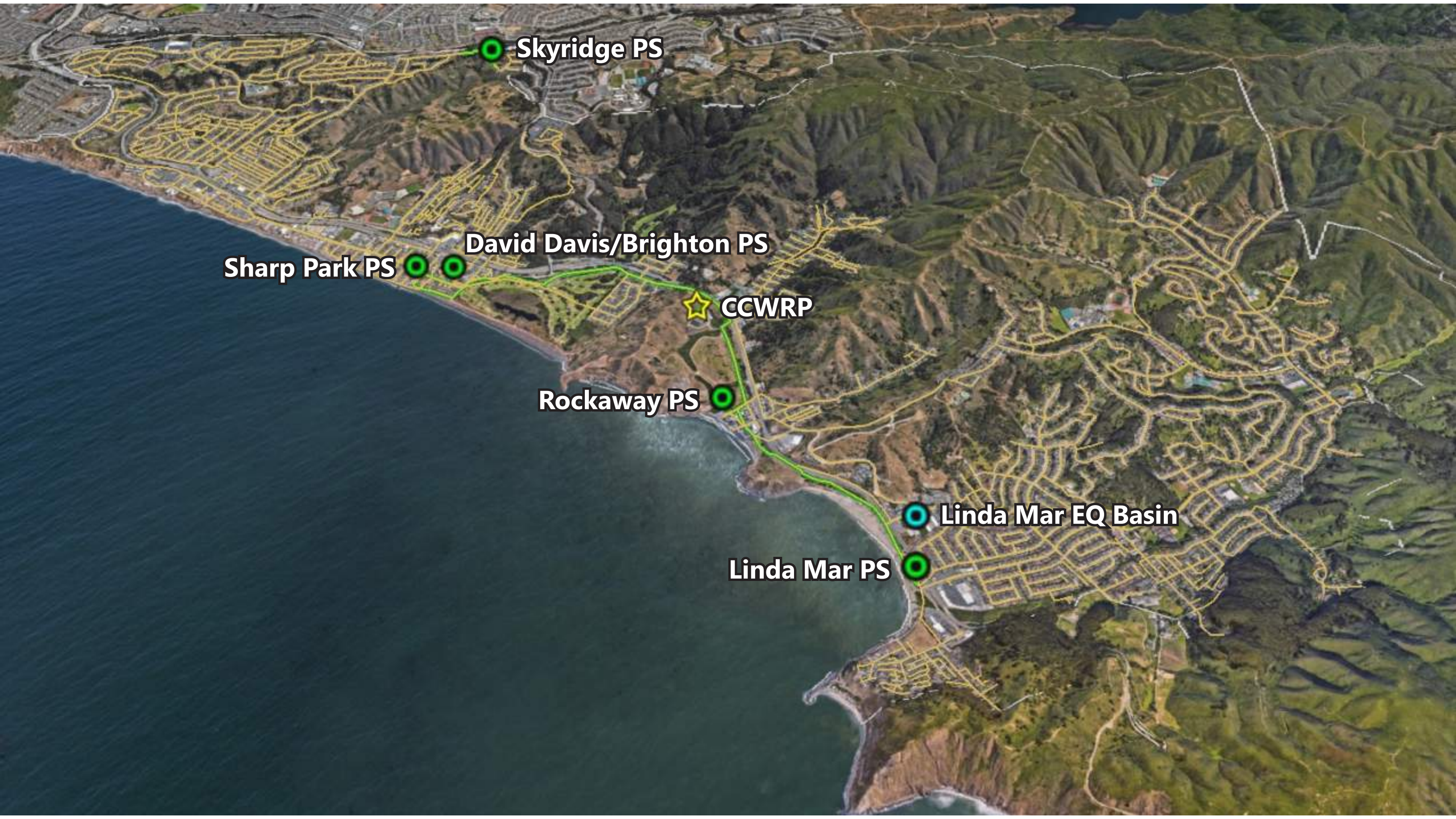
Meter ID[1]	Average BWF (mgd)[2]	PWWF (mgd)[3]	WWPF
3	0.05	1.43	29.2
4	0.12	1.99	16.7
5A	0.15	1.97	13.1
6	0.03	0.53	15.9
7	0.03	0.14	4.5
8A	0.04	0.57	14.8
9	0.05	0.93	20.2
10	0.41	3.46	8.4
13+15	0.11	1.20	11.2
14	0.11	0.97	8.9
16	0.03	0.32	9.3
17	0.04	0.71	19.3
18	0.001	0.02	12.4
19	0.11	0.46	4.3
20	0.15	1.33	8.9
21	0.13	0.48	3.7
22A	0.02	0.24	12.3
23	0.09	2.46	28.7
24	0.27	2.78	10.2
Systemwide	1.96	22.6	11.5

1. Represents incremental meter areas.
2. Based on existing average base wastewater flows (does not include GWI).
3. Based on existing design storm peak flows.

Higher peaking factors in some meter basins may be due to general I&I from defects in the original laterals that exist from the structures to the property lines, many of which are Orangeburg pipes and are known to be in poor condition and subject to I&I. Areas where Orangeburg laterals may still be present according to City staff are identified in **Figure 3-7** and include portions of meter basins 3, 4, 5A, 9, 10, 16, 20, and 23. However, not all of the Orangeburg laterals in the areas may remain, as many property owners throughout the City have replaced their laterals due to failures or the need for compliance certificates. Although meter basin 16 was part of the City's FY2014-15 R&R program, the laterals were not specifically replaced as part of that project, and some may still be Orangeburg. As shown in **Figure 3-7**, the City has a future R&R project to replace the sewers and laterals in meter basins 3 and 23, which is expected to reduce I&I and lower the WWPFs in these areas.

CHAPTER 4

Recommended Capacity Improvement Plan



4. RECOMMENDED CAPACITY IMPROVEMENT PLAN

This chapter describes the sewer improvement projects that would be needed to reduce the risk of the overflows in the collection system due to insufficient capacity for design peak wet weather flows. The assumptions that were used to define the projects are also discussed.

4.1 Capacity Improvement Projects

Capacity improvement projects were identified to address the potential deficiencies identified through the capacity analysis discussed in **Section 3.2**. For each identified gravity sewer capacity deficiency, a project was developed to replace the existing pipe with a larger pipe. Replacement pipes were sized to convey the buildout design storm PWWF with no (or only minimal) surcharge. Existing pipe slopes and depths were preserved when upsizing sewers in-place. Diameters were increased as minimally as possible in order to prevent oversizing and subsequent low velocities during dry weather conditions. Model runs with all capacity projects in place were made to determine the impact of increased capacity from upstream projects on peak flows in pipes downstream of those projects to verify that no additional collection system capacity deficiencies would result.

Four capacity improvement projects were identified as part of this Master Plan and are discussed below. The project locations are identified in **Figure 4-1** and summarized in **Table 4-1**. The Project IDs shown in **Figure 4-1** and **Table 4-1** correspond to the Deficiency IDs in **Table 3-2**. Each project is documented in further detail in **Appendix D** with an individual plan map and project information sheet that provides project details, key considerations, and a planning-level capital cost estimate. For each project, the construction method (open cut or pipe burst) was assumed based on the proposed pipe diameters and depths in order to estimate costs; however, the actual construction method should be confirmed during design based on project-specific conditions.

Project 1 – Crespi Drive

Improvement Project 1 would relieve Capacity Deficiency 1 identified in the capacity analysis. The project includes replacement of approximately 474 LF of 6-inch pipe with 8-inch pipe and 1,054 LF of 8-inch pipe with 12-inch pipe on Crespi Drive from Peralta Road to Barcelona Drive using pipe bursting (a smaller pipe diameter was modeled (e.g., 10-inch) but was not large enough to eliminate capacity deficiencies for this reach). The existing 8-inch pipe segments along Crespi Drive (west of La Mirada Way) that are recommended for replacement are located within the City's planned R&R project for the Meter 23 sewershed area, but the existing 6-inch pipe segments are not. However, since these pipes are small diameter and are adjacent to the current extents of the planned R&R project, the City should consider expanding the R&R program to also include the undersized 6-inch pipe segments.

Project 2 – Linda Mar Boulevard

Improvement Project 2 would relieve Capacity Deficiency 2 identified in the capacity analysis. The project includes replacement of approximately 307 LF of 20-inch pipe with 27-inch pipe on Linda Mar Boulevard between De Solo Drive and Peralta Road using open-cut remove and replace. However, since this capacity deficiency is downstream of the planned R&R project for the Meter 23 sewershed area, additional flow monitoring could be performed after implementation of the R&R project to confirm if the modeled deficiency is still present.

Project 3 – Fremont Avenue

Improvement Project 3 would relieve Capacity Deficiency 3 identified in the capacity analysis. The project includes replacement of approximately 278 LF of 12-inch pipe with 15-inch pipe on Fremont Avenue between Nelson Avenue and Monterey Road using pipe bursting. However, it is recommended that the City perform additional flow monitoring prior to implementing Project 3 to better isolate I&I in the Meter 10 sewershed area and confirm if the modeled deficiency is still present.

Project 4 – Catalina Avenue

Improvement Project 4 would relieve Capacity Deficiency 4 identified in the capacity analysis. The project includes replacement of approximately 940 LF of 10-inch pipe with 12-inch pipe on Catalina Avenue and Beachview Avenue from Brookhaven Court to Crestmoor Circle using pipe bursting. However, it is recommended that the City perform additional flow monitoring prior to implementing Project 4 to better isolate I&I in the Meter 10 sewershed area and confirm if the modeled deficiency is still present.

4.1.1 Cost Criteria

Costs for capacity improvement projects were estimated based on Woodard & Curran's experience with similar projects in the greater San Francisco Bay Area. These cost estimates are planning or conceptual level estimates and are considered to have an estimated accuracy range of -30 to +50 percent. This level of accuracy corresponds to an "order of magnitude" or "Class 5" cost estimate as defined by the American Association of Cost Estimators. These estimates are suitable for use for budget forecasting, CIP development, and project evaluations, with the understanding that refinements to the project details and costs would be necessary as projects proceed into the design and construction phases. All costs have been adjusted to an Engineering News Record Construction Cost Index (ENR CCI) of 13,169, which represents the December 2020 ENR CCI for the San Francisco Area.

Cost criteria include baseline unit construction costs for gravity sewers using open-cut and trenchless (e.g., pipe bursting) methods. Costs for gravity trunk sewers vary with pipe diameter and depth (in the case of open-cut construction) and include an allowance for lateral reconnections. Allowances added to the baseline construction cost include mobilization/demobilization and project-specific costs for bypass pumping, traffic control, and extra shoring and dewatering in areas with high groundwater. A 30 percent allowance for contingencies for unknown conditions was also included for all projects, as well as an allowance of 25 percent of construction cost for engineering, administration, and legal costs. A detailed cost estimate for all four capacity improvement projects is provided in **Appendix D**.

Table 4-1: Recommended Capacity Improvement Projects

Project ID	Project Name	Deficiency Type	Description[2]	Estimated Construction Cost	Estimated Project Cost[1]
1	Crespi Drive	Predicted overflow	Upsize 474 LF of 6" to 8" pipe and upsize 1,054 LF of 8" to 12" pipe on Crespi Dr. from Peralta Rd. to Barcelona Dr.	$792,000	$1,069,000
2	Linda Mar Boulevard	Inadequate freeboard	Upsize 307 LF of 20" to 27" pipe on Linda Mar Blvd. between De Solo Dr. and Peralta Rd.	$335,000	$453,000
3	Fremont Avenue	Inadequate freeboard	Upsize 278 LF of 12" to 15" pipe on Fremont Ave. between Nelson Ave. and Monterey Rd.	$154,000	$207,000
4	Catalina Avenue	Predicted overflow	Upsize 940 LF of 10" to 12" pipe on Catalina Ave. and Beachview Ave. from Brookhaven Ct. to Crestmoor Cir.	$547,000	$739,000

1. Includes construction costs (pipe installation, lateral reconnection, bypass pumping, traffic control, mobilization / demobilization, contingencies) plus engineering, administration, legal fees (estimated as 35 percent of construction costs).
2. Proposed pipe sizes are based on standard sewer pipe diameters. If pipe bursting with HDPE, a pipe with an equivalent inside diameter would be used.

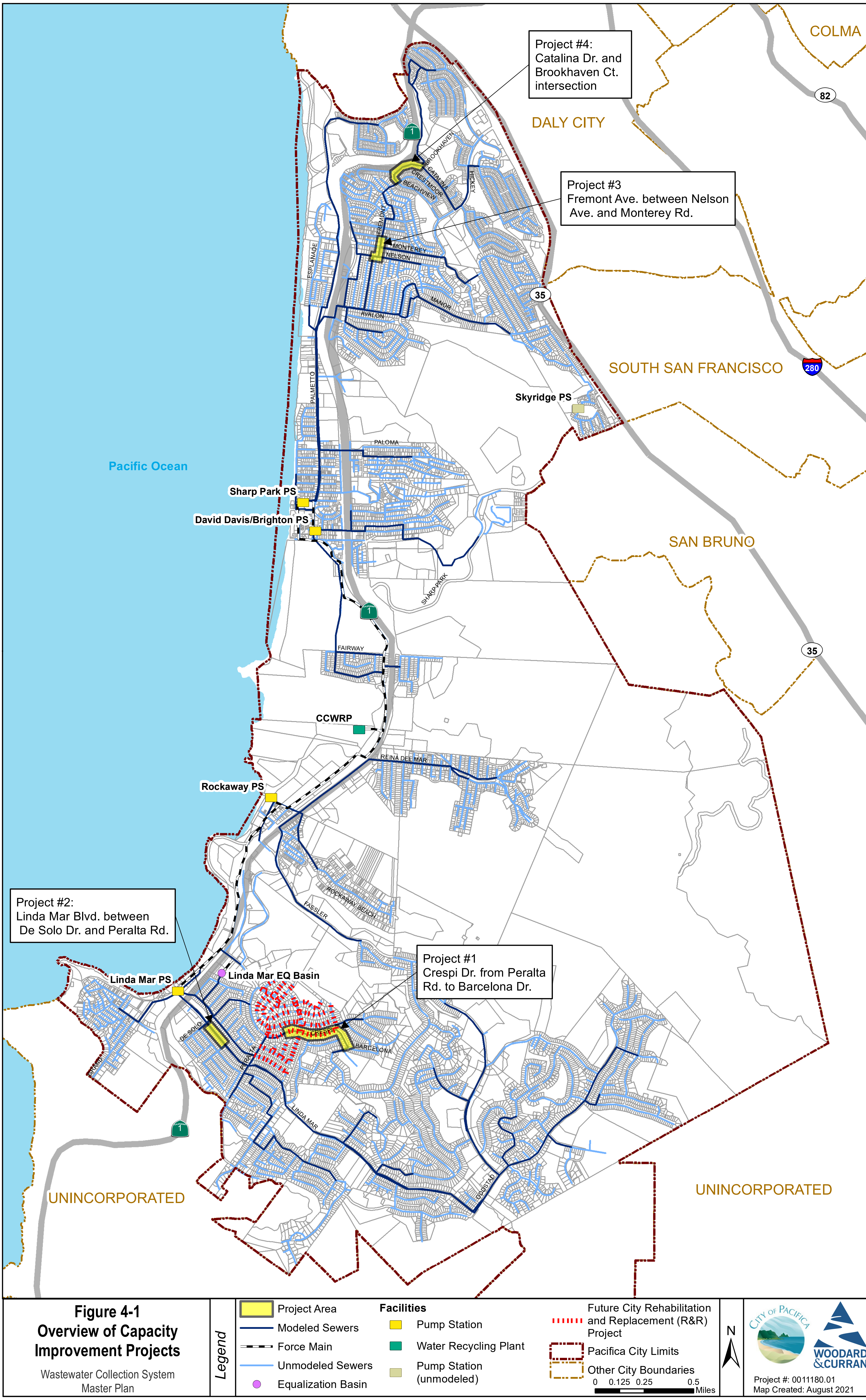


Figure 4-1
Overview of Capacity Improvement Projects

Wastewater Collection System Master Plan

4.2 Project Implementation Recommendations

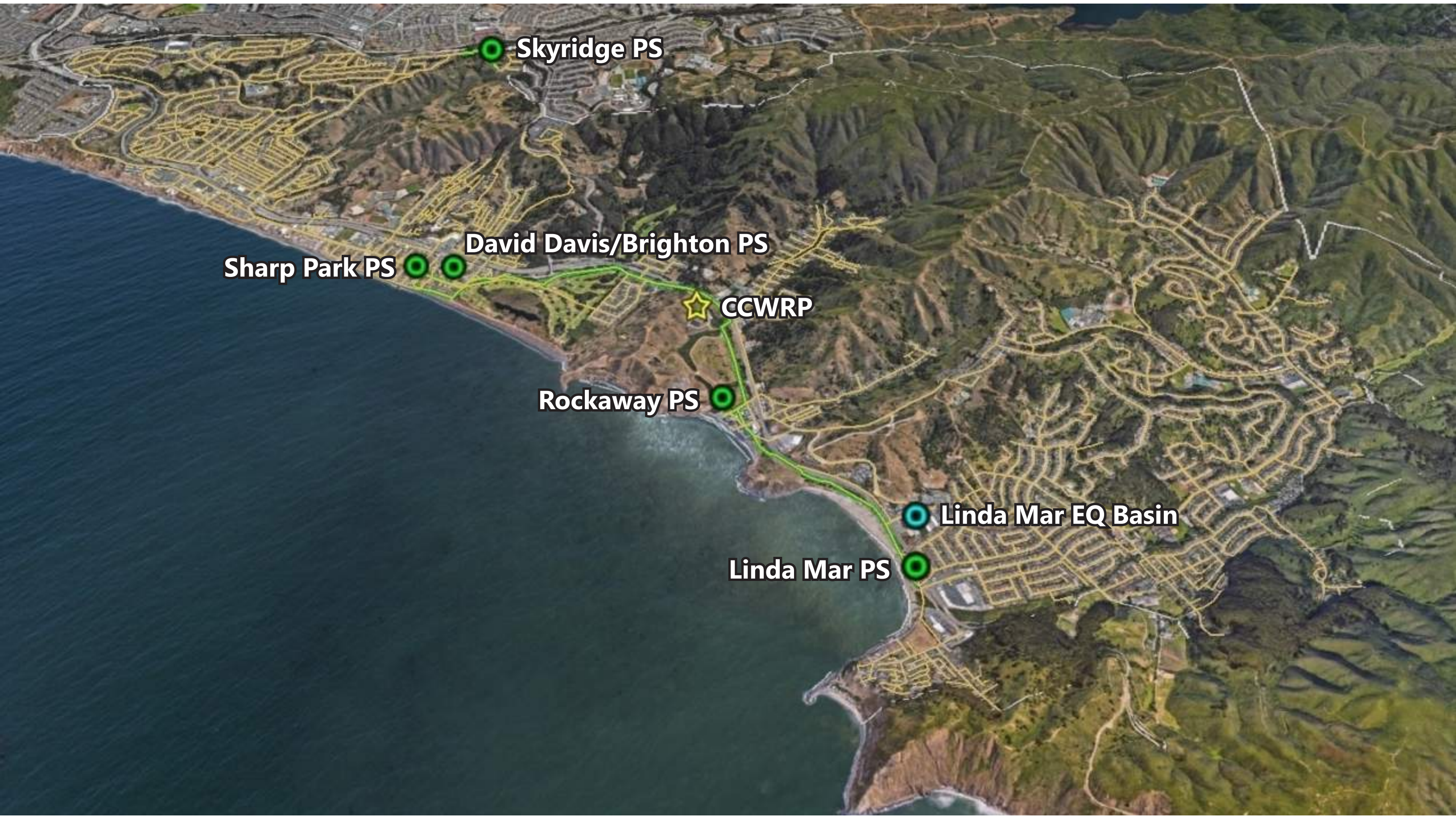
The City should begin implementation of the capacity improvements recommended in this Master Plan. This plan does not specify an implementation schedule, as the City will need to balance the timing of sewer capacity improvements with the need for other capital projects, such as sewer rehabilitation and pump station upgrades. The following items should be considered in project scheduling and design, and in future updates of the Master Plan:

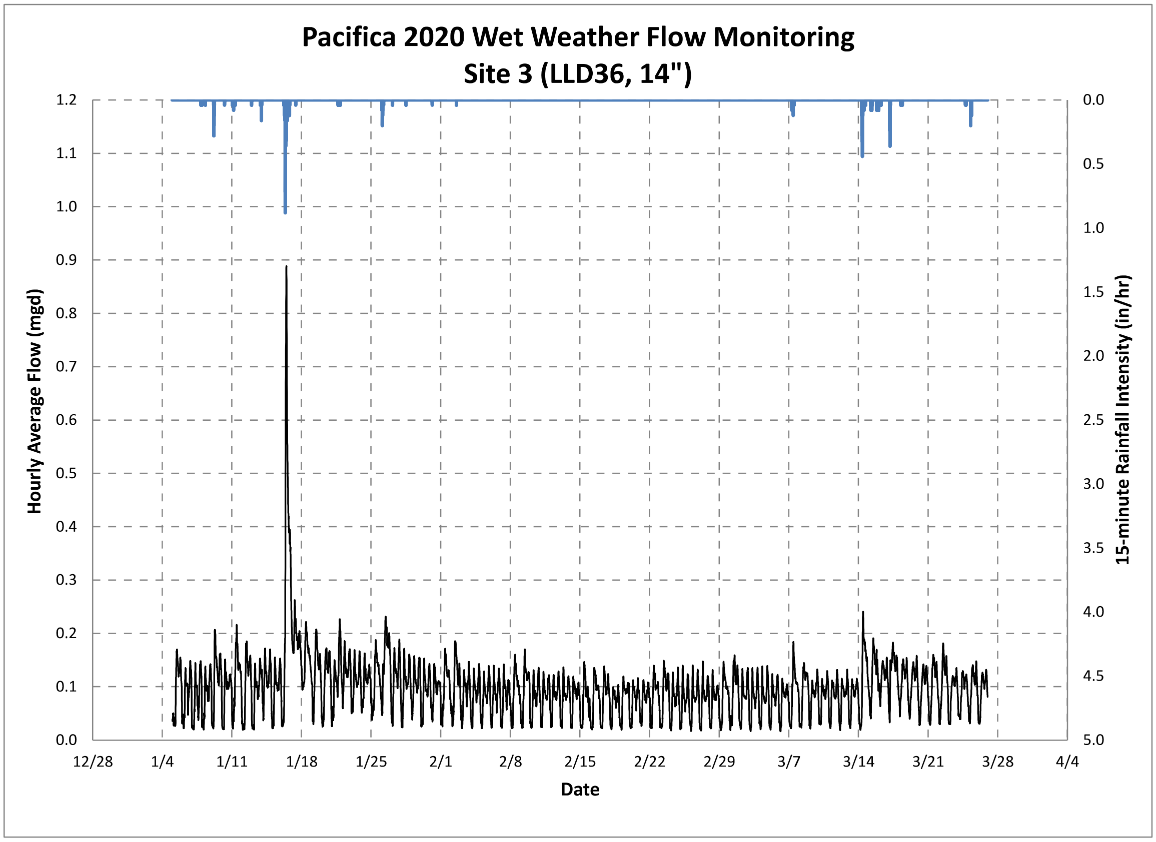
- The alignments and sizes of all recommended projects should be verified with detailed predesign analyses, including topographic surveys, geotechnical investigations, utility research, and constructability reviews;
- The projects recommended in this report are based on pipe replacement. The decision to parallel or replace existing sewers should consider the physical condition and remaining useful life of the existing pipelines; the availability of pipeline corridors for new sewer construction; and operation and maintenance concerns;
- Only standard pipe diameters (e.g., 8, 10, 12, 15, 18 inches, etc.) were modeled; appropriate pipe sizes for HDPE pipe should be considered as part of design;
- The hydraulic model has been developed to assist the City in performing capacity analyses and updating the Master Plan in the future. The model should be kept up-to-date with any changes to existing sewer connections, development plans, and sewer system facilities;
- The City should continue with its sewer inspection and condition assessment program, identifying sewers that should be replaced due to poor condition. To the extent possible, these improvements should be coordinated with the recommended capacity-related improvements;
- In addition to the project implementation recommendations listed above, the City should continue to address I&I through continued CCTV inspection and rehabilitation of sewer mains and lower laterals. Additional flow monitoring and field investigations should be conducted in high I&I areas to identify possible opportunities for I&I reduction, and the resulting elimination or downsizing of some of the CIP projects presented herein;
- Growth projections assumed herein should be updated as needed to reflect the City's General Plan and Sharp Park Specific Plan updates, which are currently ongoing, and need to meeting regional housing needs. Based on the Draft Regional Housing Needs Allocation (RHNA) Plan for the San Francisco Bay Area, prepared in May 2021, the City must plan to accommodate a total of 1,892 new households between 2023-2031 to meet regional housing needs;
- The City should assess its connection fees and sewer rates and evaluate financial alternatives to fund the recommended capacity improvement projects, including methods for allocating costs to future development; and
- Although this recommended project is not a capacity-related improvement, the City should consider re-routing the 12-inch sewer line that runs underneath the San Francisco RV park main building to an alignment along Palmetto Avenue.

This Master Plan is intended to be a working document to be refined and updated as additional data and new planning information becomes available. The Master Plan should be updated whenever there are major changes in planning assumptions and conditions or, at a minimum, every 5 to 10 years.

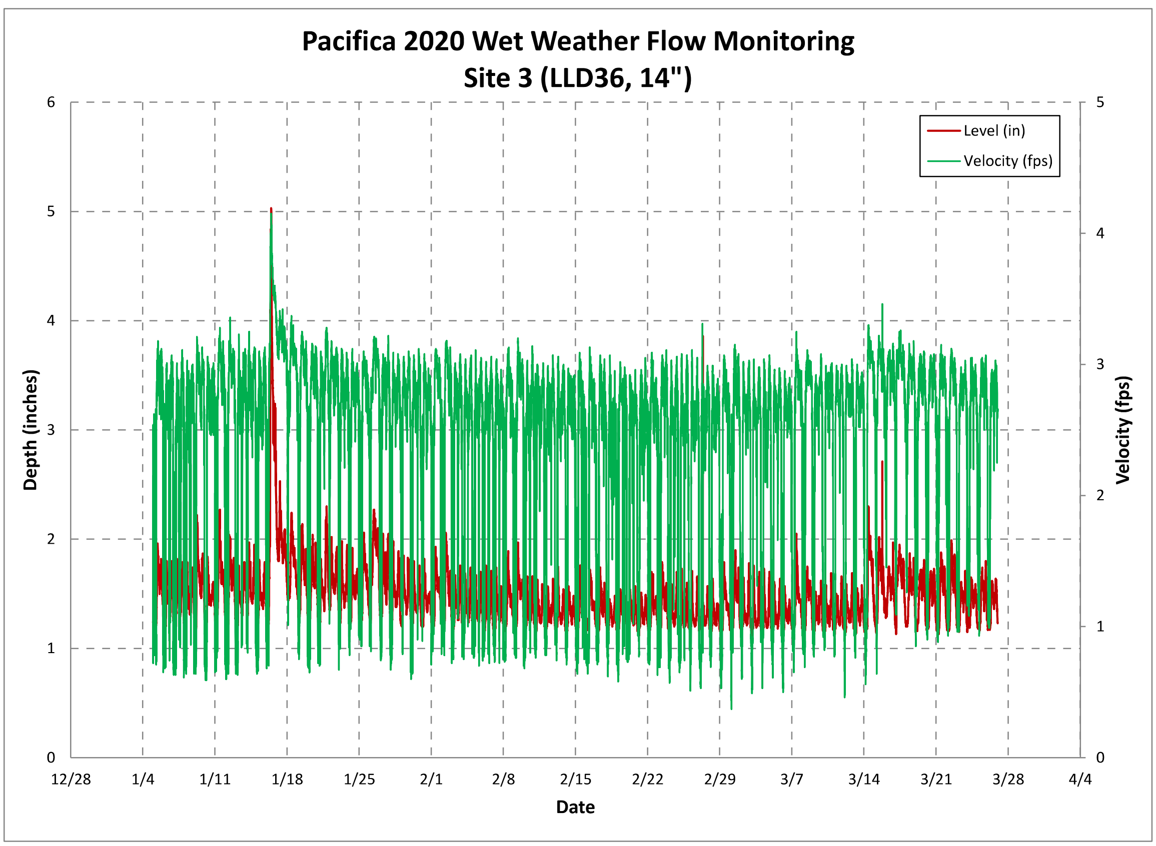
APPENDIX A

Plots of Monitored Flow and Rainfall Data

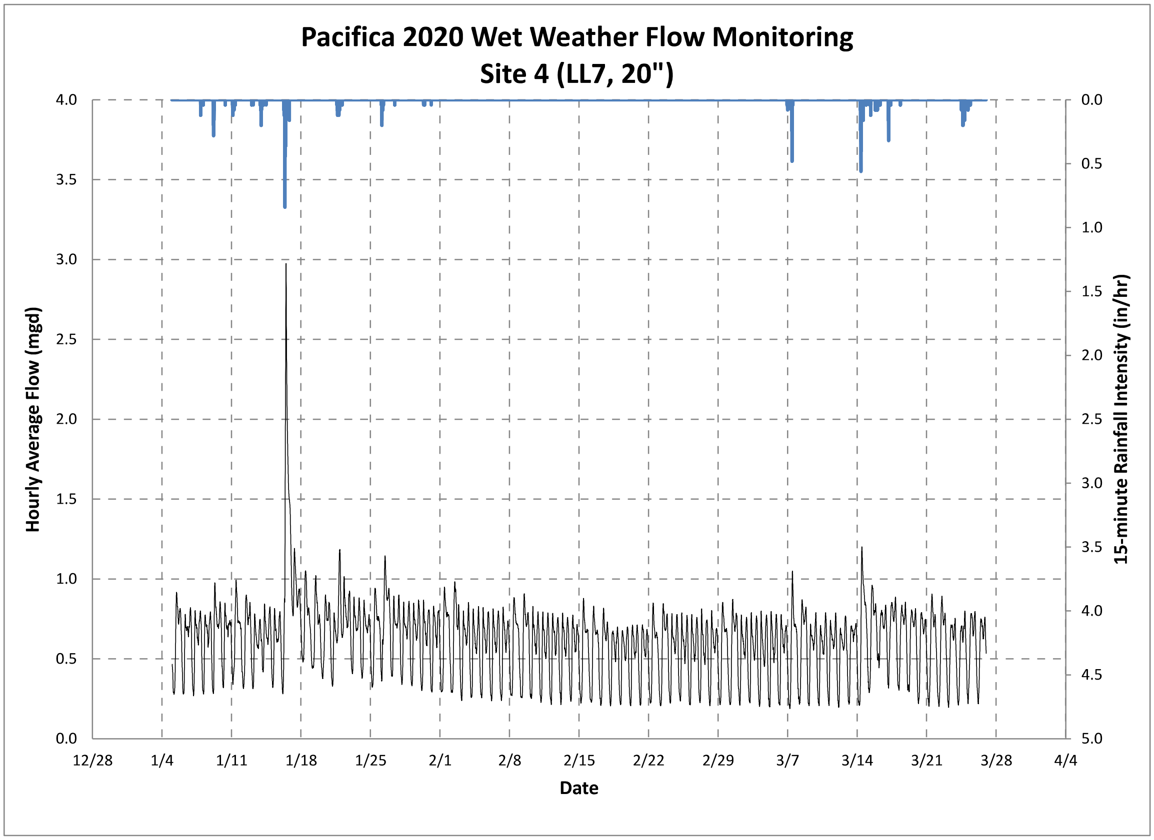




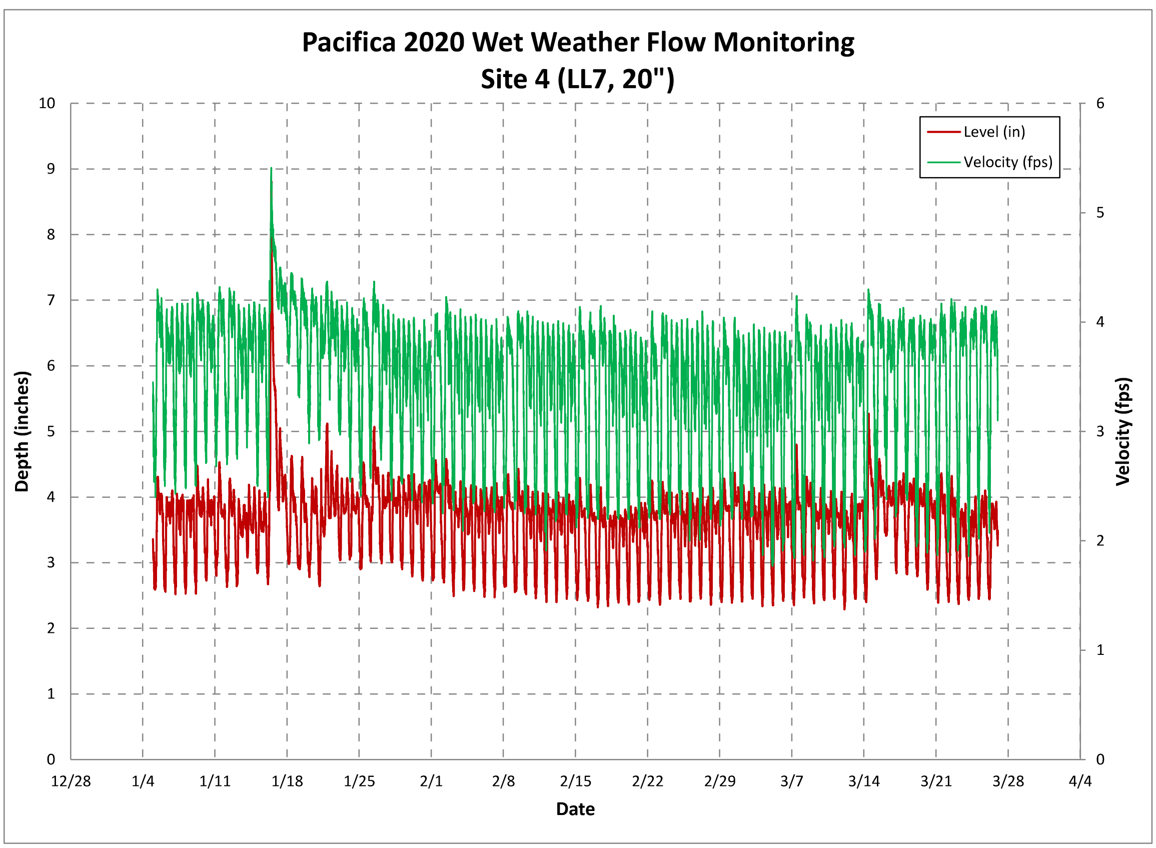
Pacifica 2020 Wet Weather Flow Monitoring
Site 3 (LLD36, 14")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



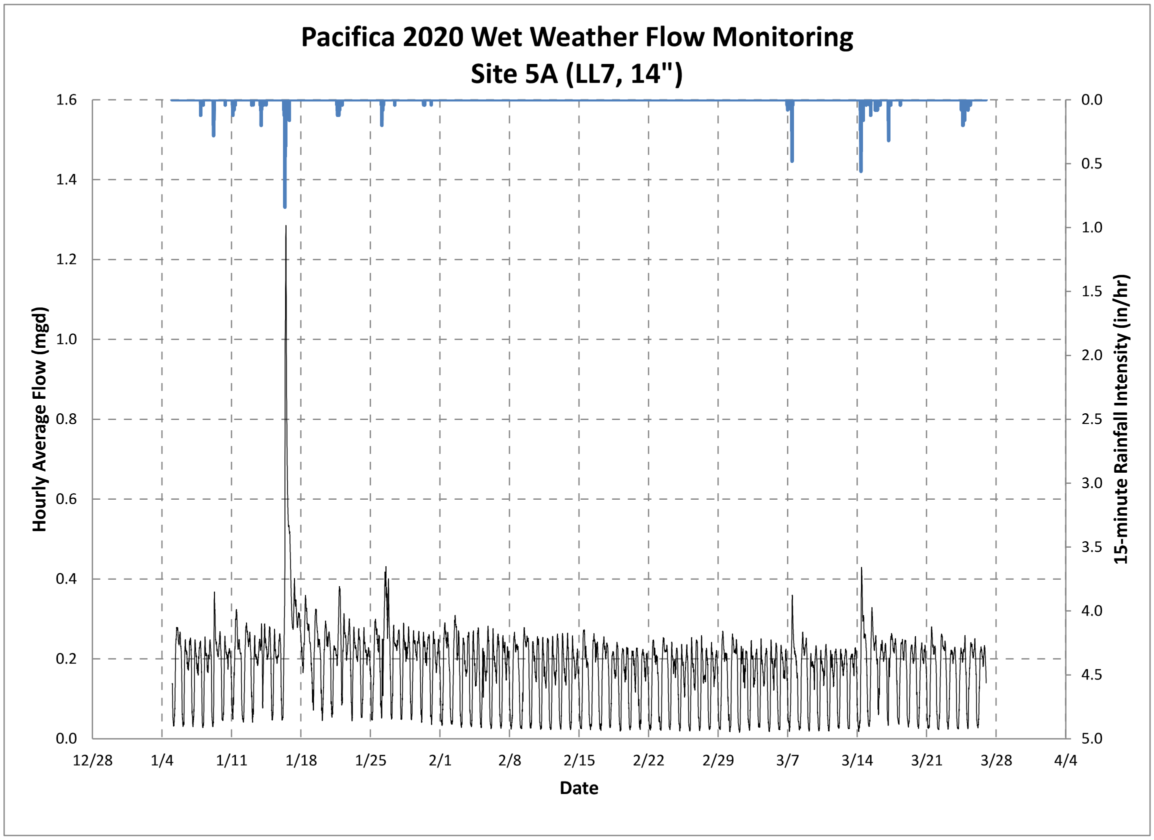
Pacifica 2020 Wet Weather Flow Monitoring
Site 3 (LLD36, 14")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
0
1
2
3
4
5
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 4 (LL7, 20")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 4 (LL7, 20")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
10
9
8
7
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 5A (LL7, 14")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
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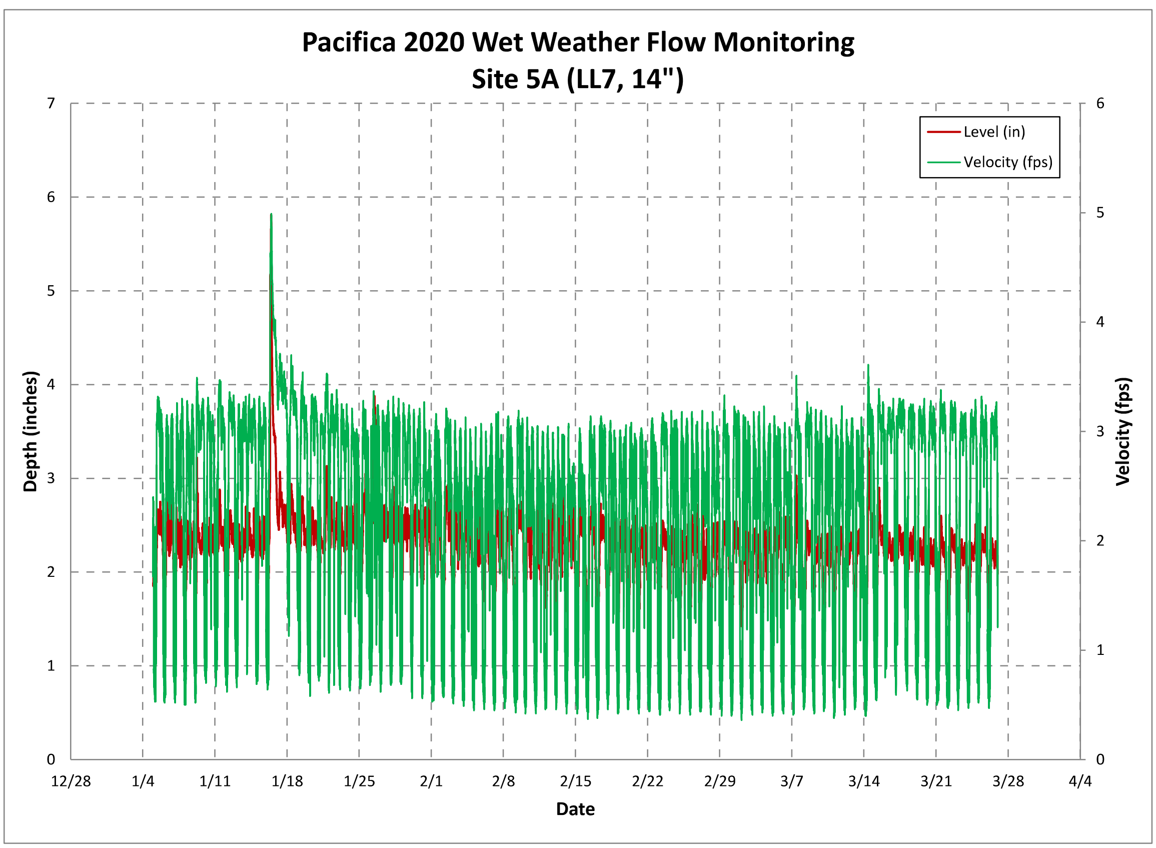
3/7
3/14
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 5A (LL7, 14")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
7
6
5
4
3
2
1
0
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
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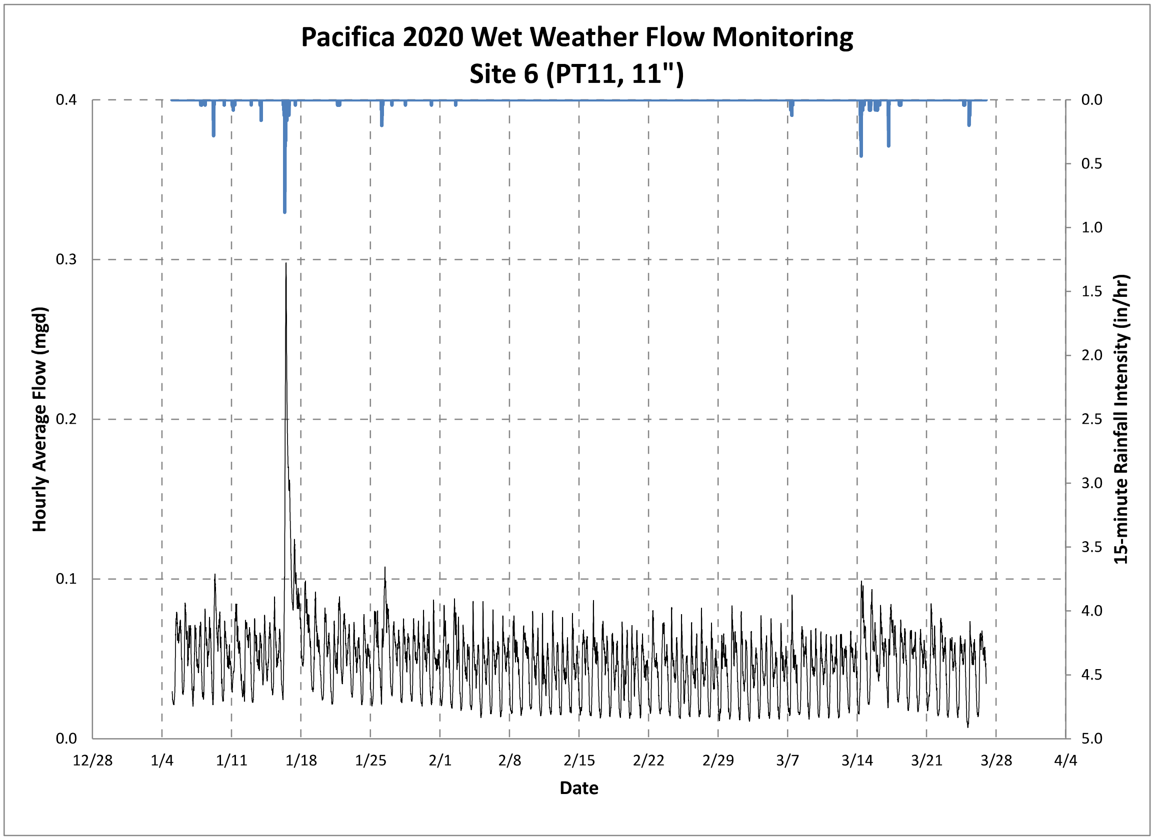
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 6 (PT11, 11")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
0.0
0.1
0.2
0.3
0.4
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
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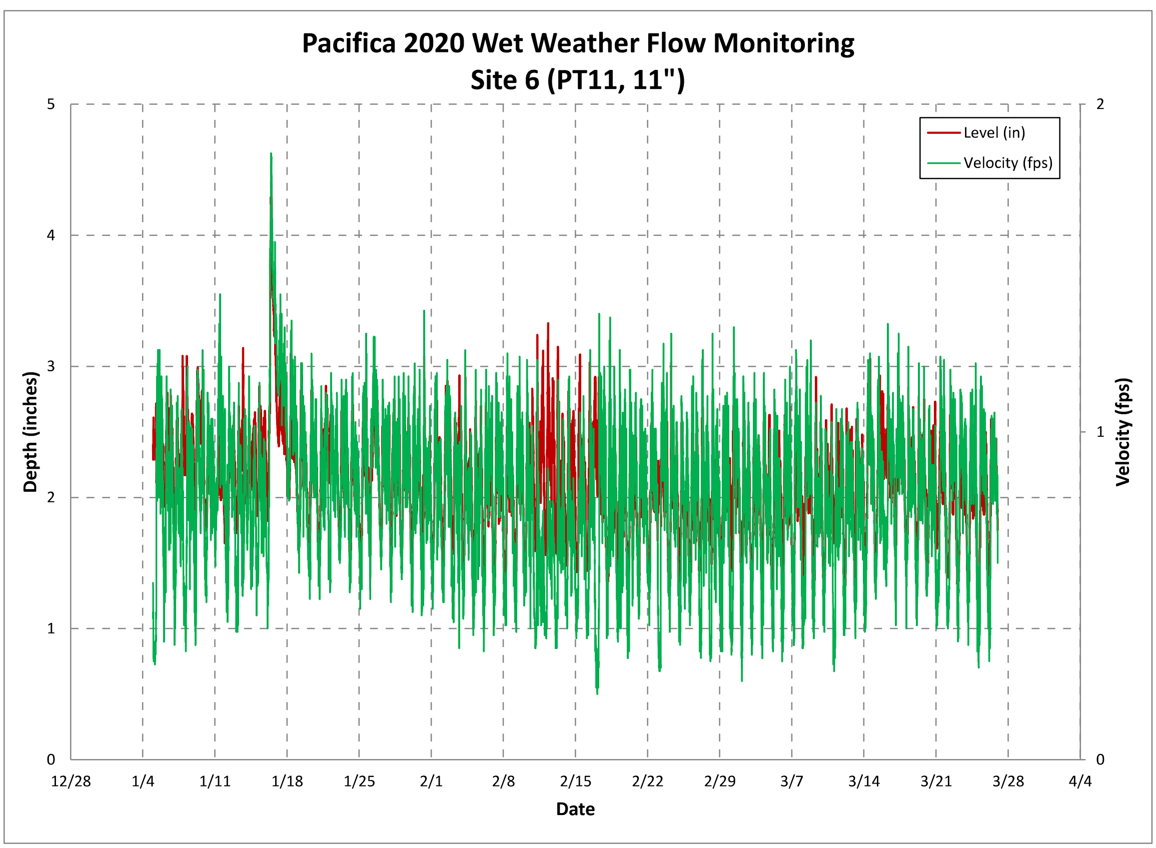
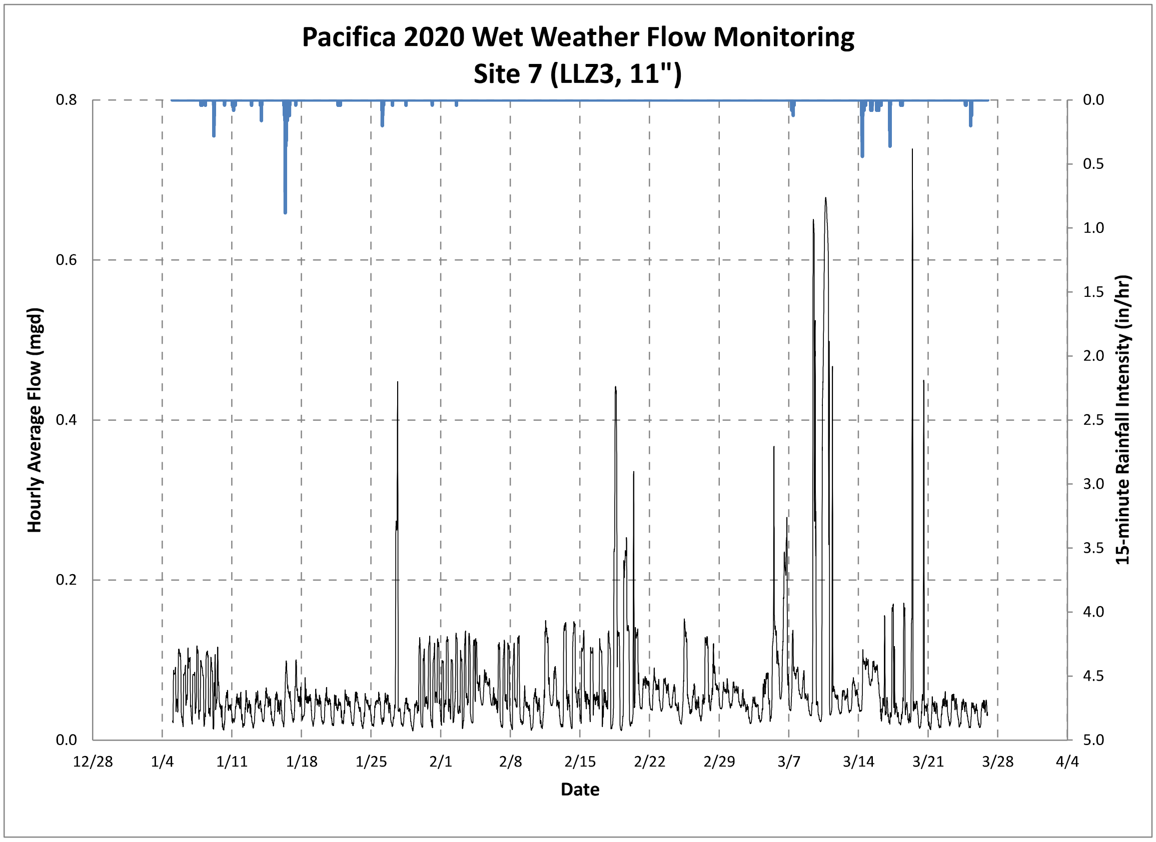
3/14
3/21
3/28
4/4
Date


Pacifica 2020 Wet Weather Flow Monitoring
Site 6 (PT11, 11")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
0
1
2
3
4
5
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4
Date


Pacifica 2020 Wet Weather Flow Monitoring
Site 7 (LLZ3, 11")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.2
0.4
0.6
0.8
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
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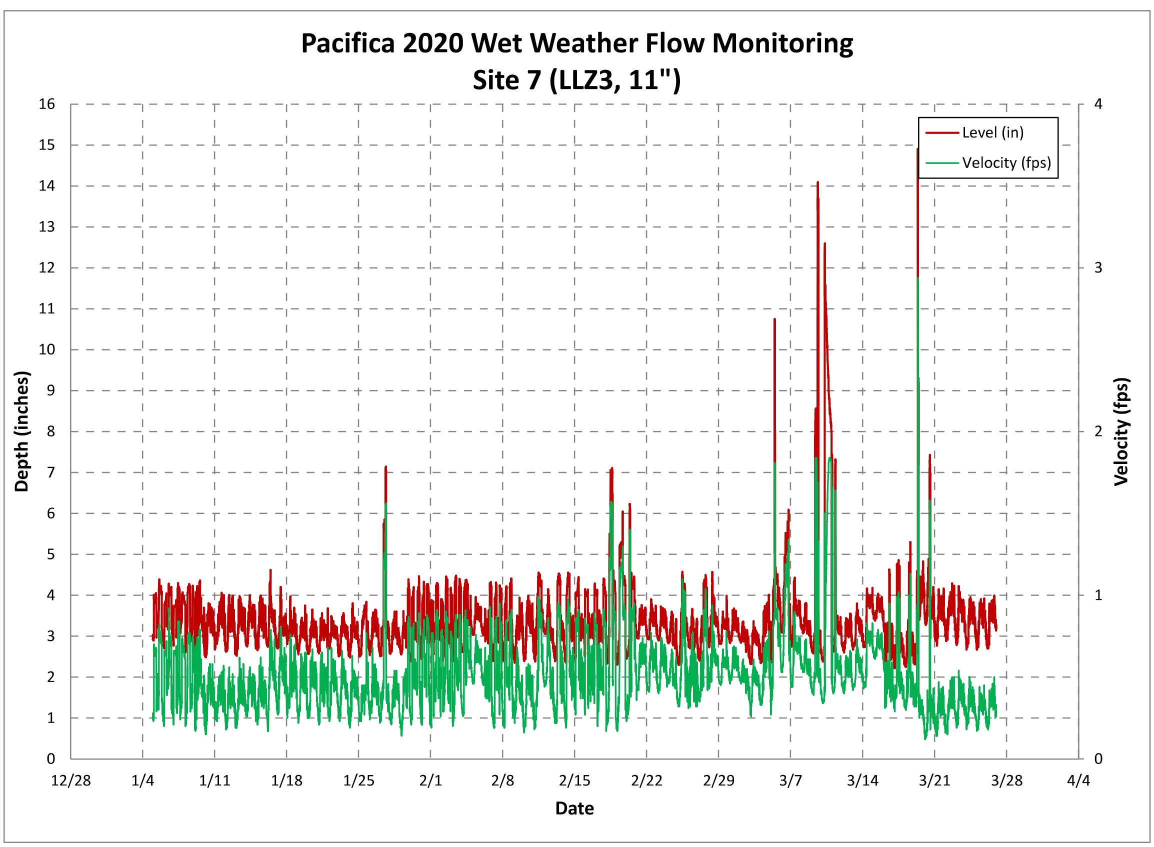
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 7 (LLZ3, 11")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
12/28
1/4
1/11
1/18
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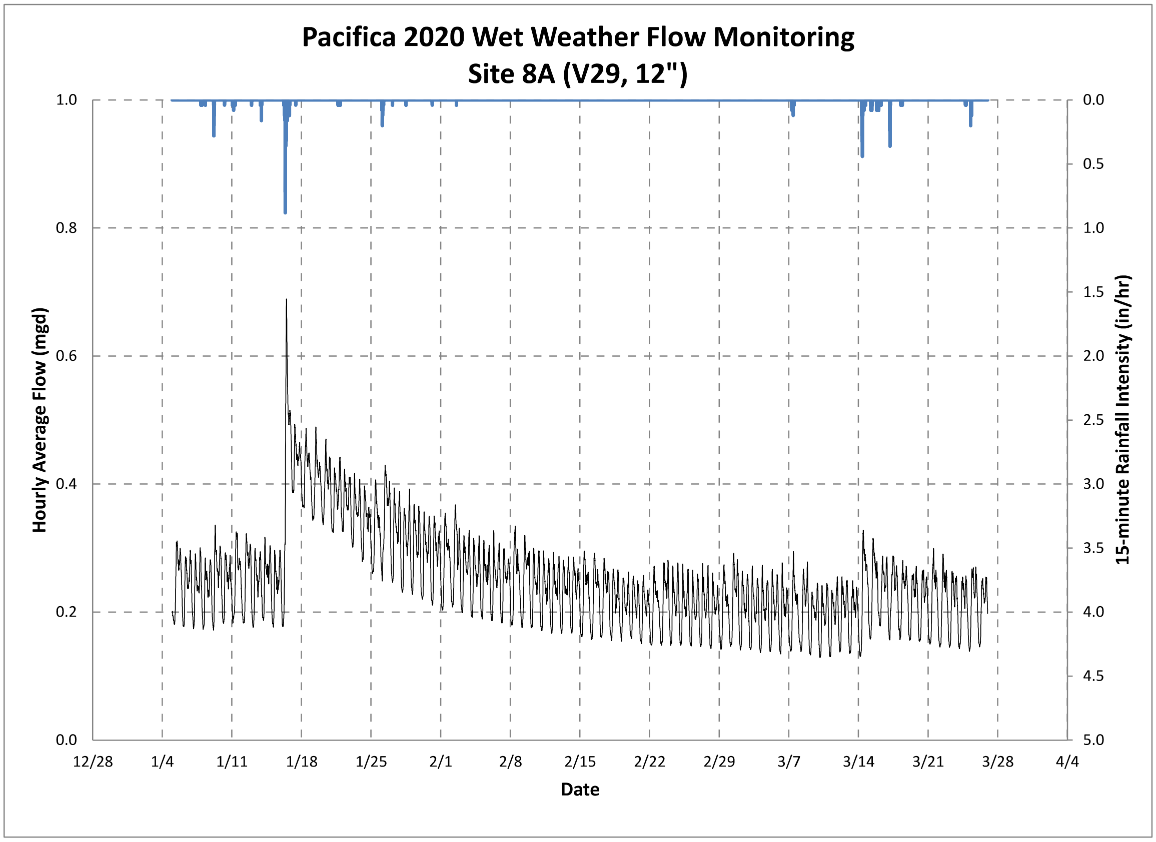
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 8A (V29, 12")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
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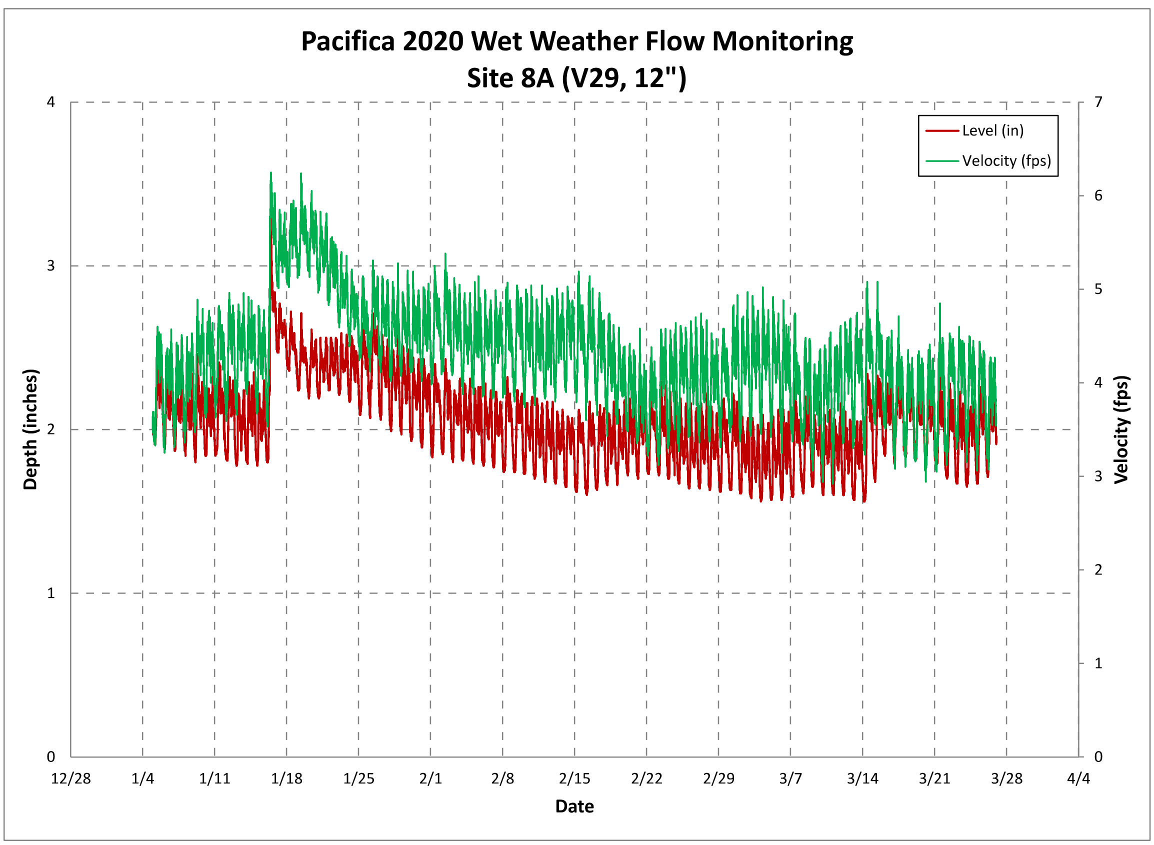
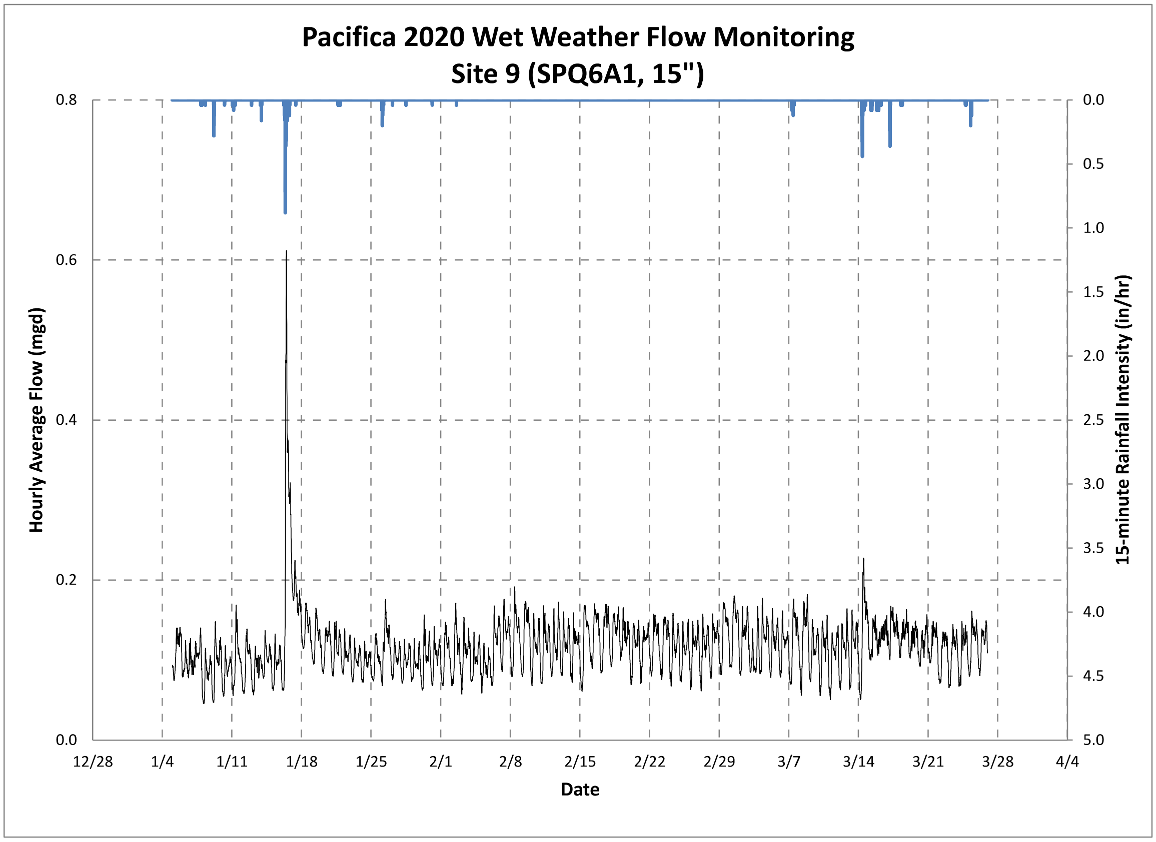
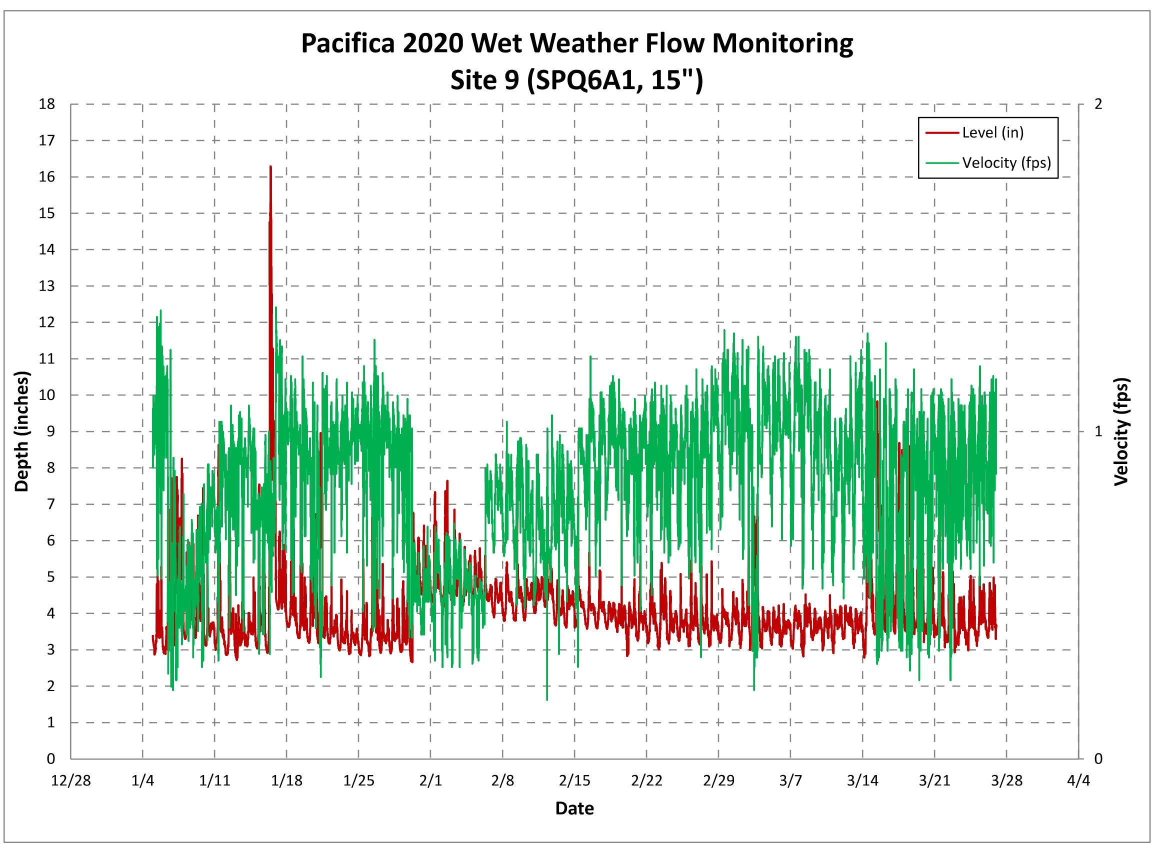
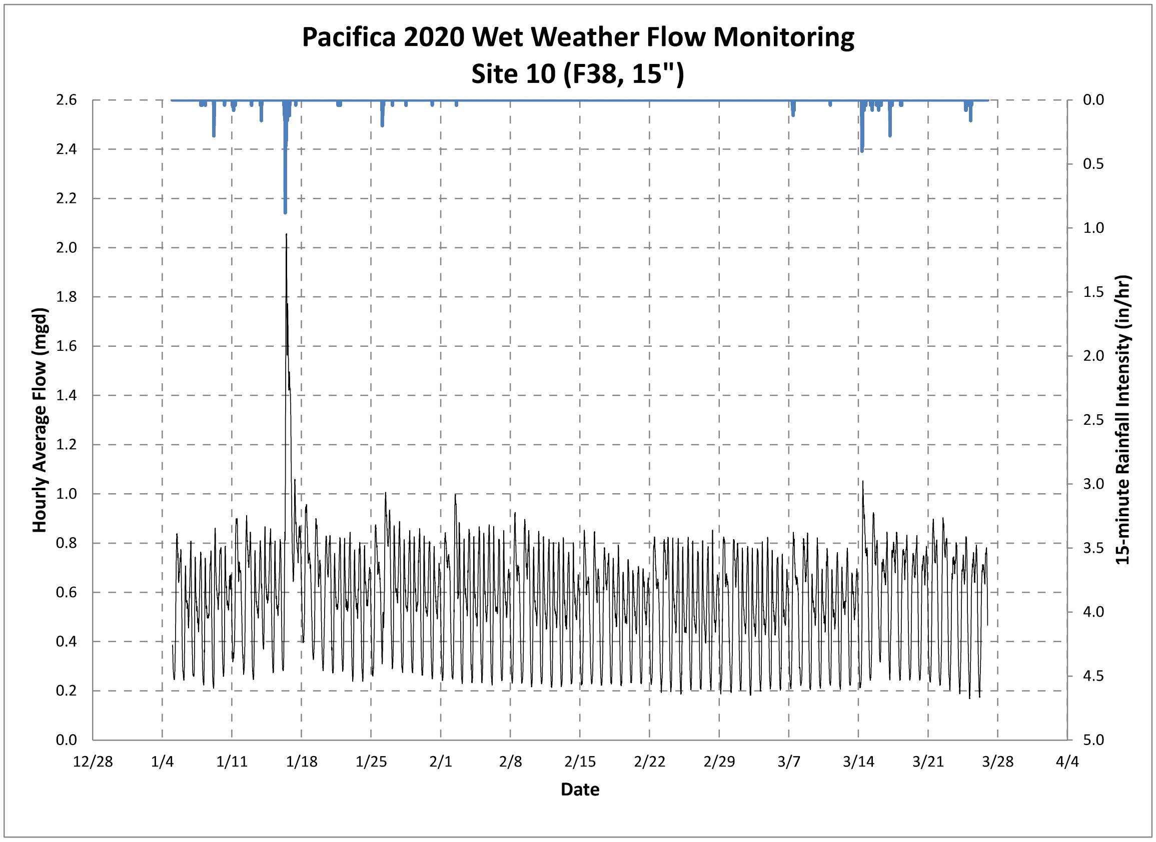
3/14
3/21
3/28
4/4

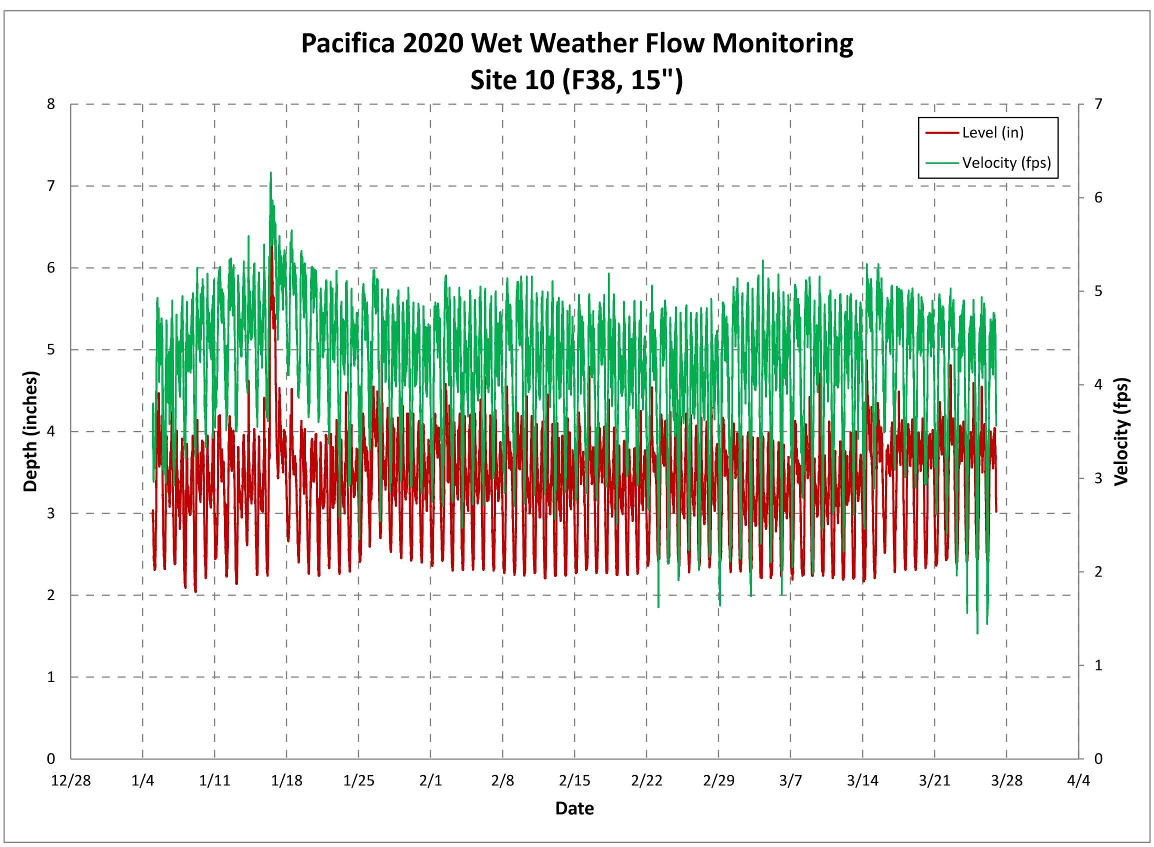


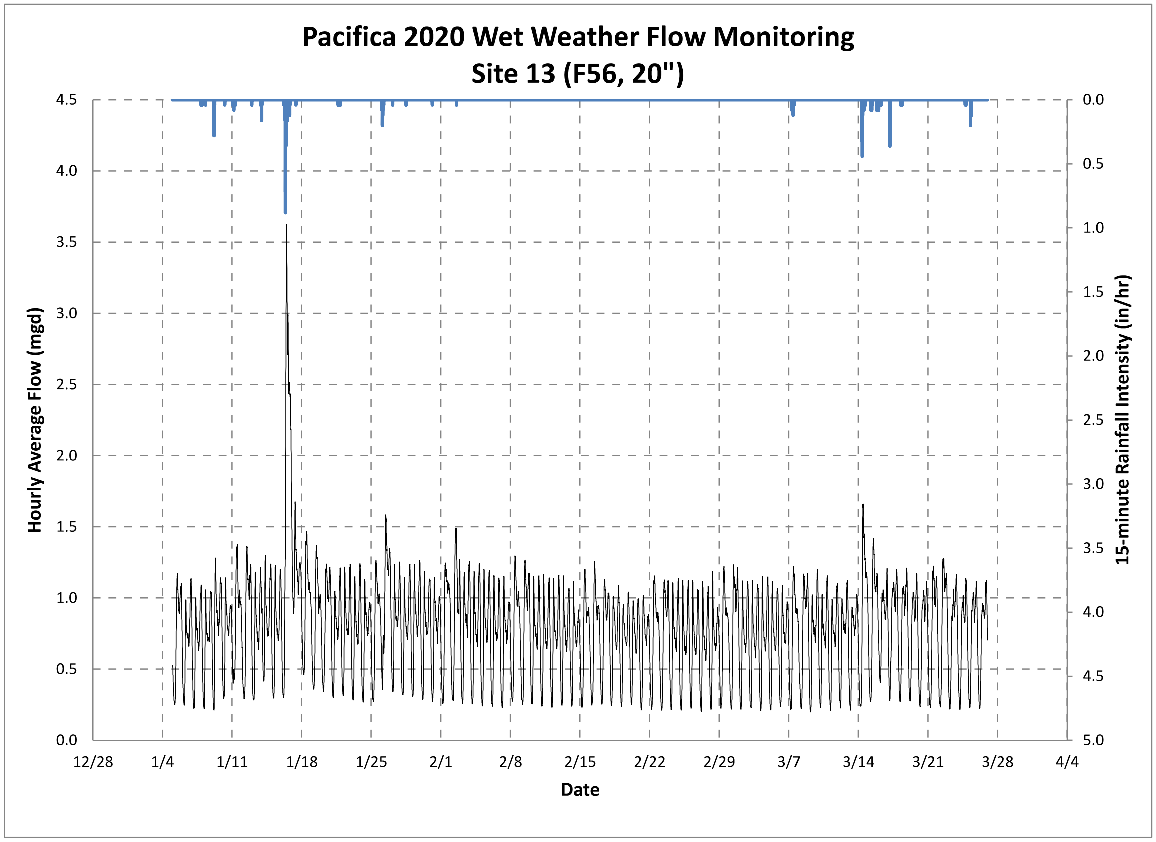
Pacifica 2020 Wet Weather Flow Monitoring
Site 8A (V29, 12")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
4
3
2
1
0
7
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 9 (SPQ6A1, 15")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.2
0.4
0.6
0.8
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

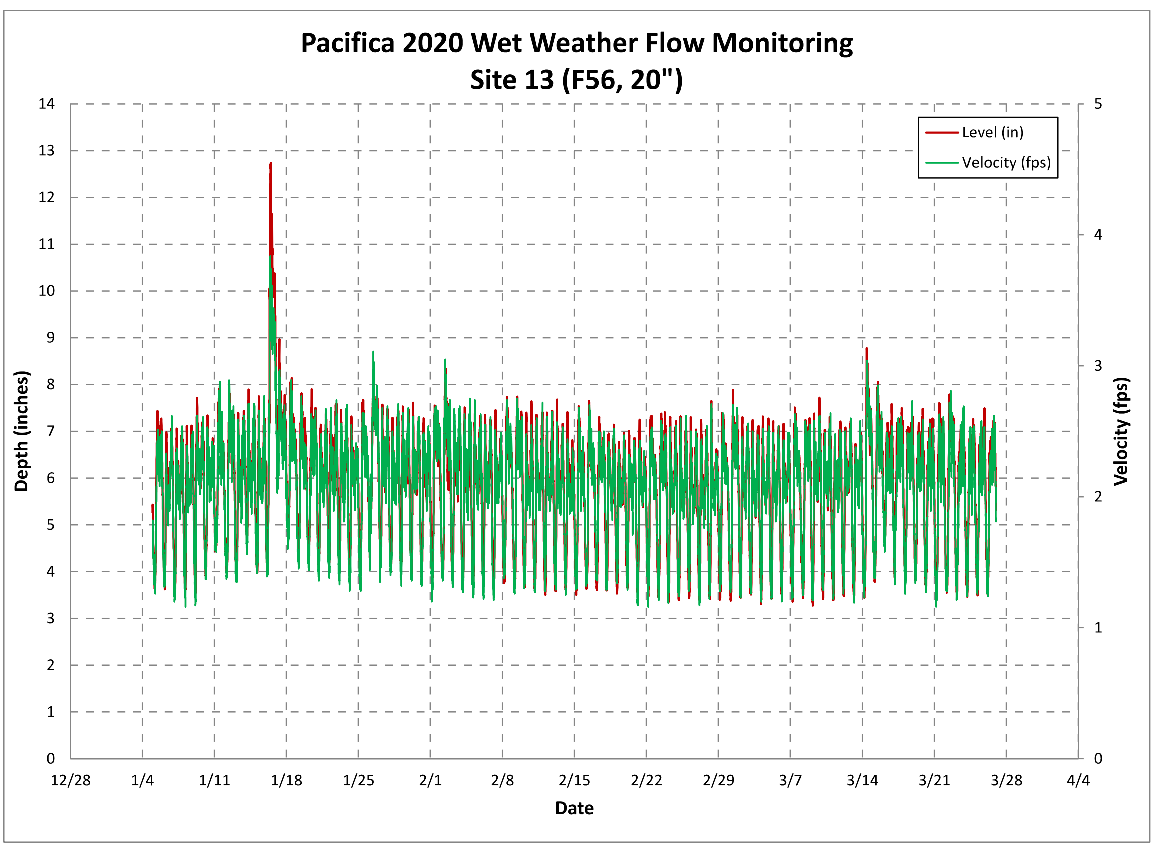

Pacifica 2020 Wet Weather Flow Monitoring
Site 9 (SPQ6A1, 15")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 10 (F38, 15")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

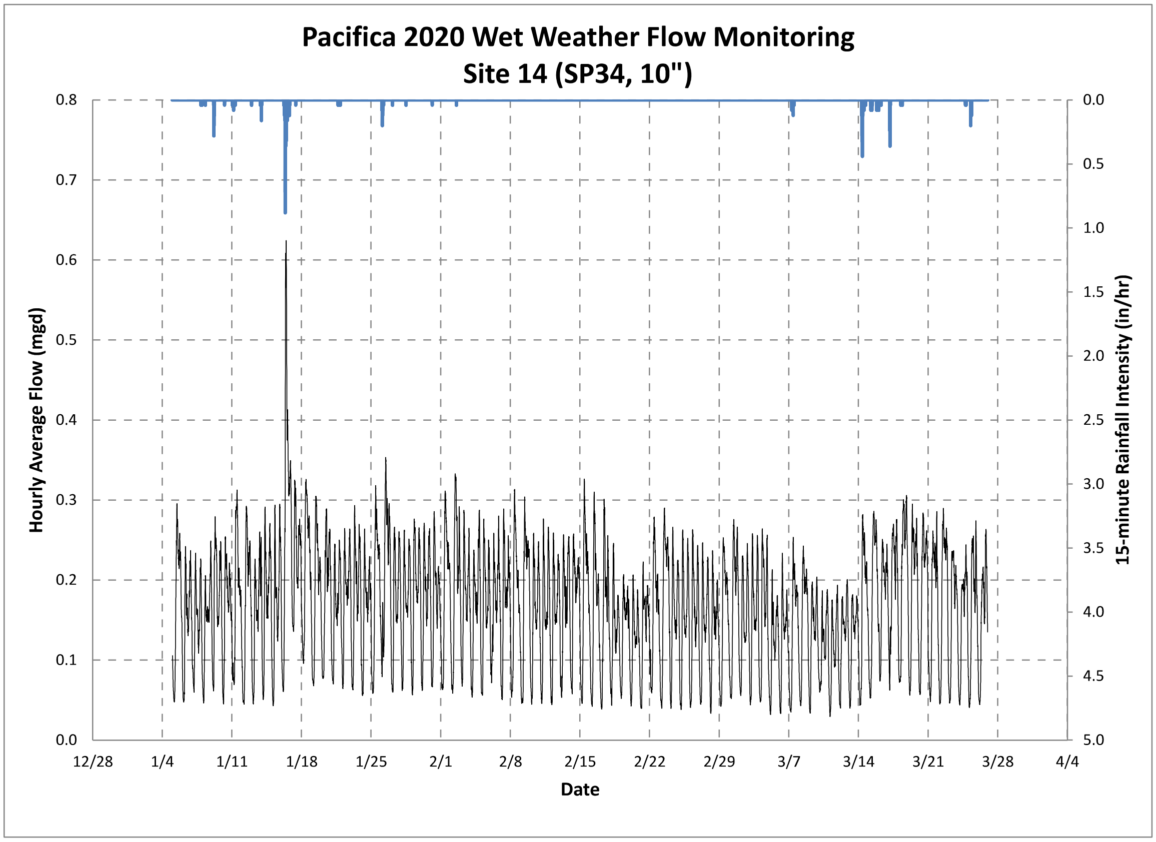

Pacifica 2020 Wet Weather Flow Monitoring
Site 10 (F38, 15")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
8
7
6
5
4
3
2
1
0
7
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

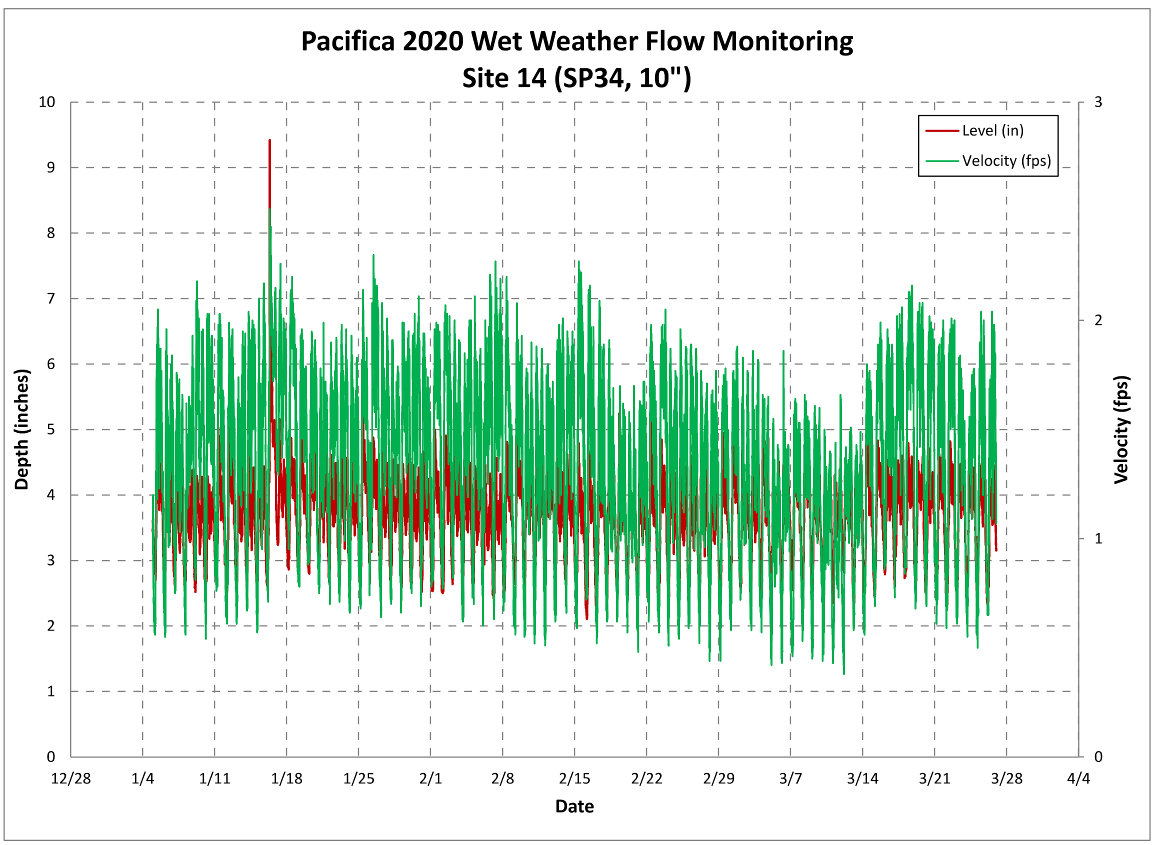


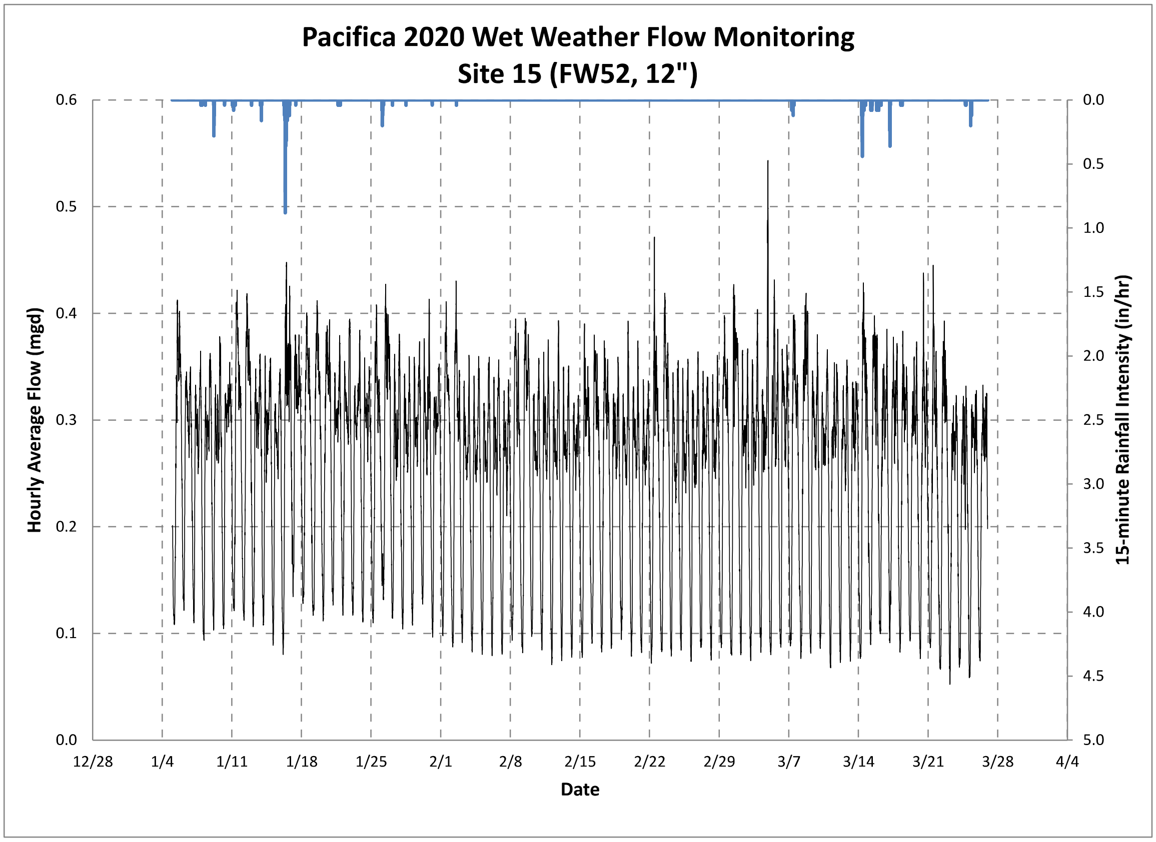
Pacifica 2020 Wet Weather Flow Monitoring
Site 13 (F56, 20")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



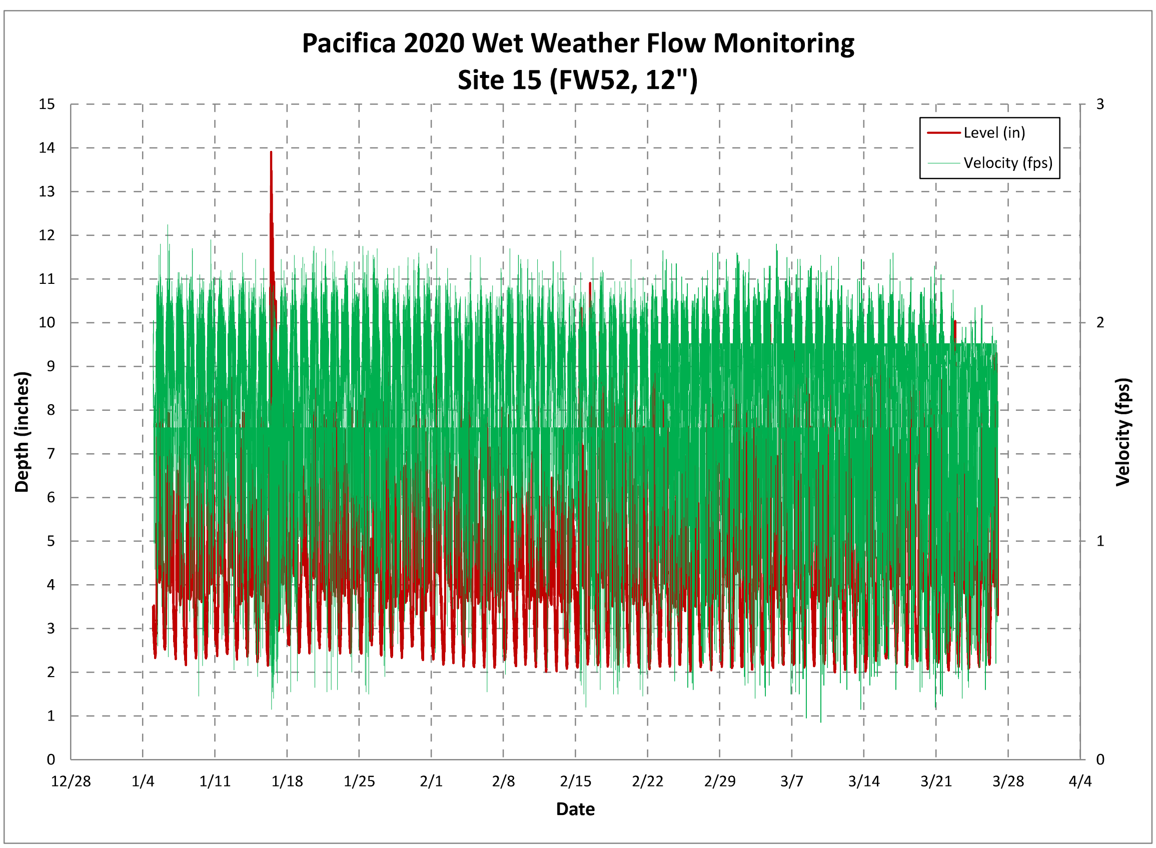
Pacifica 2020 Wet Weather Flow Monitoring
Site 13 (F56, 20")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 14 (SP34, 10")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

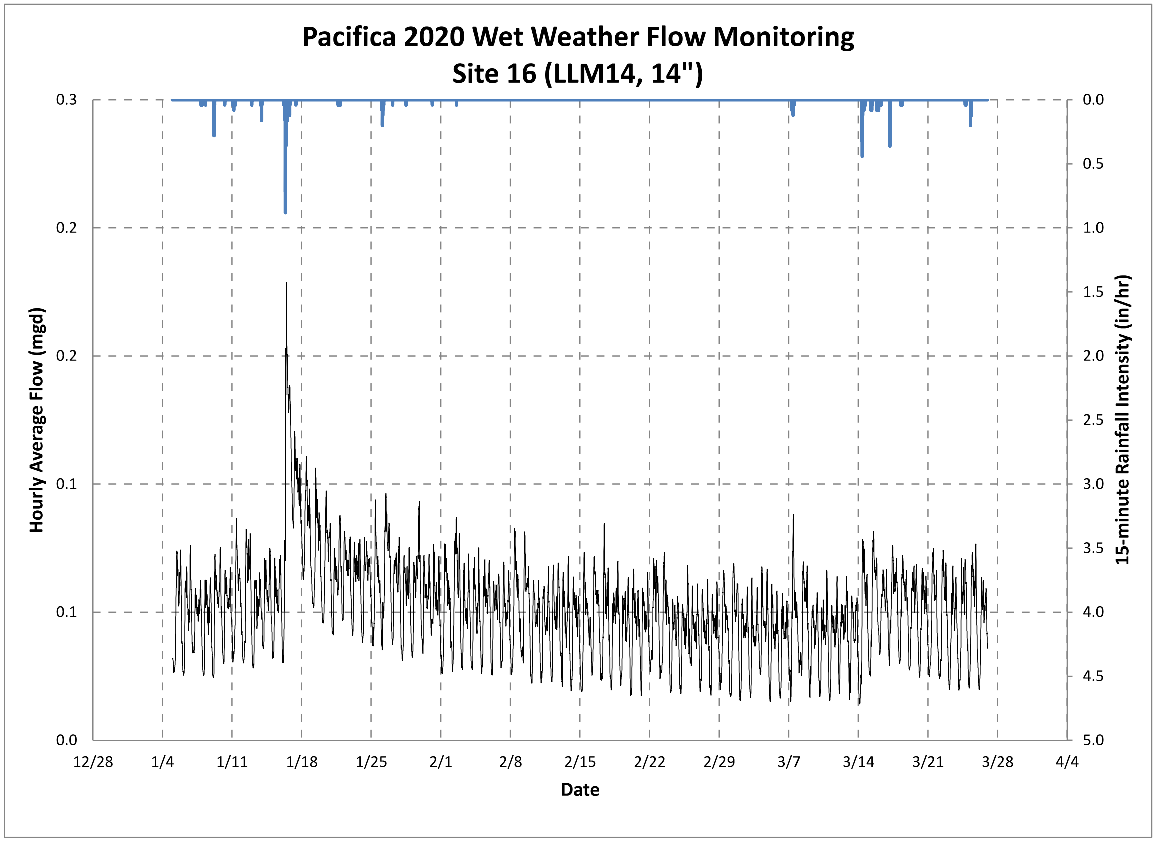

Pacifica 2020 Wet Weather Flow Monitoring
Site 14 (SP34, 10")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
0
1
2
3
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

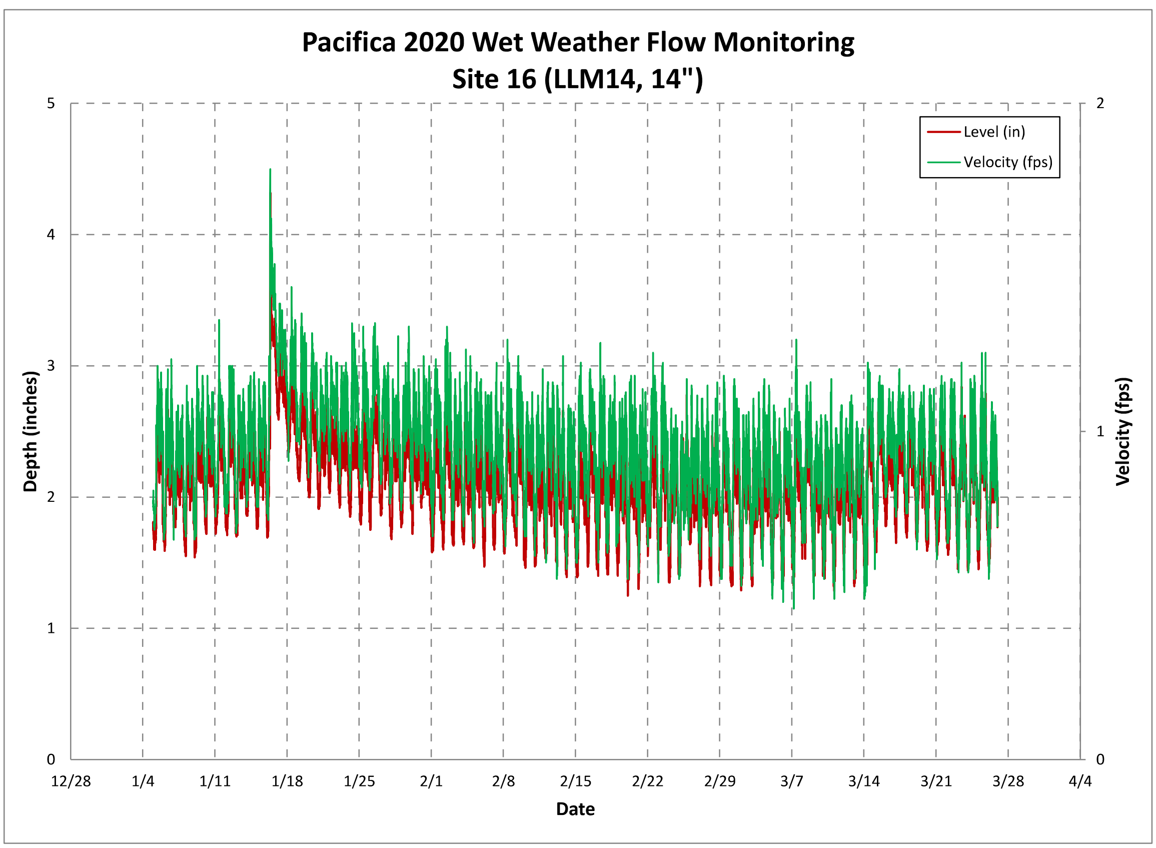


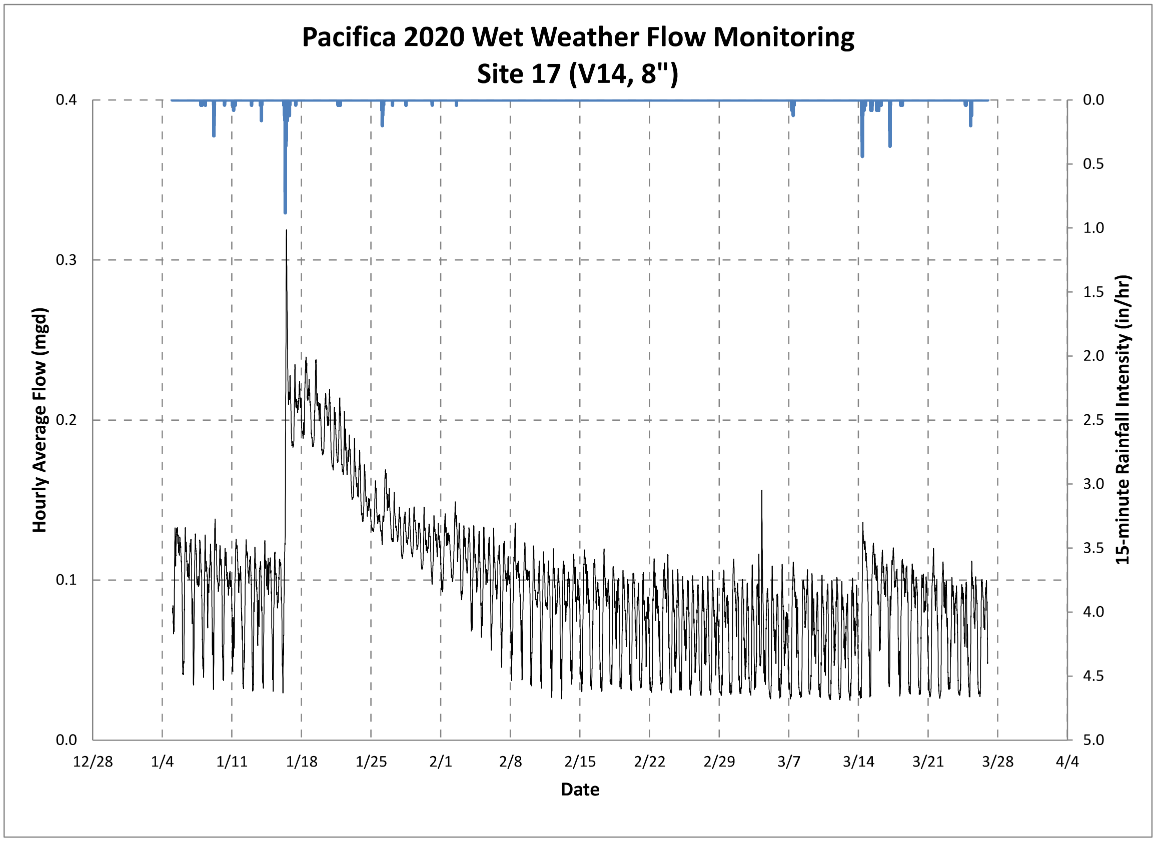
Pacifica 2020 Wet Weather Flow Monitoring
Site 15 (FW52, 12")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



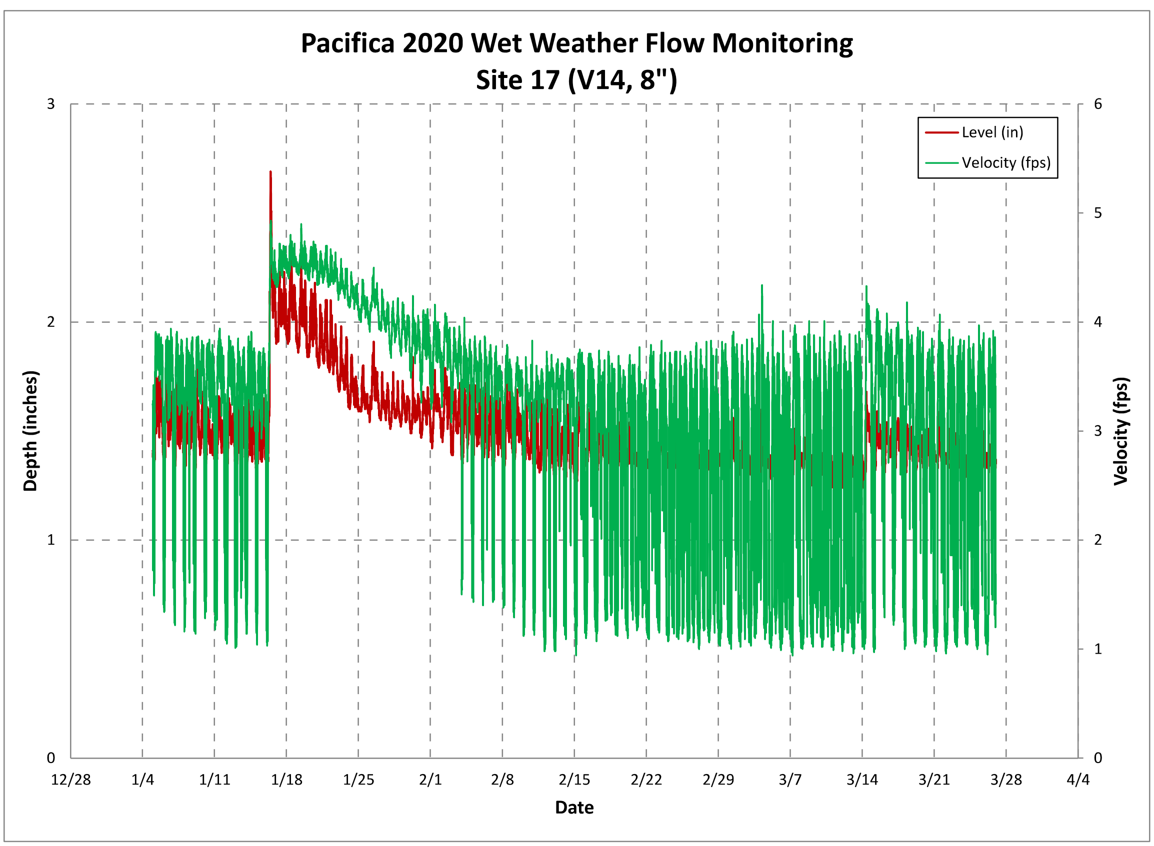
Pacifica 2020 Wet Weather Flow Monitoring
Site 15 (FW52, 12")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 16 (LLM14, 14")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.3
0.2
0.2
0.1
0.1
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

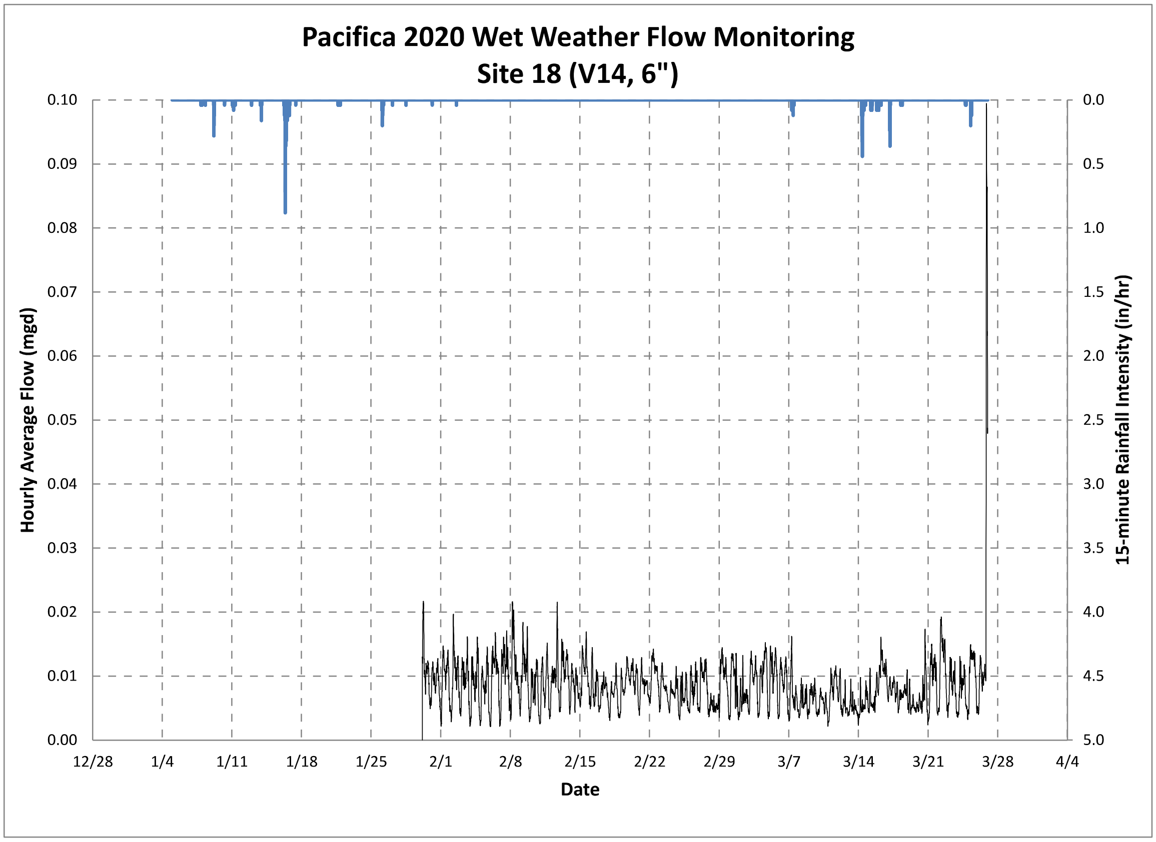

Pacifica 2020 Wet Weather Flow Monitoring
Site 16 (LLM14, 14")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
5
4
3
2
1
0
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

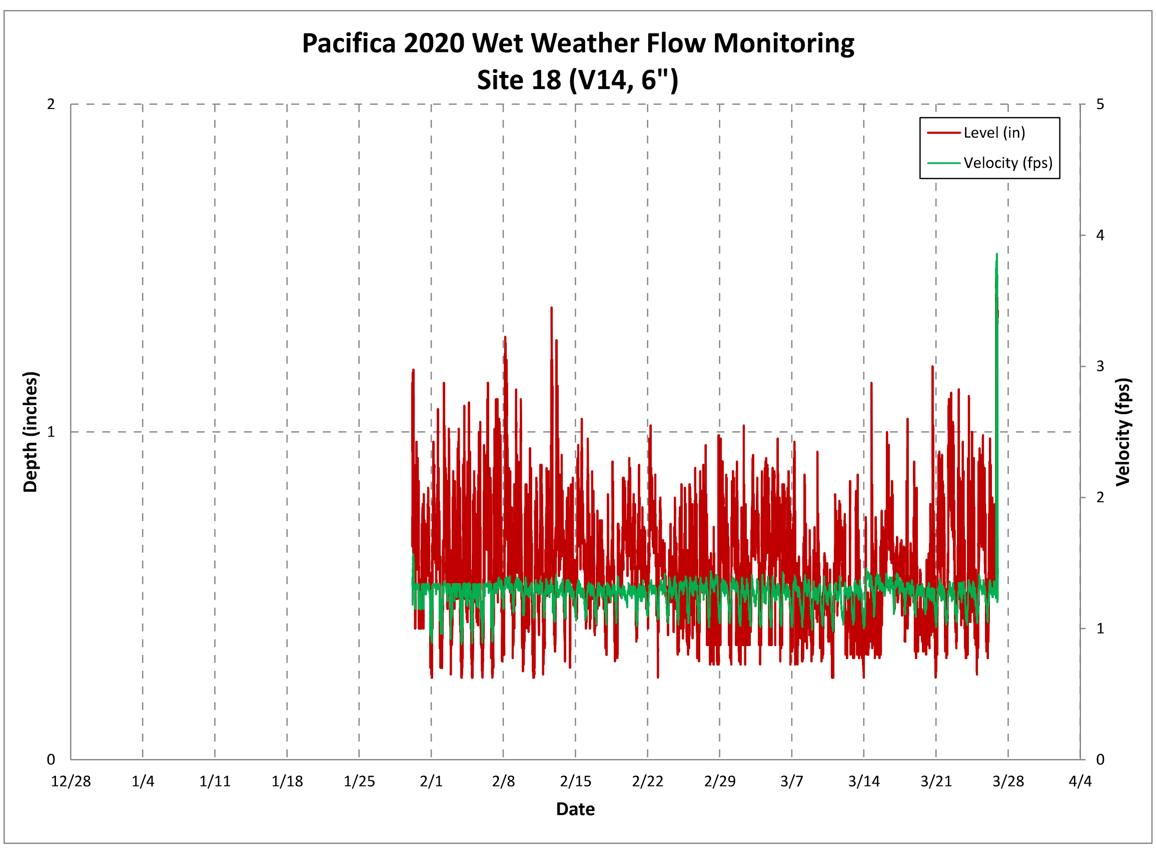


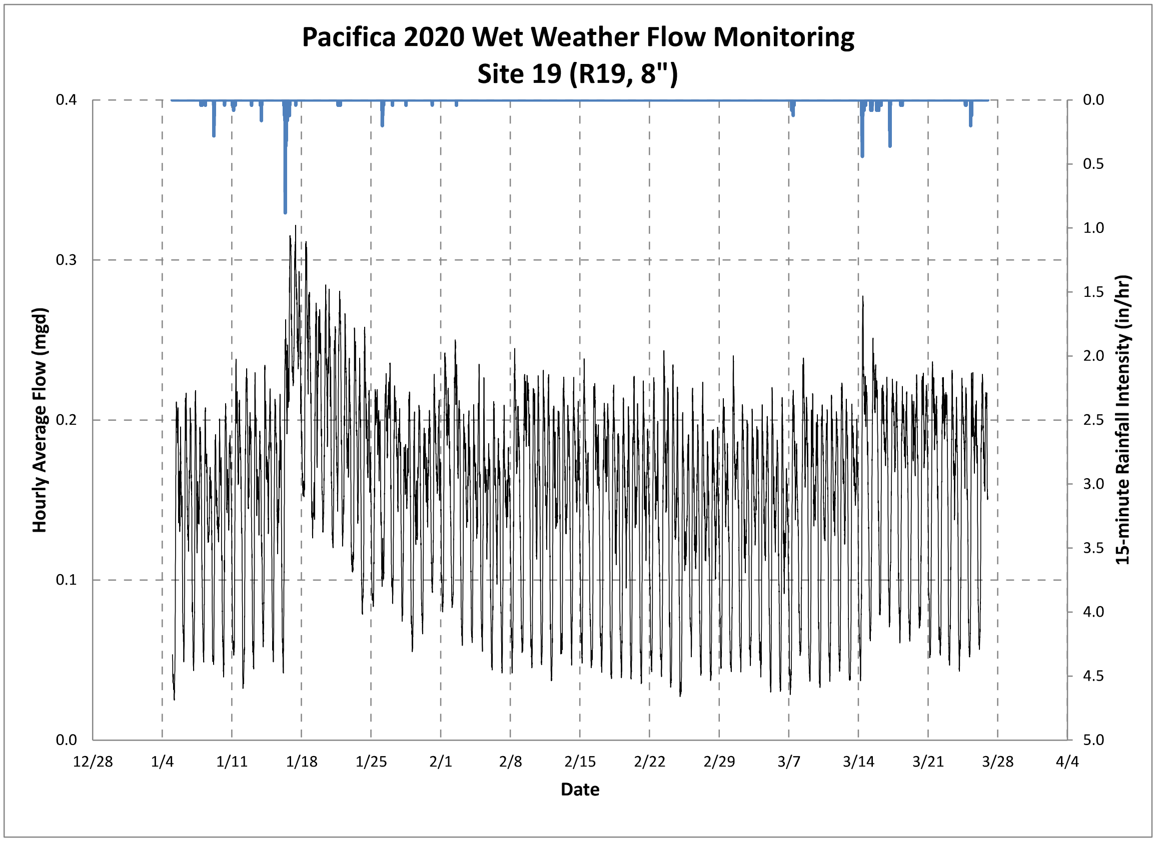
Pacifica 2020 Wet Weather Flow Monitoring
Site 17 (V14, 8")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
0.4
0.3
0.2
0.1
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4
Date

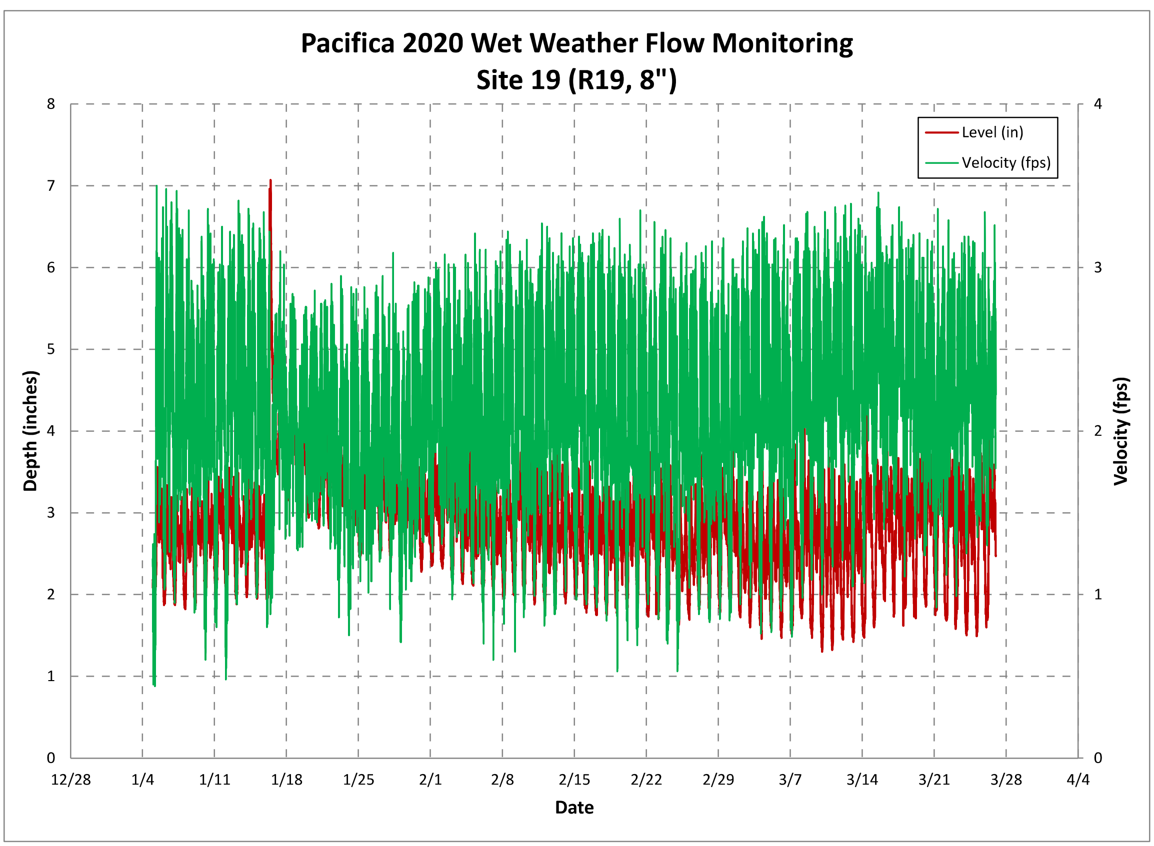


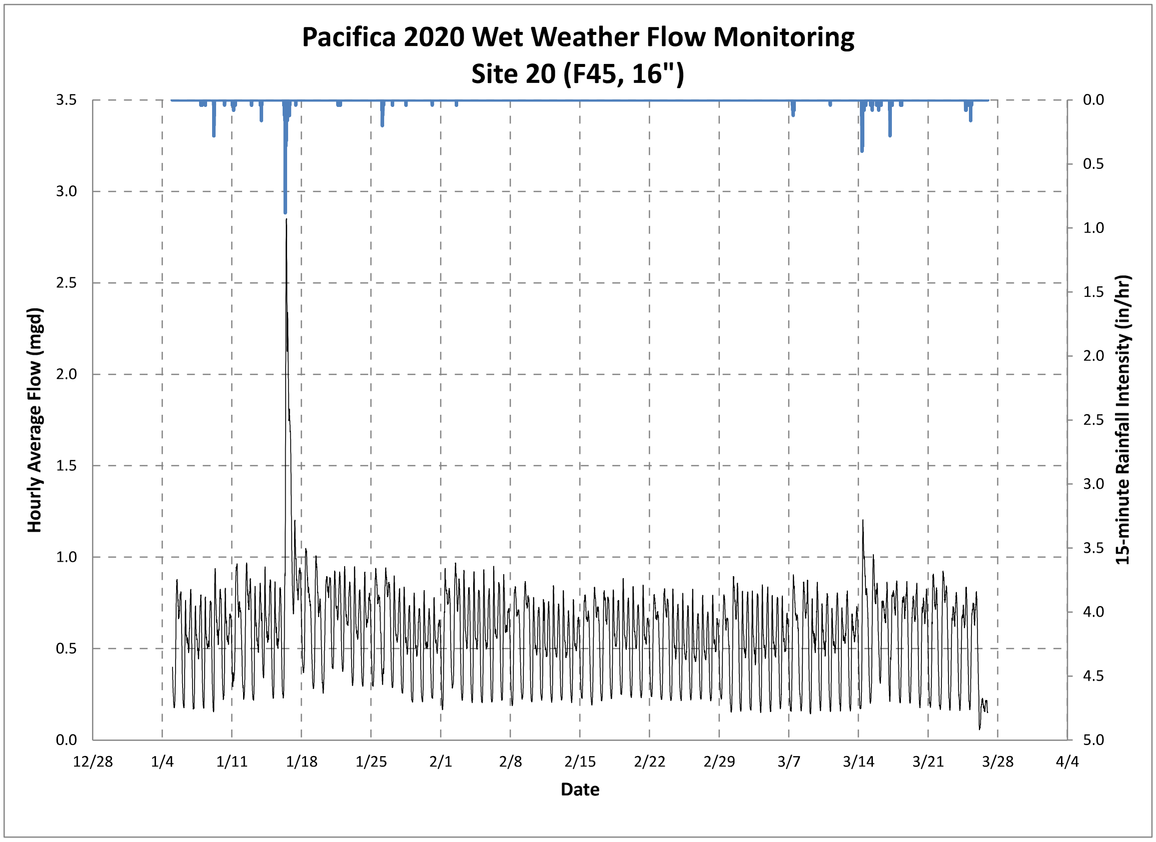
Pacifica 2020 Wet Weather Flow Monitoring
Site 17 (V14, 8")
Depth (inches)
Velocity (fps)
Level (in)
Velocity (fps)
3
2
1
0
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4
Date


Pacifica 2020 Wet Weather Flow Monitoring
Site 18 (V14, 6")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

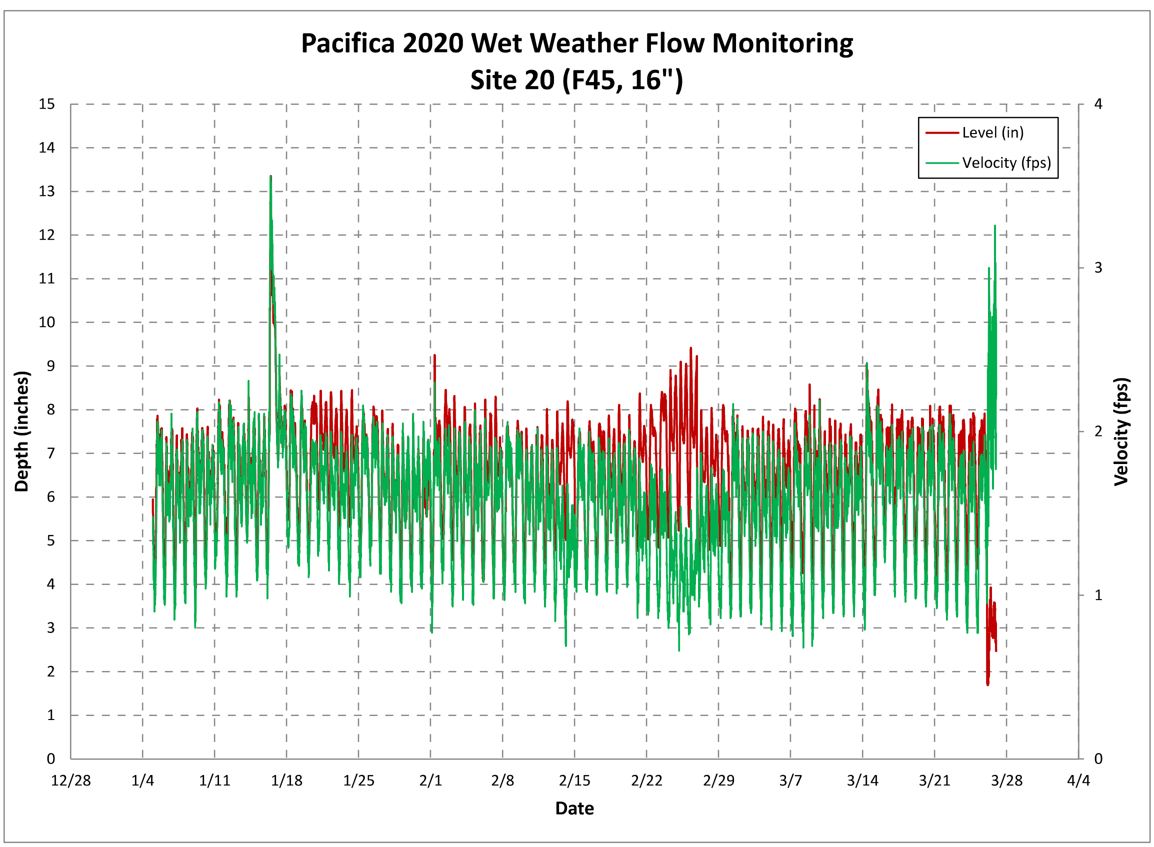

Pacifica 2020 Wet Weather Flow Monitoring
Site 18 (V14, 6")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
2
1
0
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 19 (R19, 8")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.1
0.2
0.3
0.4
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

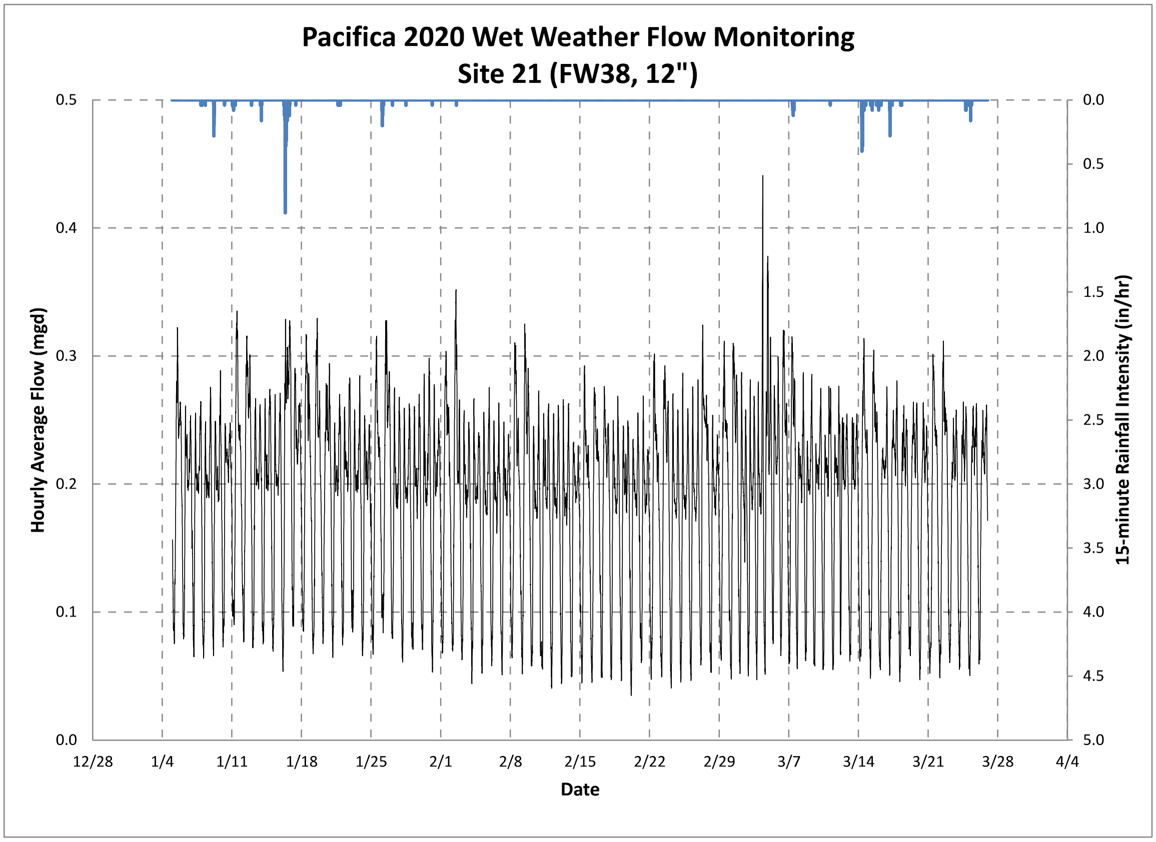

Pacifica 2020 Wet Weather Flow Monitoring
Site 19 (R19, 8")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

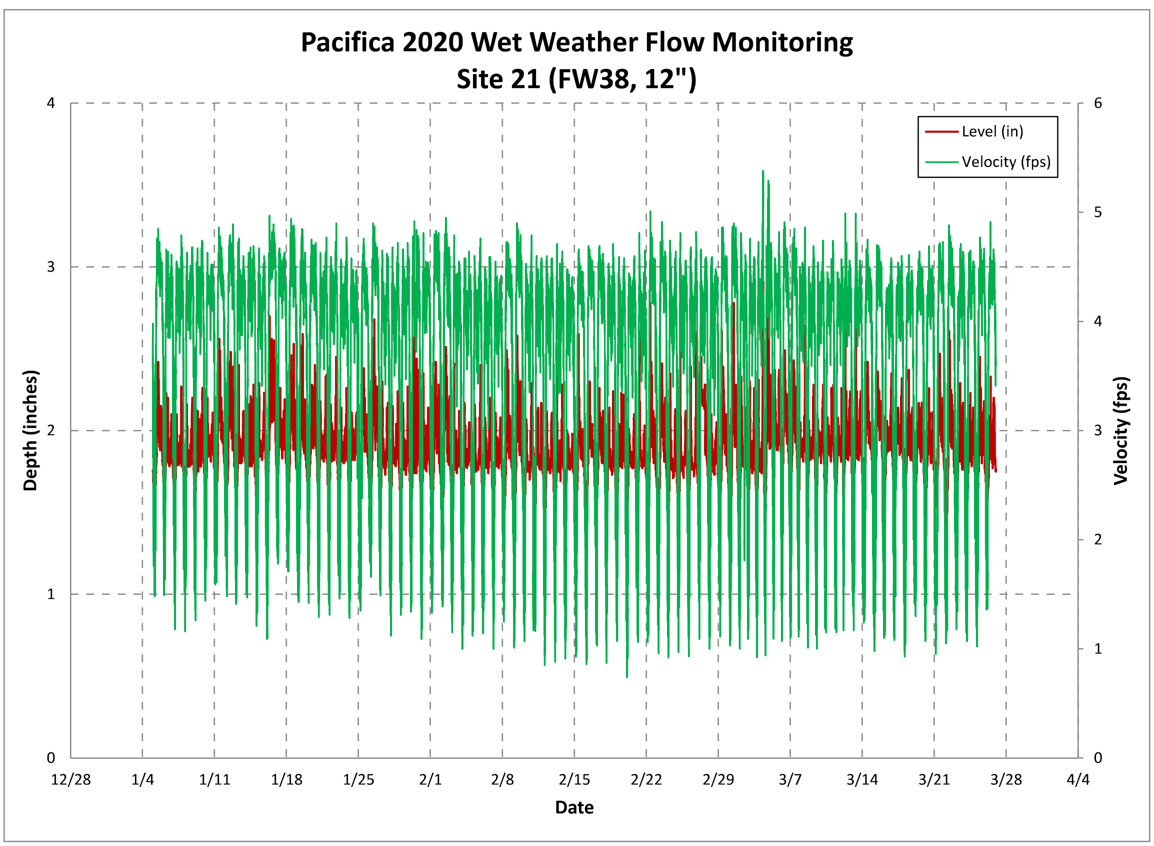


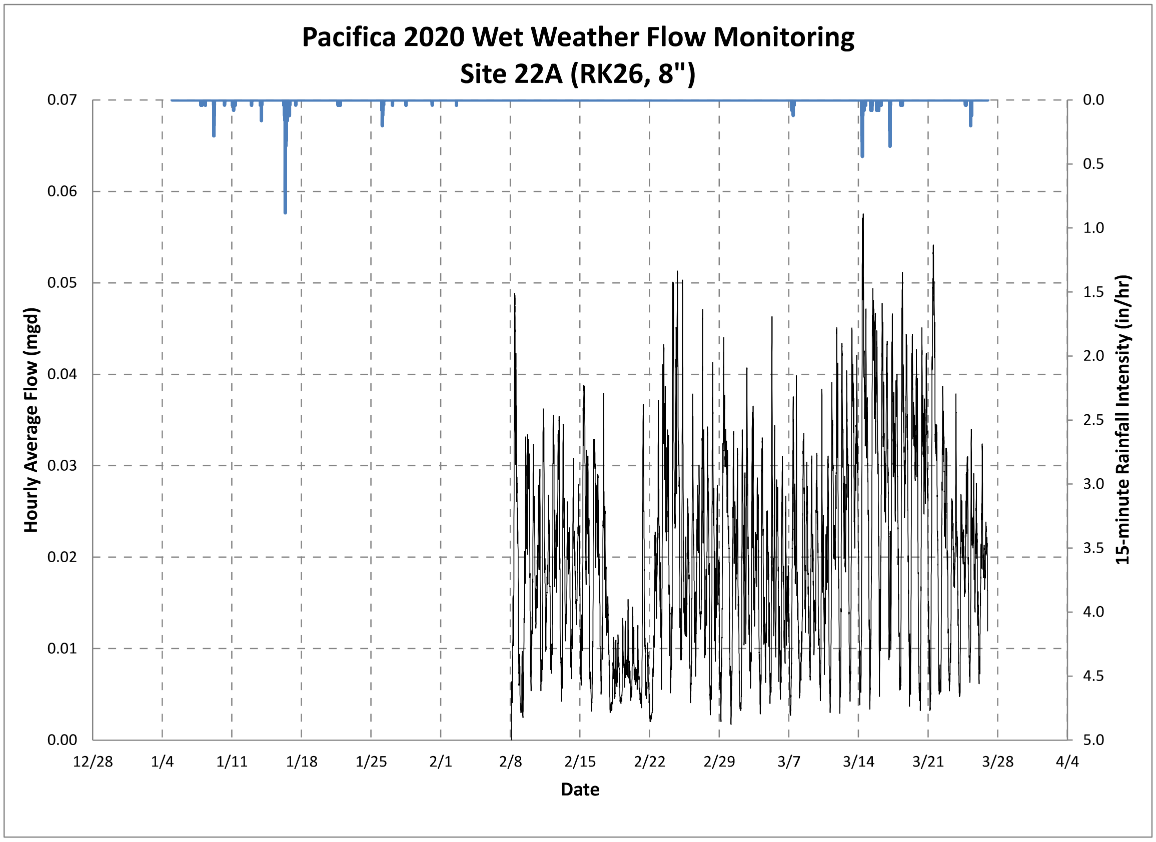
Pacifica 2020 Wet Weather Flow Monitoring
Site 20 (F45, 16")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

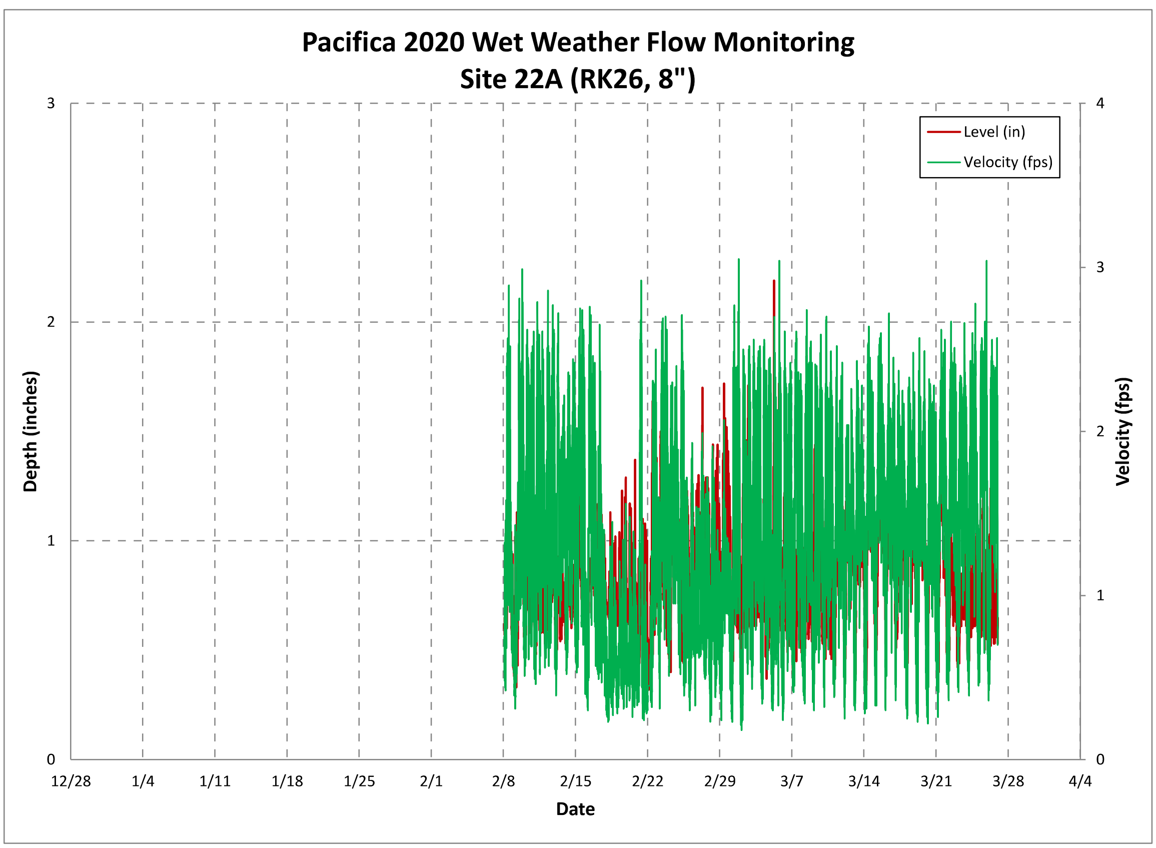


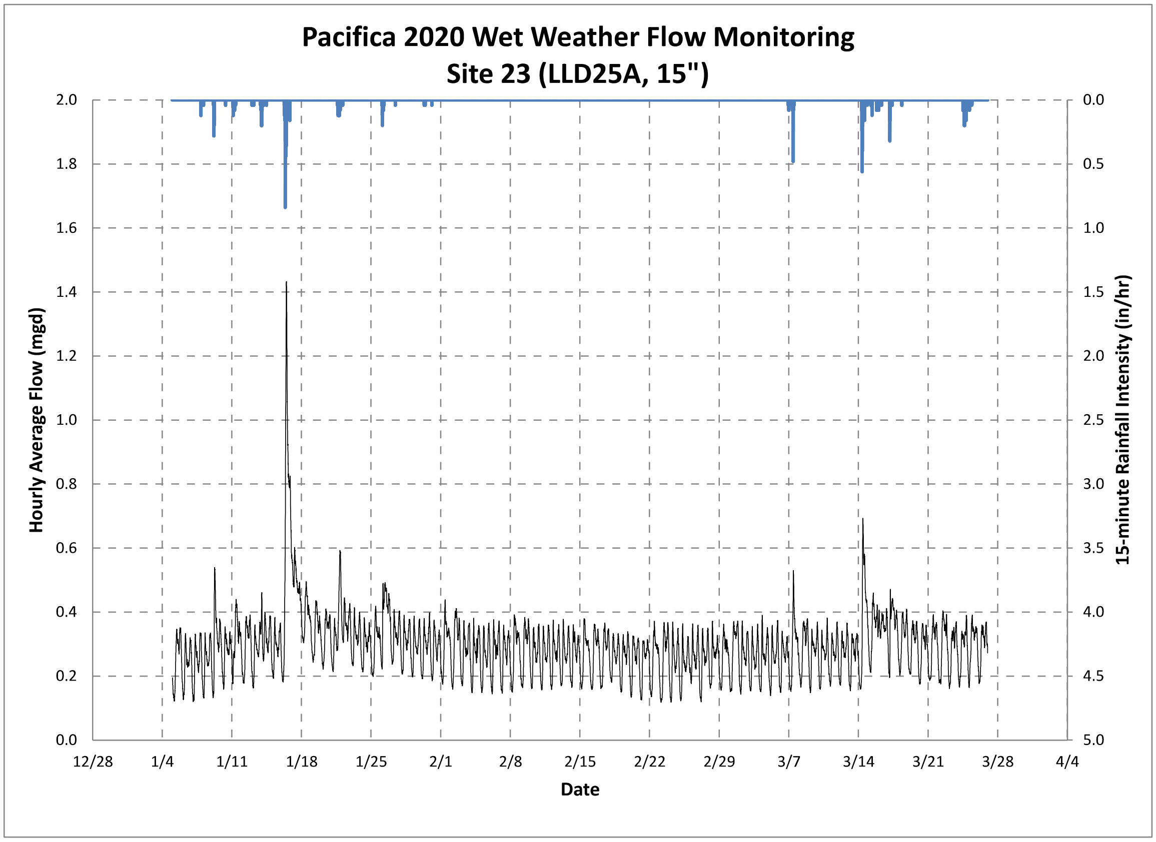
Pacifica 2020 Wet Weather Flow Monitoring
Site 20 (F45, 16")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

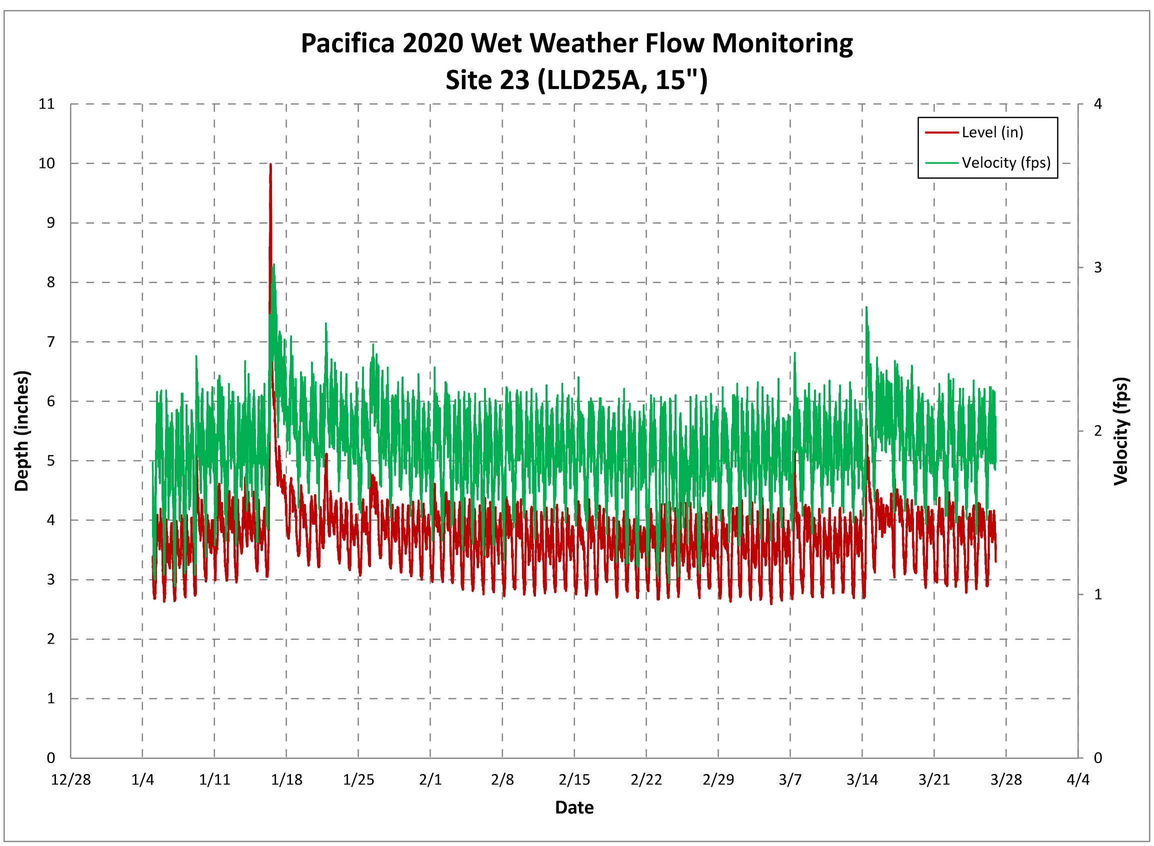

Pacifica 2020 Wet Weather Flow Monitoring
Site 21 (FW38, 12")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.1
0.2
0.3
0.4
0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

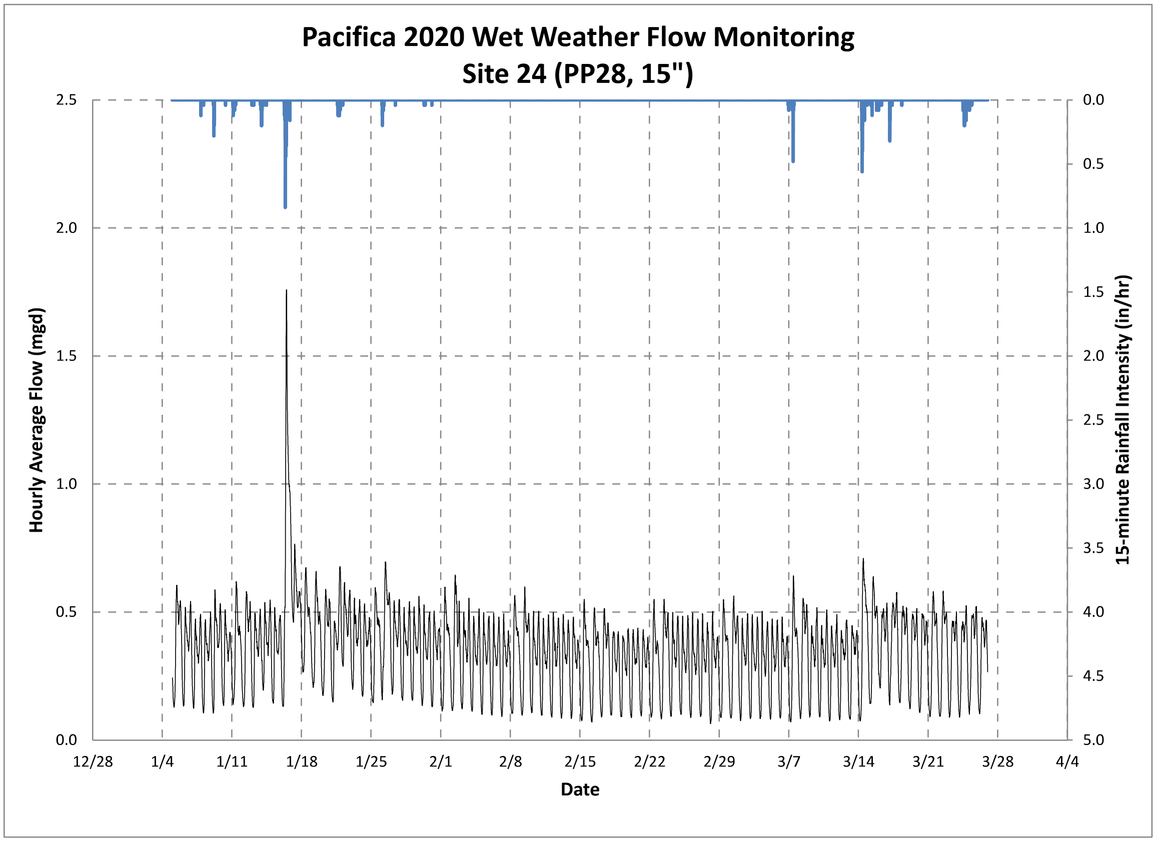

Pacifica 2020 Wet Weather Flow Monitoring
Site 21 (FW38, 12")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
0
1
2
3
4
5
6
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 22A (RK26, 8")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

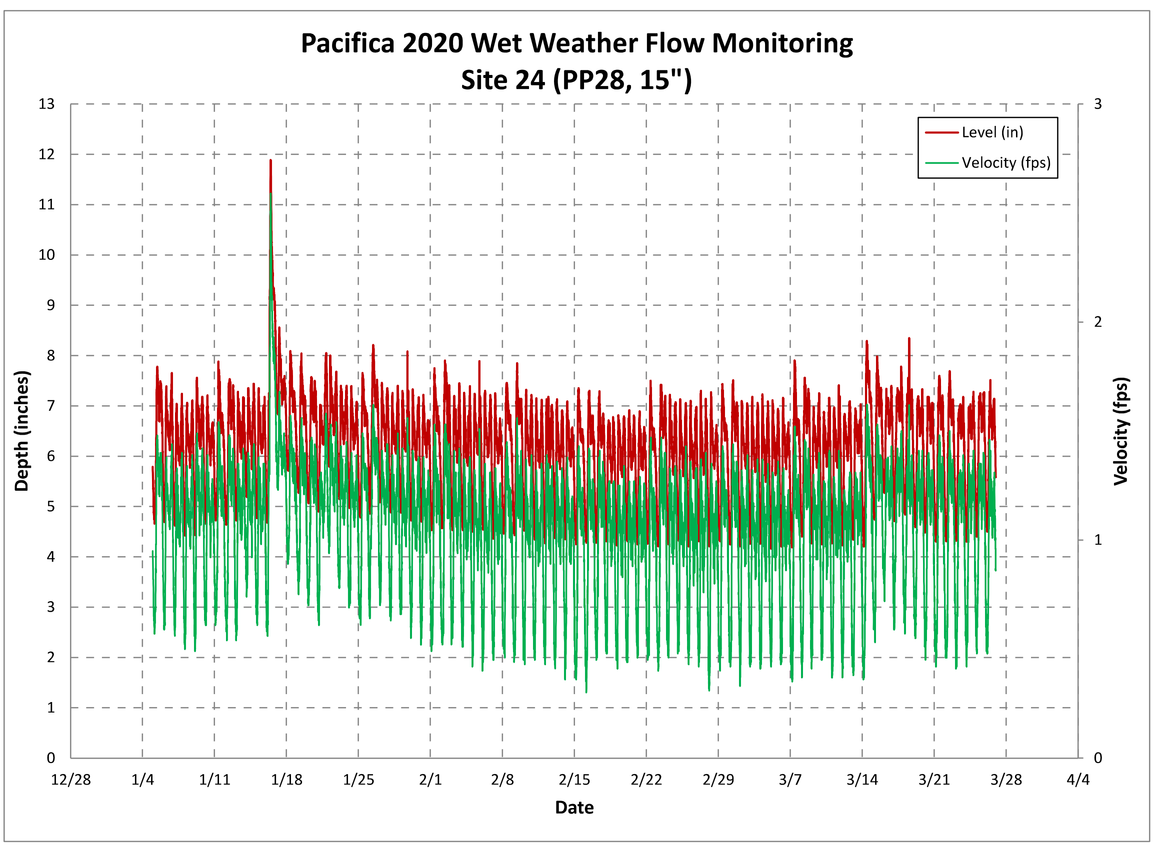

Pacifica 2020 Wet Weather Flow Monitoring
Site 22A (RK26, 8")
Depth (inches)
Velocity (fps)
Level (in)
Velocity (fps)
Date
0
1
2
3
0
1
2
3
4
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4


Pacifica 2020 Wet Weather Flow Monitoring
Site 23 (LLD25A, 15")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4

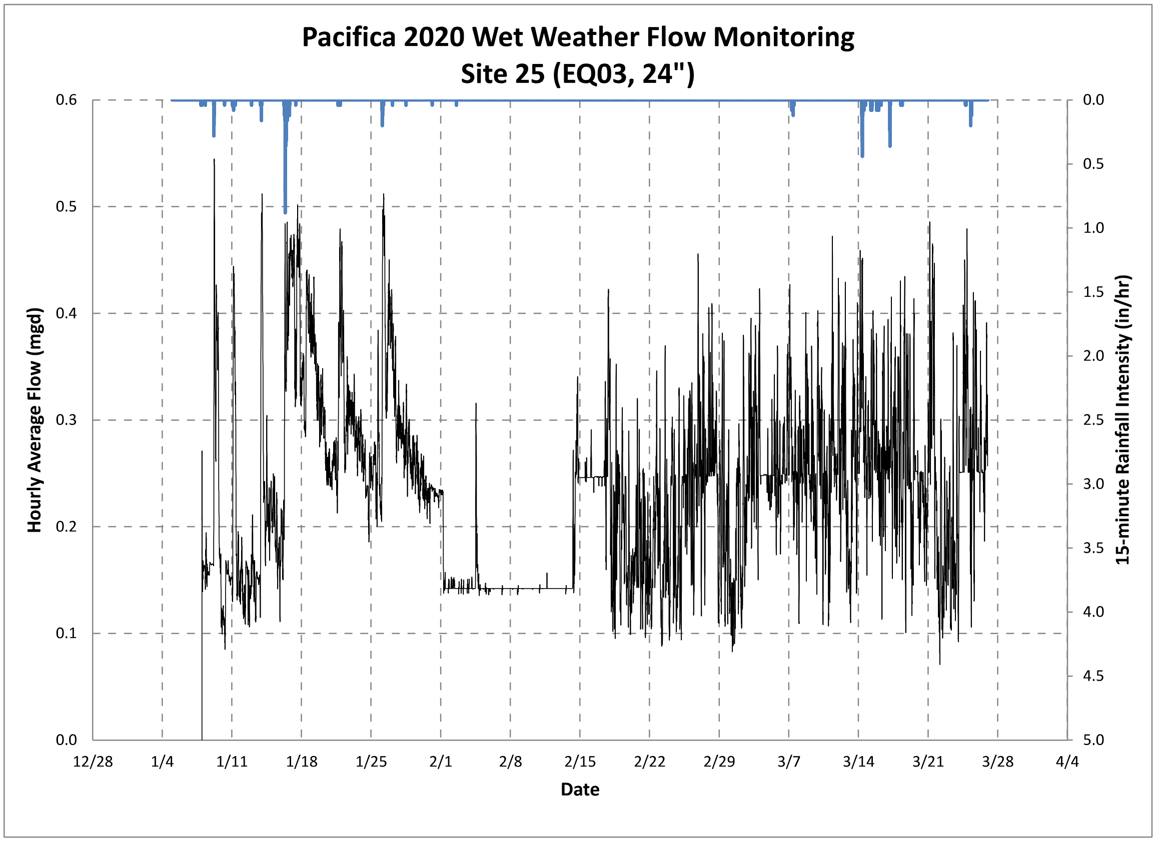

Pacifica 2020 Wet Weather Flow Monitoring
Site 23 (LLD25A, 15")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
11
10
9
8
7
6
5
4
3
2
1
0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



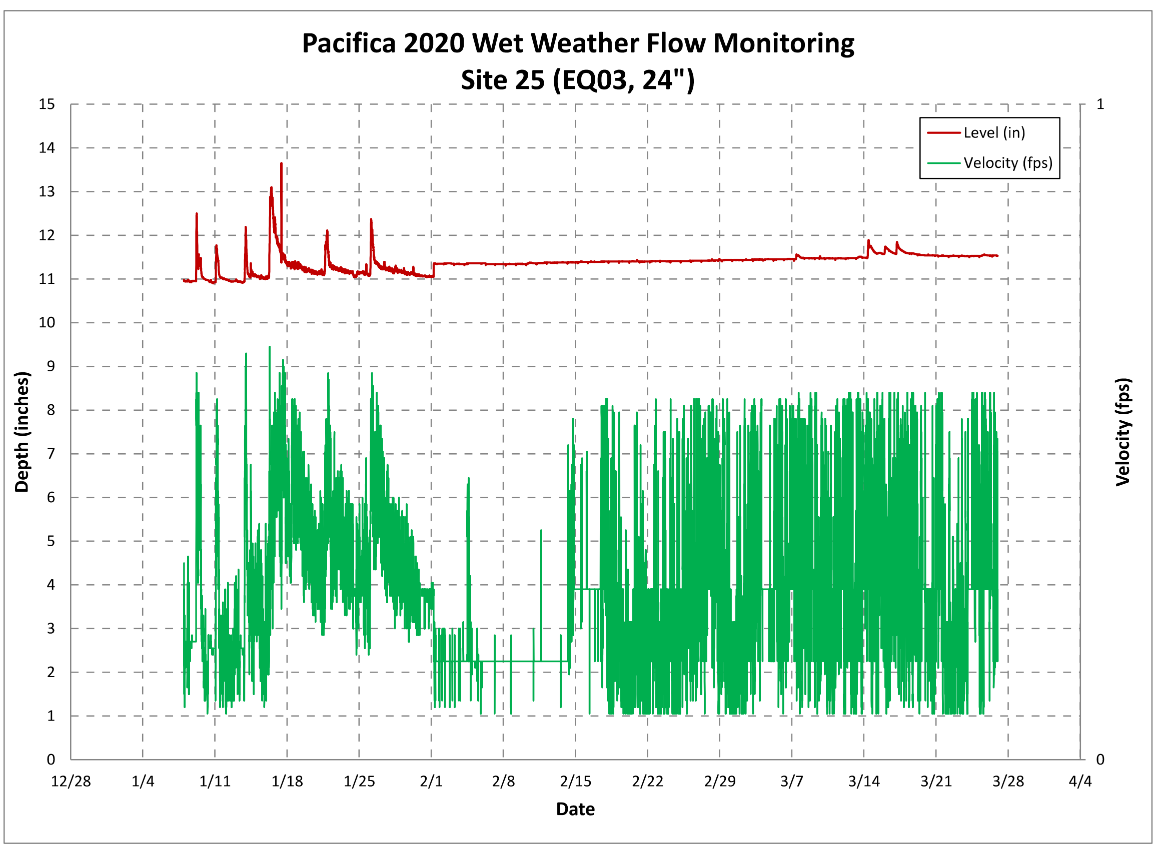
Pacifica 2020 Wet Weather Flow Monitoring
Site 24 (PP28, 15")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
Date
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



Pacifica 2020 Wet Weather Flow Monitoring
Site 24 (PP28, 15")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
Date
0
1
2
3
4
5
6
7
8
9
10
11
12
13
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4



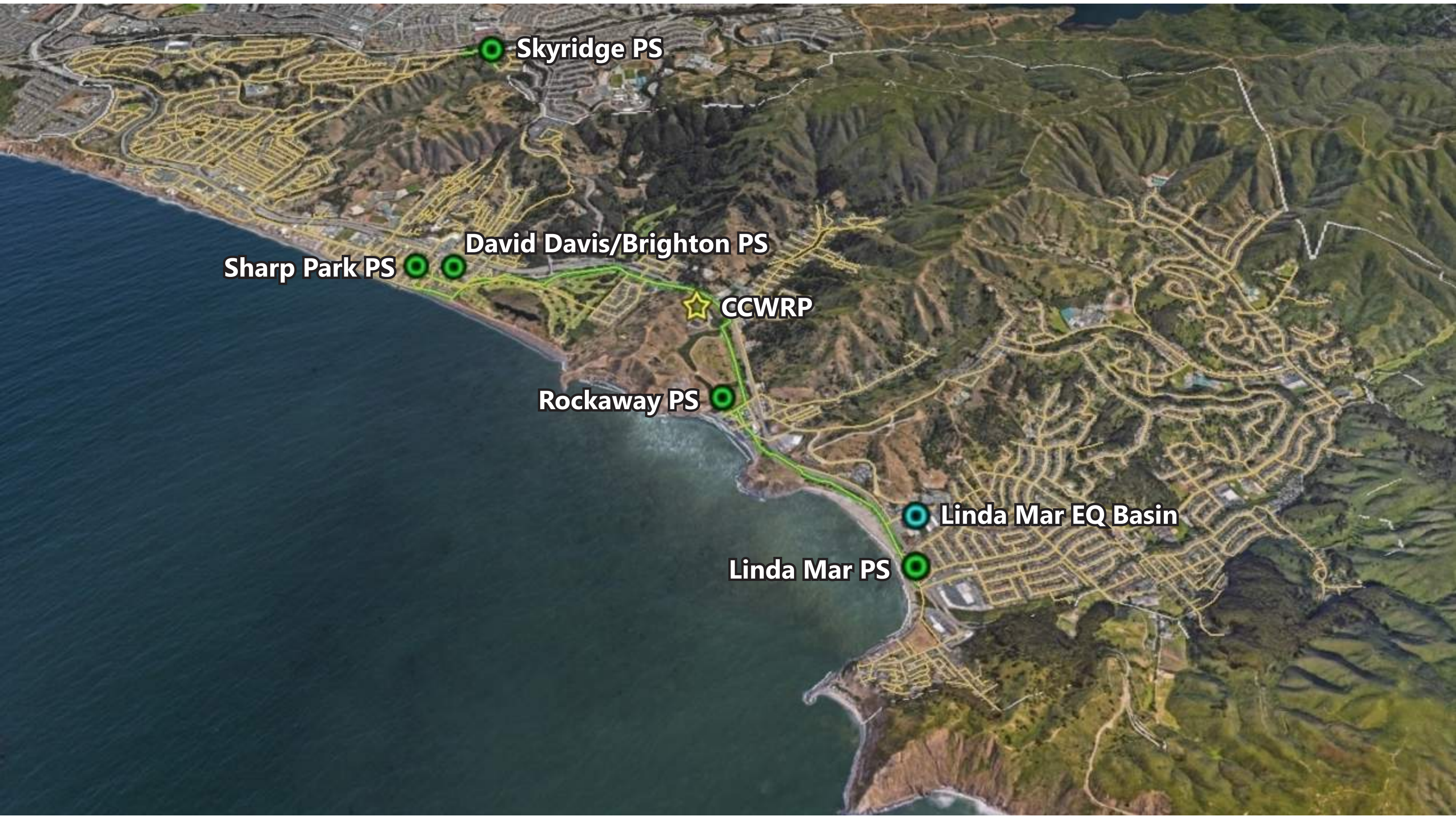
Pacifica 2020 Wet Weather Flow Monitoring
Site 25 (EQ03, 24")
Hourly Average Flow (mgd)
15-minute Rainfall Intensity (in/hr)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4
Date



Pacifica 2020 Wet Weather Flow Monitoring
Site 25 (EQ03, 24")
Level (in)
Velocity (fps)
Depth (inches)
Velocity (fps)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
1
12/28
1/4
1/11
1/18
1/25
2/1
2/8
2/15
2/22
2/29
3/7
3/14
3/21
3/28
4/4
Date

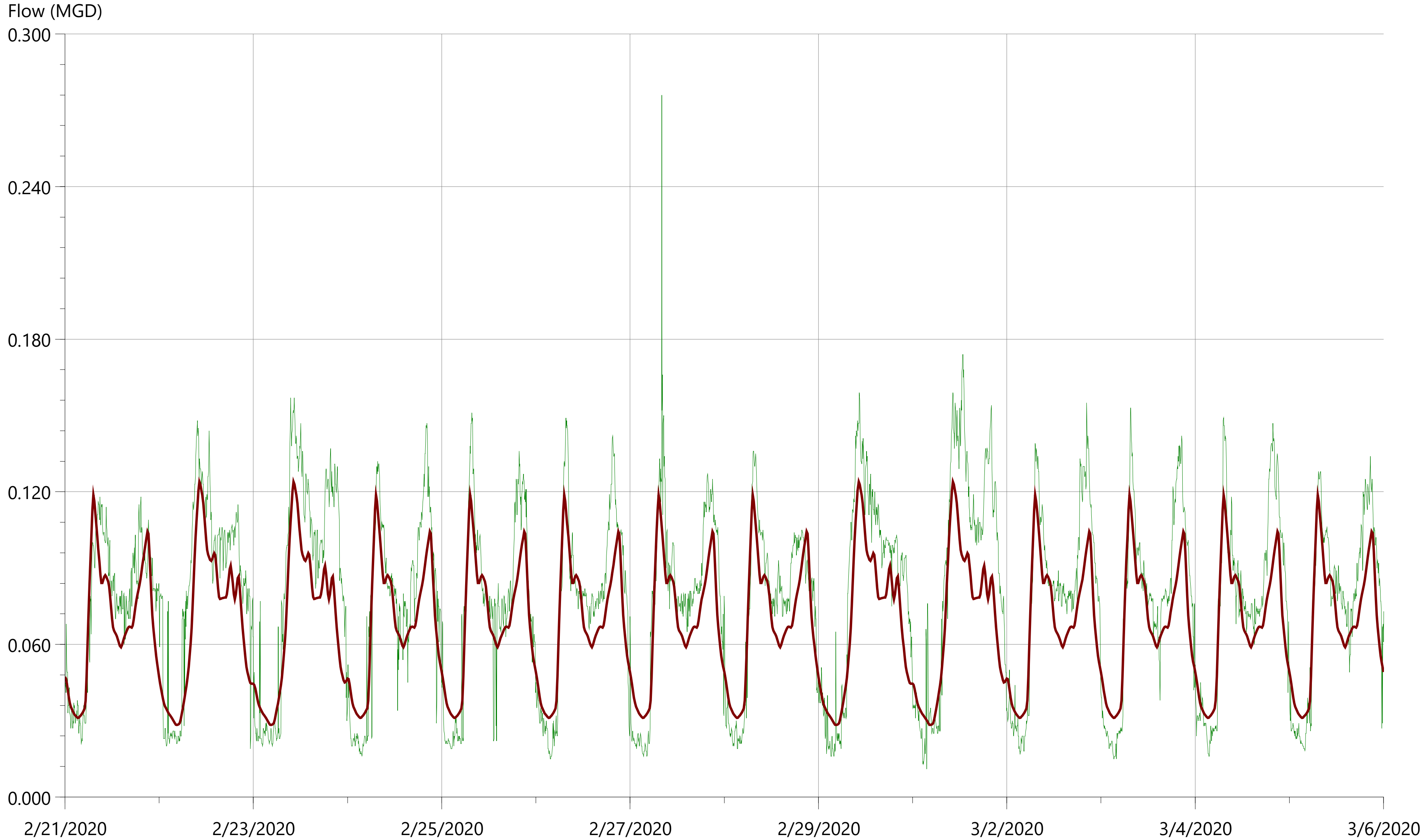
APPENDIX B

Dry Weather Model Calibration Plots



Observed / Predicted Report Produced by shubli (1/8/2021 3:36:44 PM) Page 1 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

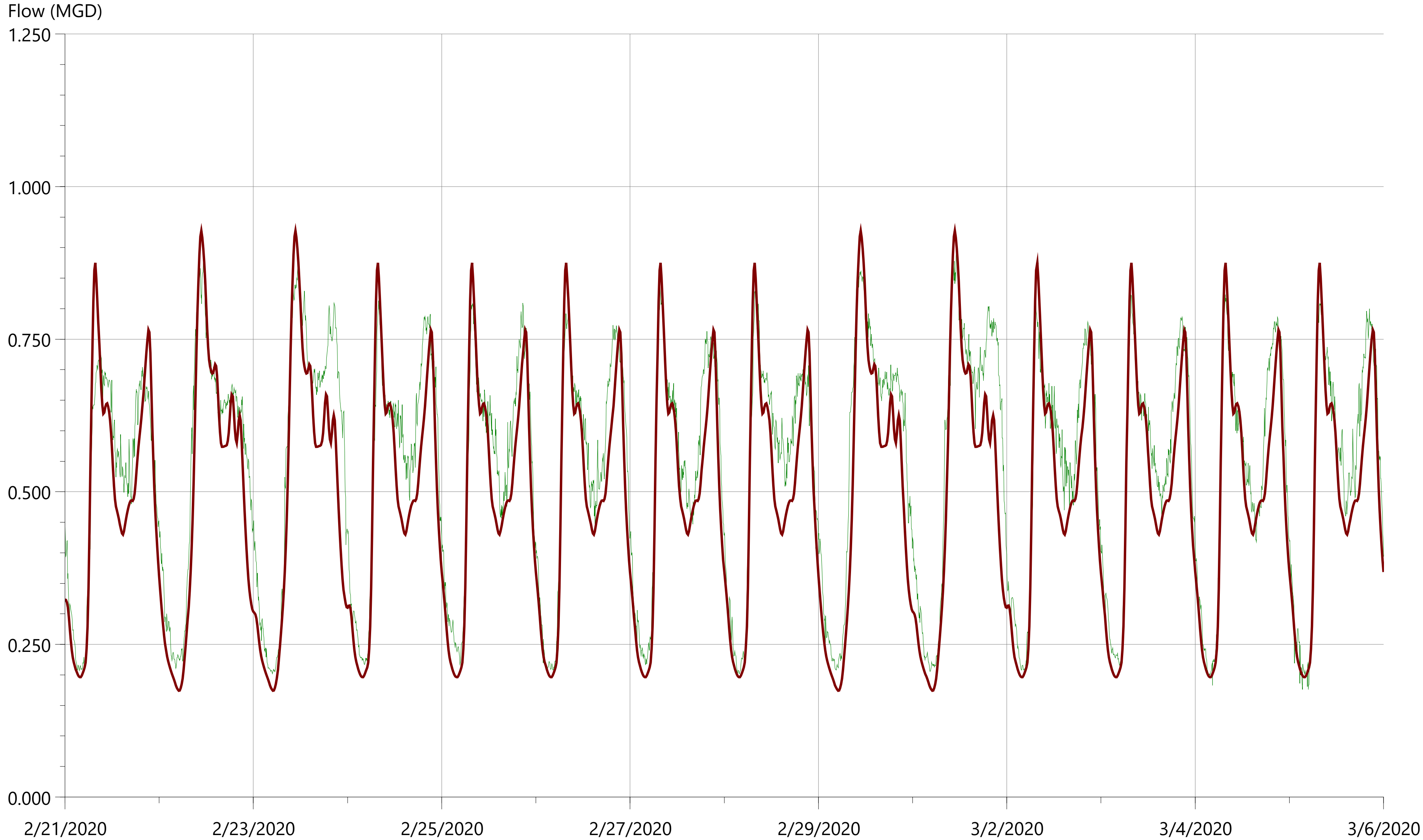
Flow Survey Location (Obs.) 3, Model Location (Pred.) D/S LLD36.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.011	0.276	1.107
... Rainfall event 2 (RGs 1,2,3) 5-min	0.028	0.124	0.962

Observed / Predicted Report Produced by shubli (1/8/2021 3:35:55 PM) Page 2 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

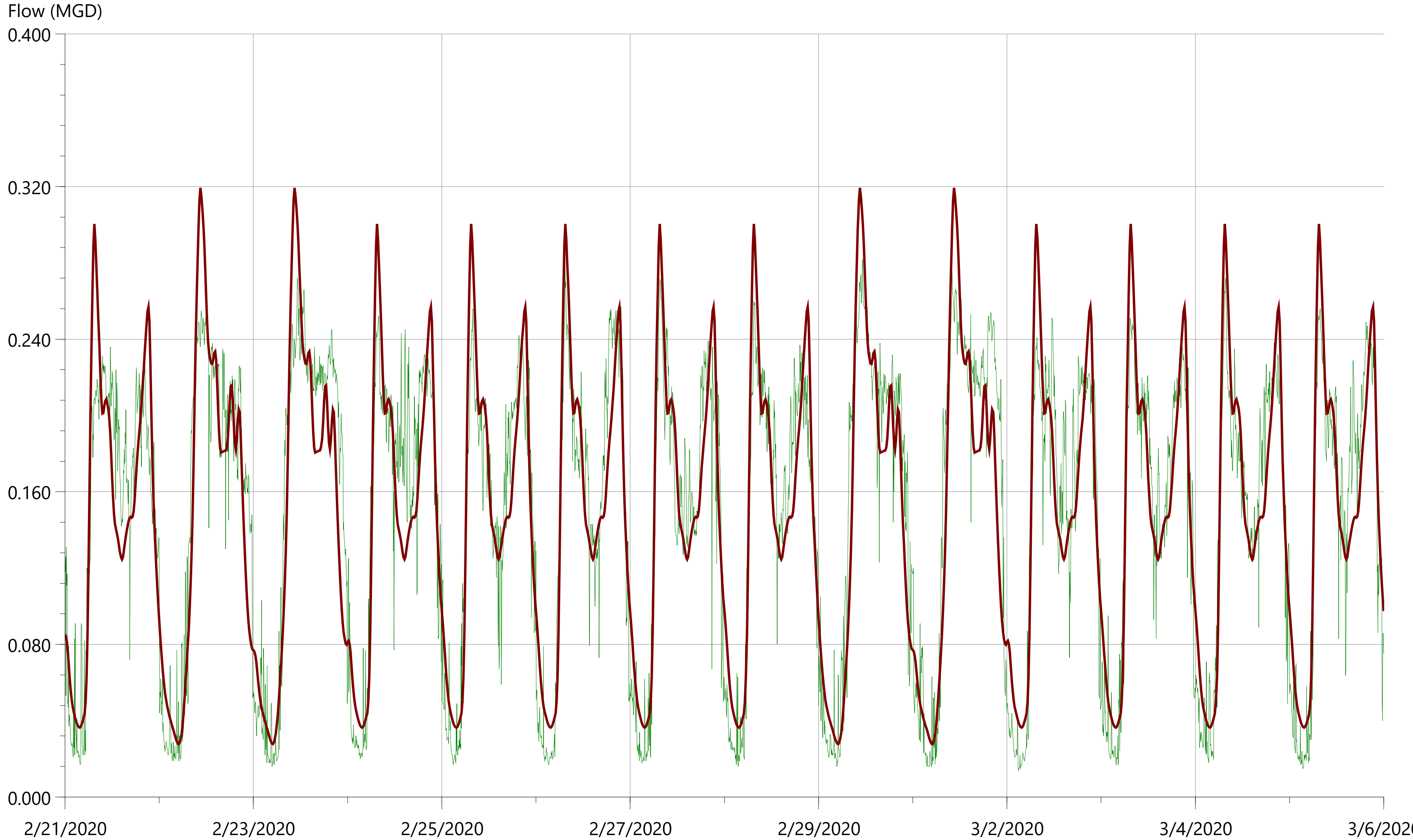
Flow Survey Location (Obs.) 4, Model Location (Pred.) D/S LL6.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.176	0.902	7.600
... Rainfall event 2 (RGs 1,2,3) 5-min	0.174	0.928	6.949

Observed / Predicted Report Produced by shubli (1/8/2021 3:35:10 PM) Page 3 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

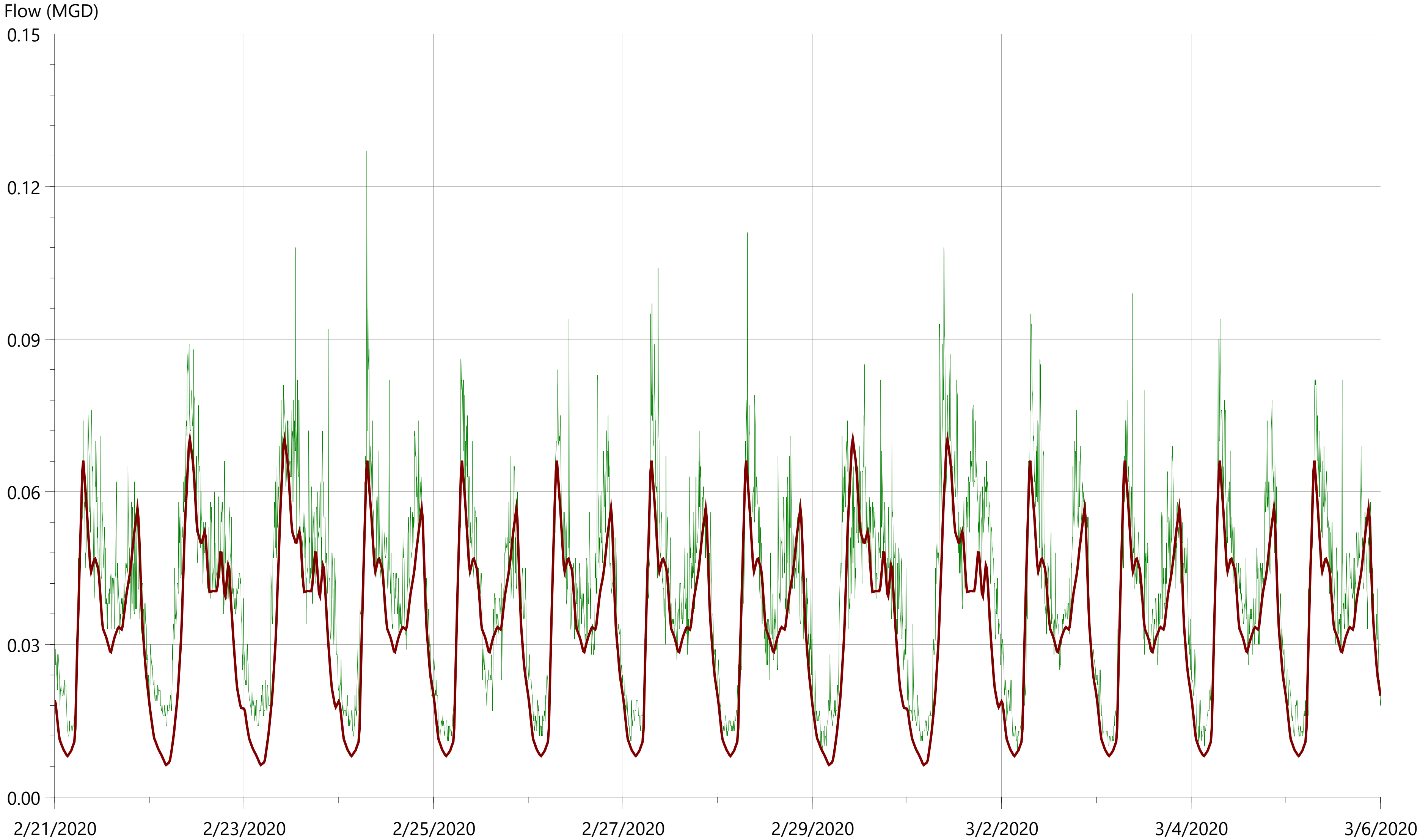
Flow Survey Location (Obs.) 5A, Model Location (Pred.) D/S LLS11.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.014	0.282	2.124
... Rainfall event 2 (RGs 1,2,3) 5-min	0.028	0.319	2.122

Observed / Predicted Report Produced by shubli (1/8/2021 3:34:28 PM) Page 4 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

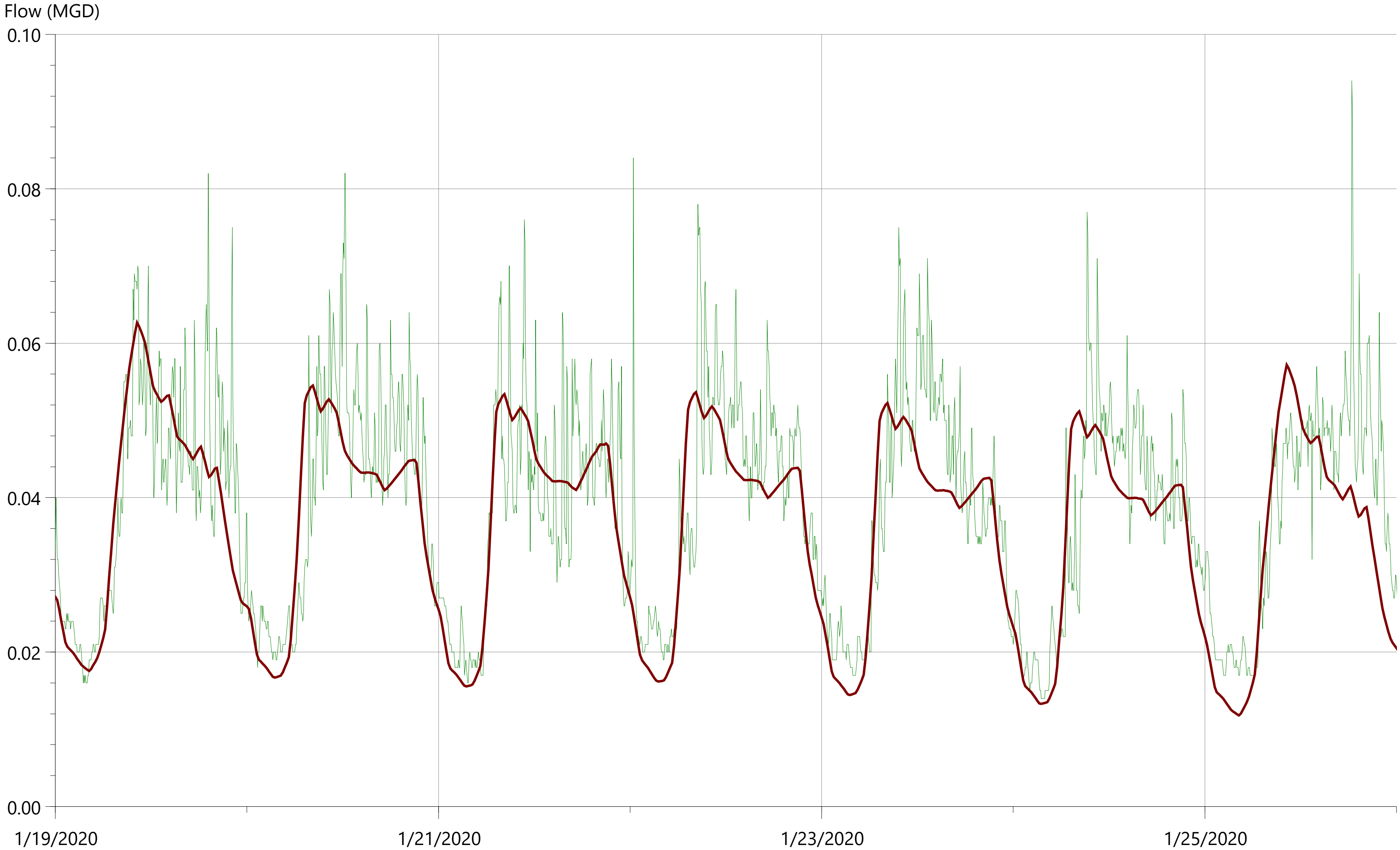
Flow Survey Location (Obs.) 6, Model Location (Pred.) D/S PT10.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.009	0.127	0.568
... Rainfall event 2 (RGs 1,2,3) 5-min	0.006	0.070	0.471

Observed / Predicted Report Produced by shubli (1/8/2021 3:38:43 PM) Page 5 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

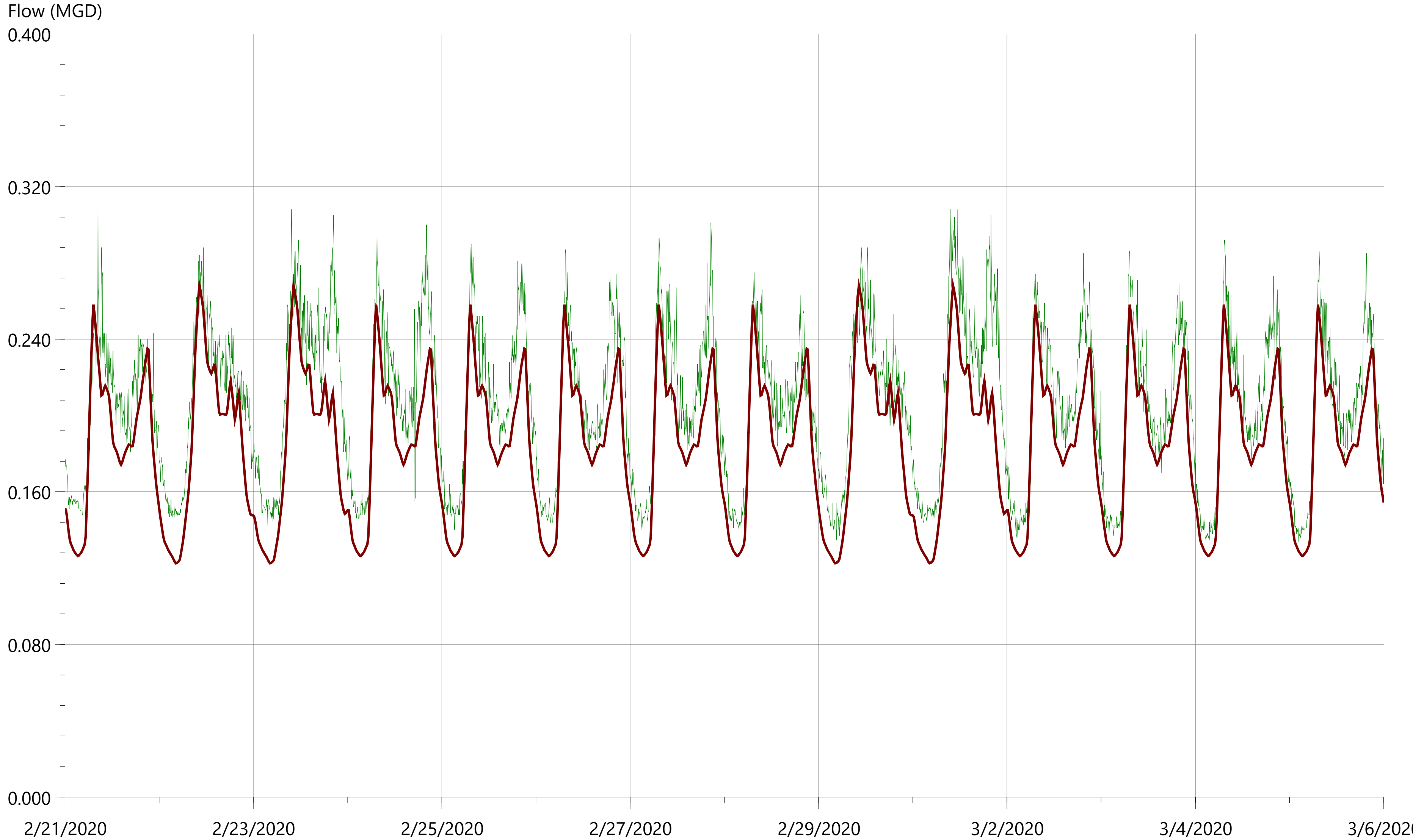
Flow Survey Location (Obs.) 7, Model Location (Pred.) D/S LLZ2.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.014	0.094	0.274
... Rainfall event 2 (RGs 1,2,3) 5-min	0.012	0.063	0.255

Observed / Predicted Report Produced by shubli (1/8/2021 3:33:18 PM) Page 6 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

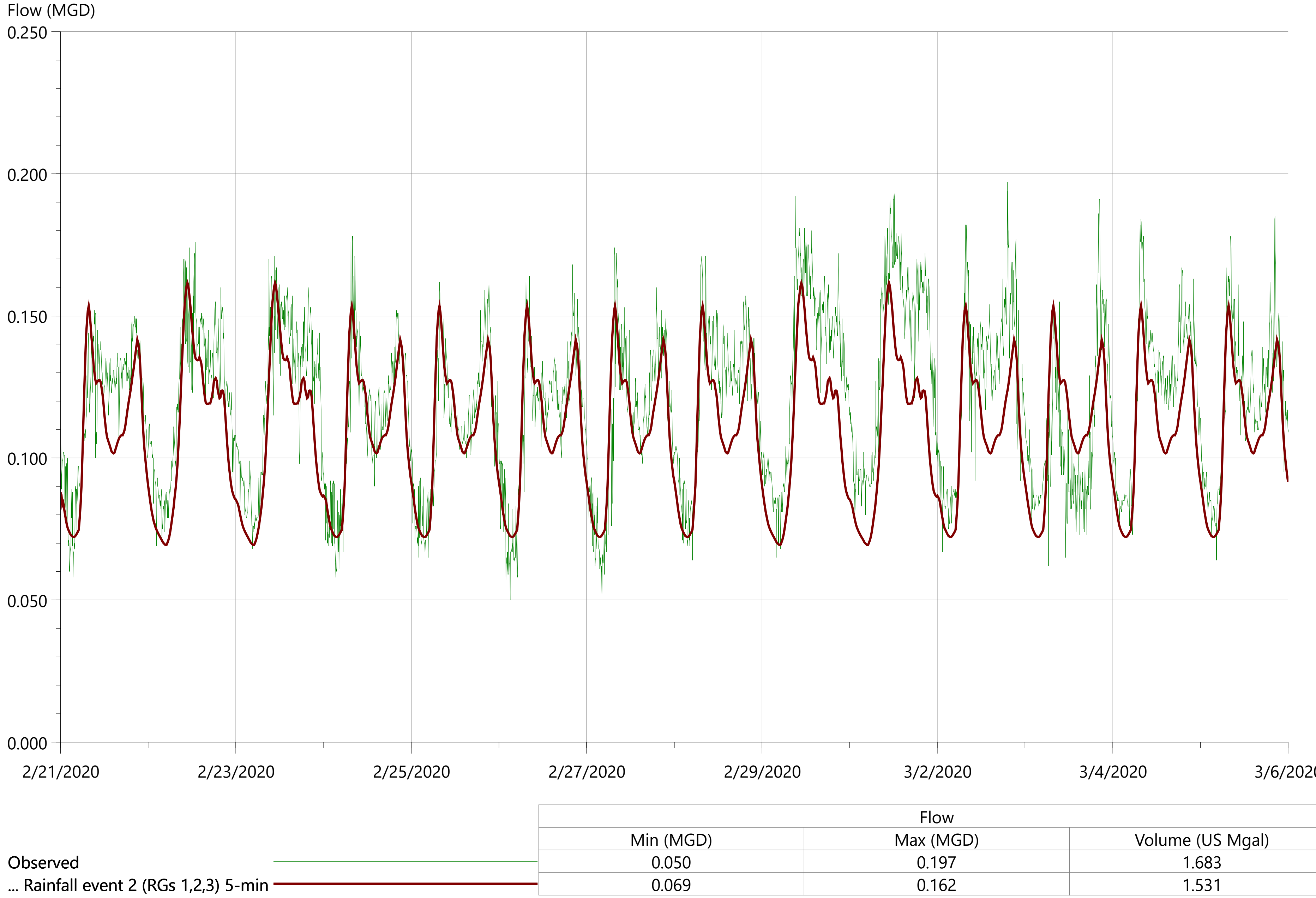
Flow Survey Location (Obs.) 8A, Model Location (Pred.) D/S V27.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.134	0.314	2.890
... Rainfall event 2 (RGs 1,2,3) 5-min	0.122	0.268	2.588

Observed / Predicted Report Produced by shubli (1/8/2021 3:30:57 PM) Page 7 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

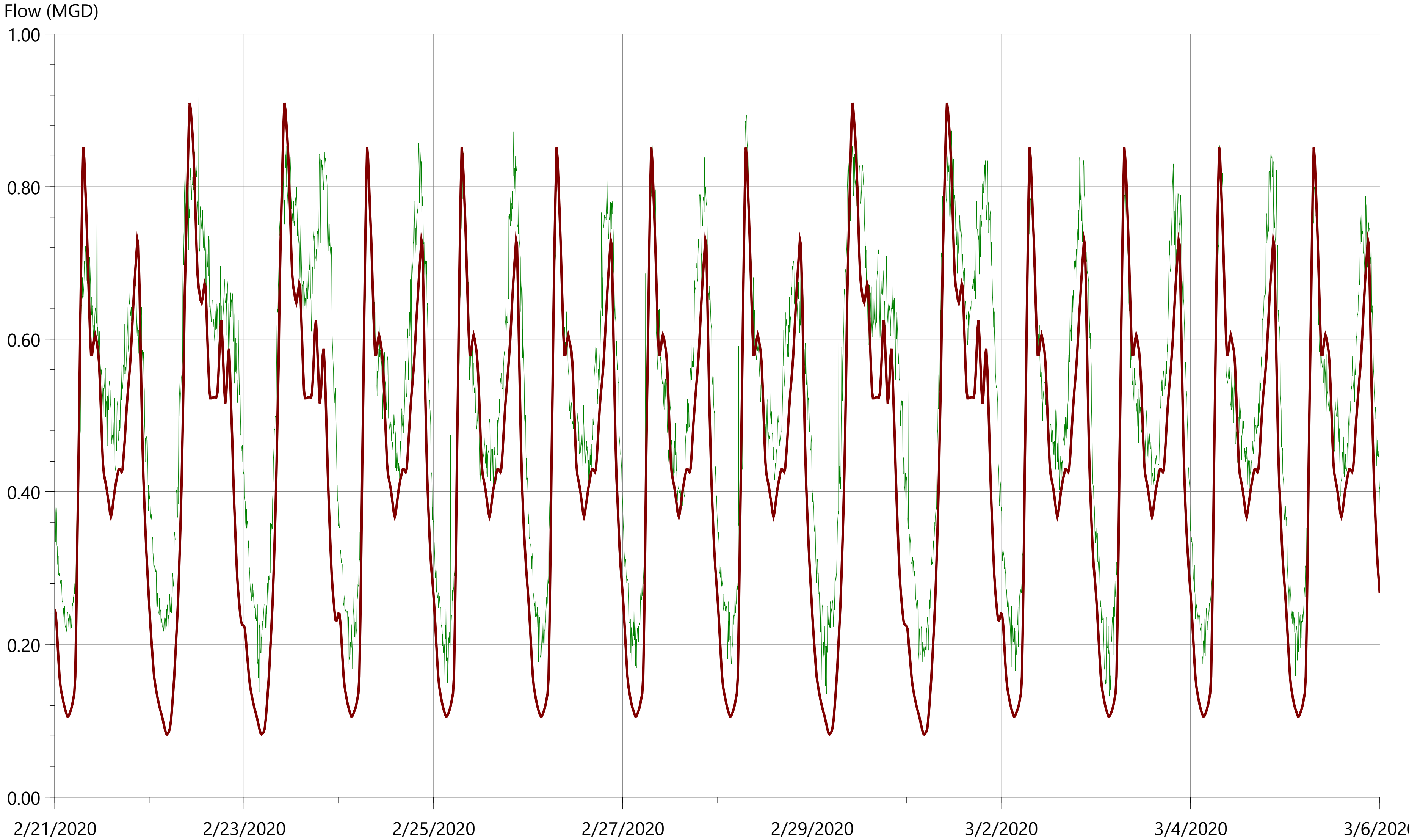
Flow Survey Location (Obs.) 9, Model Location (Pred.) D/S SPQ6A1.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.050	0.197	1.683
... Rainfall event 2 (RGs 1,2,3) 5-min	0.069	0.162	1.531

Observed / Predicted Report Produced by shubli (1/8/2021 3:30:22 PM) Page 8 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

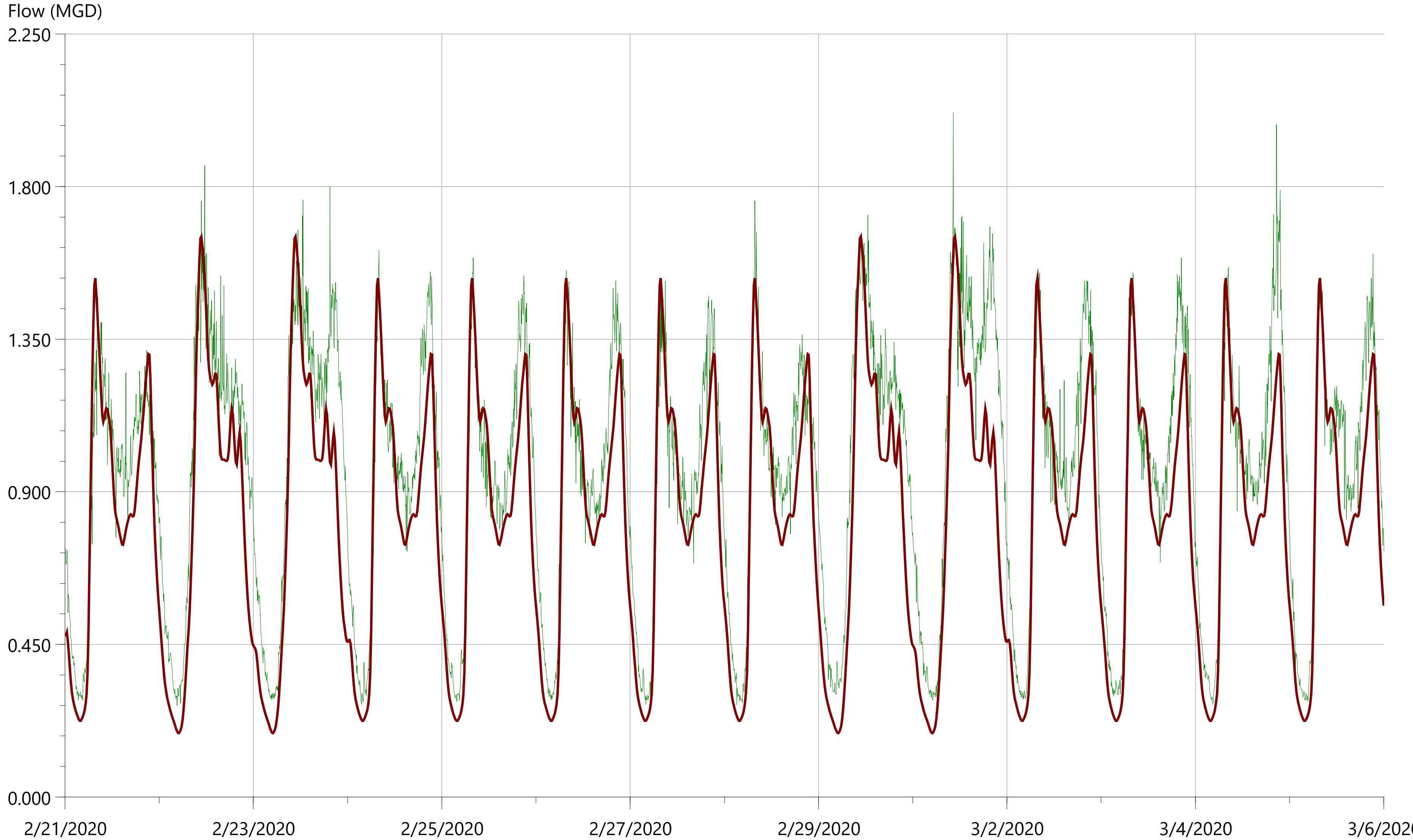
Flow Survey Location (Obs.) 10, Model Location (Pred.) D/S F37.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.132	1.009	7.253
... Rainfall event 2 (RGs 1,2,3) 5-min	0.082	0.910	6.100

Observed / Predicted Report Produced by shubli (1/8/2021 3:29:08 PM) Page 9 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

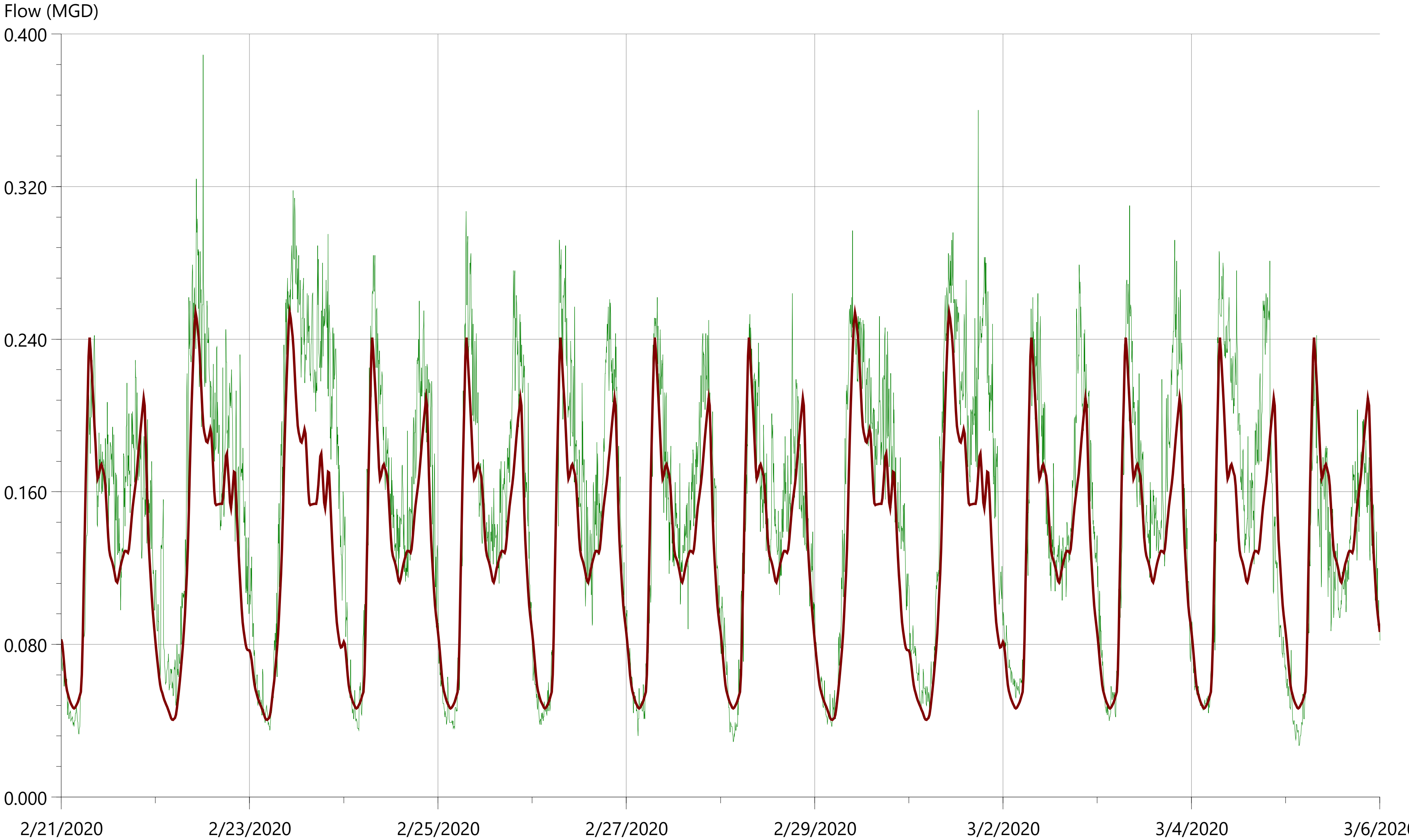
Flow Survey Location (Obs.) 13+15, Model Location (Pred.) D/S FW54.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.270	2.018	13.411
... Rainfall event 2 (RGs 1,2,3) 5-min	0.188	1.653	11.572

Observed / Predicted Report Produced by shubli (1/8/2021 3:28:01 PM) Page 10 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

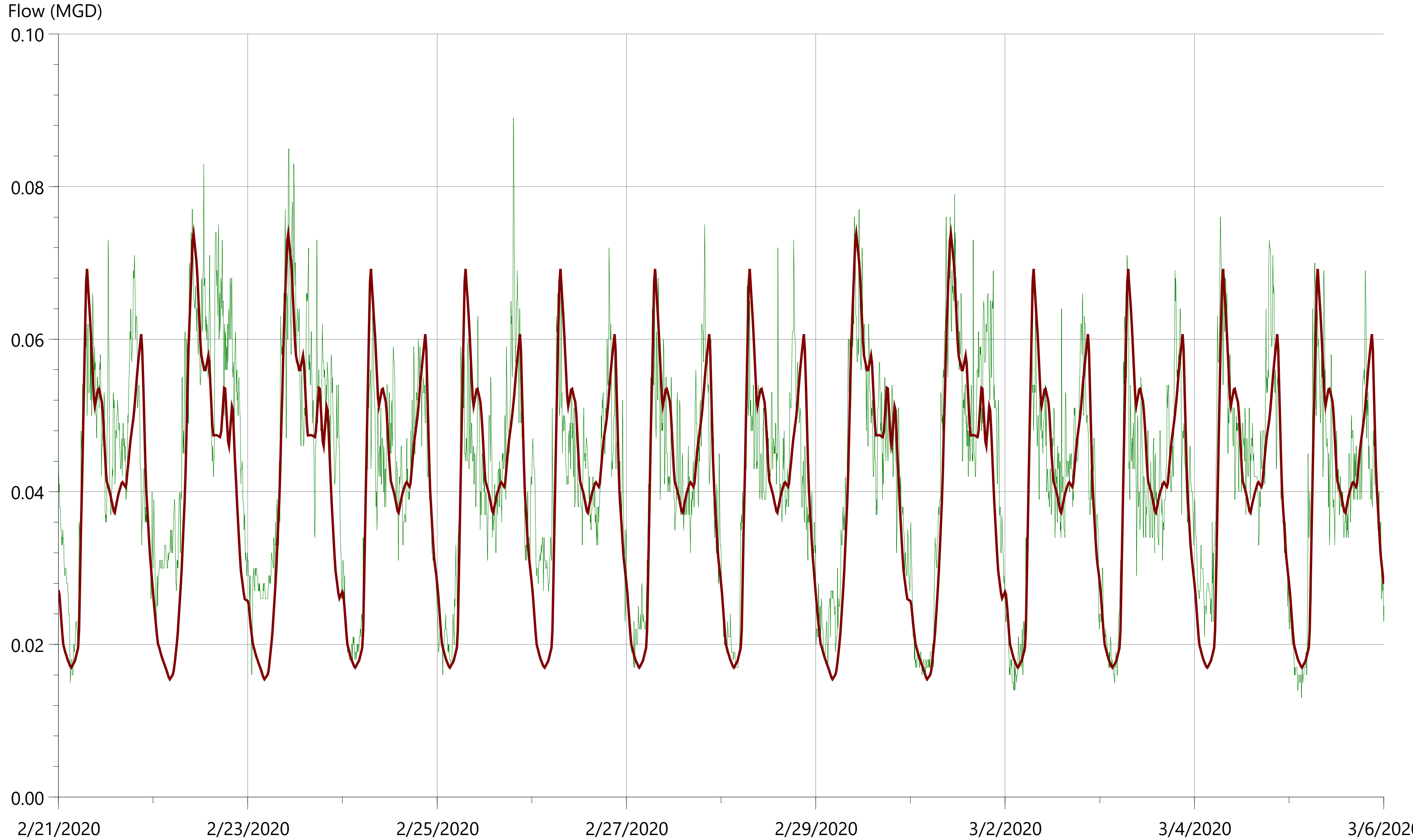
Flow Survey Location (Obs.) 14, Model Location (Pred.) D/S SP34.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.027	0.389	2.114
... Rainfall event 2 (RGs 1,2,3) 5-min	0.040	0.254	1.838

Observed / Predicted Report Produced by shubli (1/8/2021 3:27:21 PM) Page 11 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

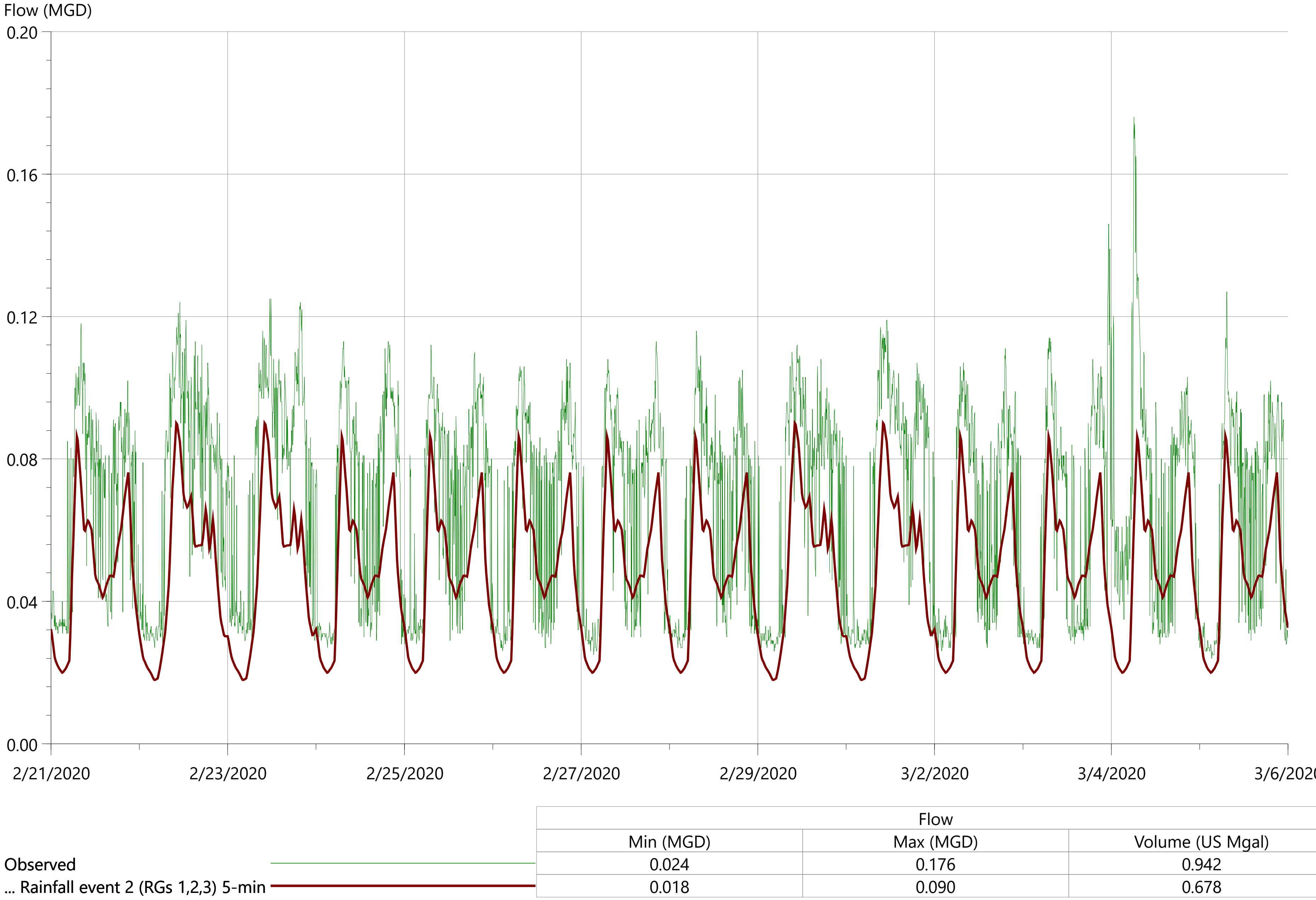
Flow Survey Location (Obs.) 16, Model Location (Pred.) D/S LLM14.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.013	0.089	0.594
... Rainfall event 2 (RGs 1,2,3) 5-min	0.015	0.074	0.571

Observed / Predicted Report Produced by shubli (1/8/2021 3:26:36 PM) Page 12 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

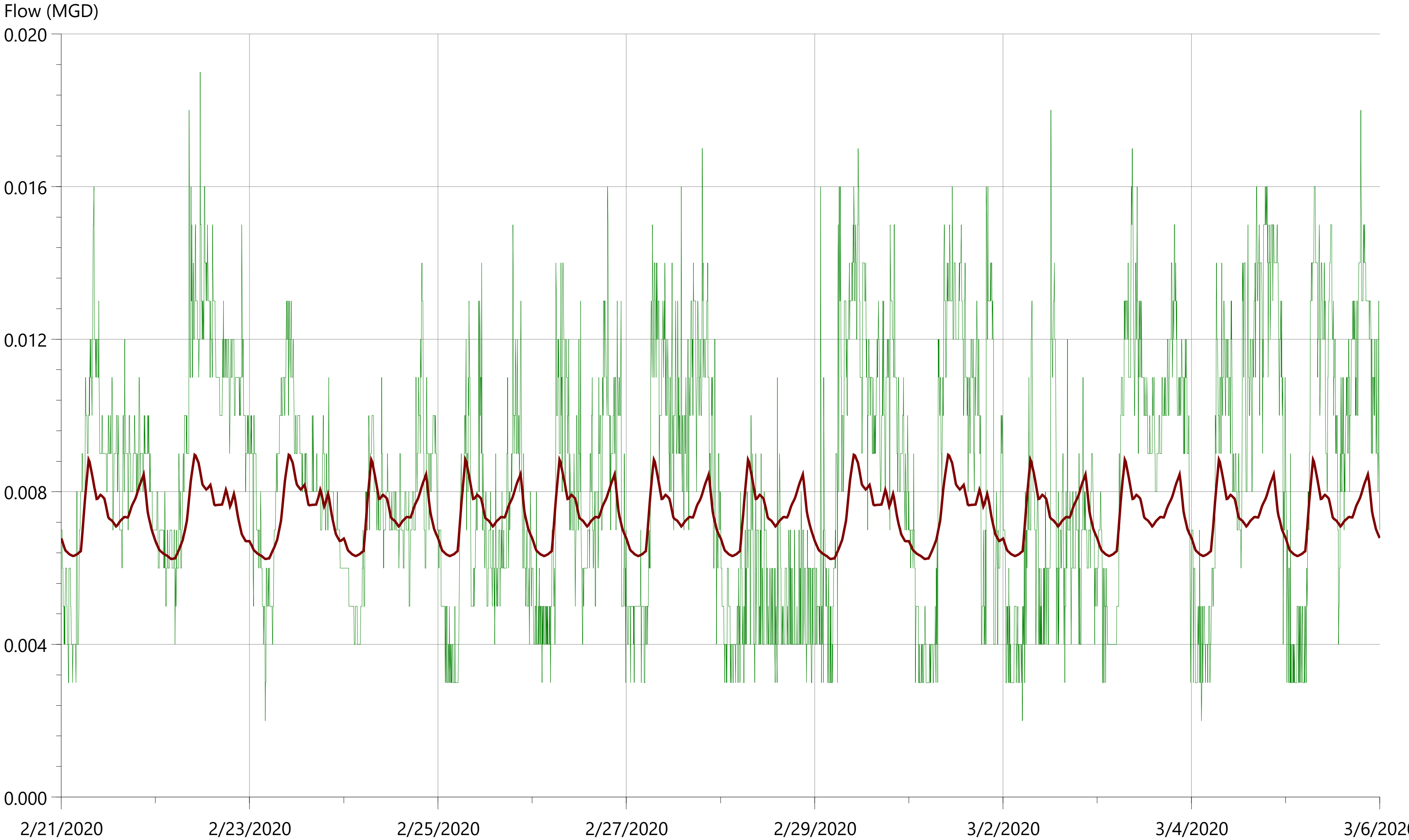
Flow Survey Location (Obs.) 17, Model Location (Pred.) D/S V13.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.024	0.176	0.942
... Rainfall event 2 (RGs 1,2,3) 5-min	0.018	0.090	0.678

Observed / Predicted Report Produced by shubli (1/8/2021 3:25:55 PM) Page 13 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

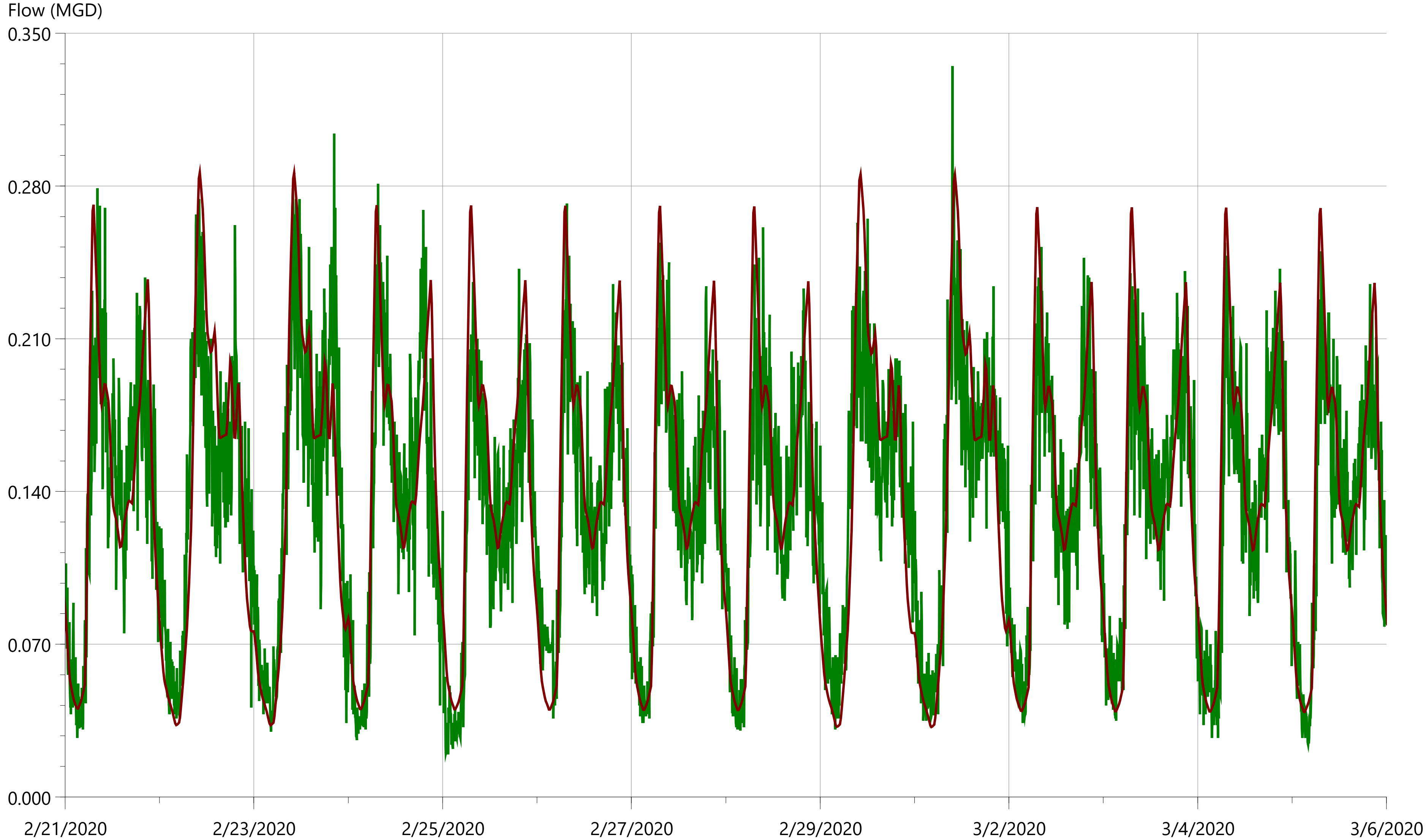
Flow Survey Location (Obs.) 18, Model Location (Pred.) D/S VF8.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.002	0.019	0.117
... Rainfall event 2 (RGs 1,2,3) 5-min	0.006	0.009	0.103

Observed / Predicted Report Produced by shubli (1/8/2021 3:12:37 PM) Page 14 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

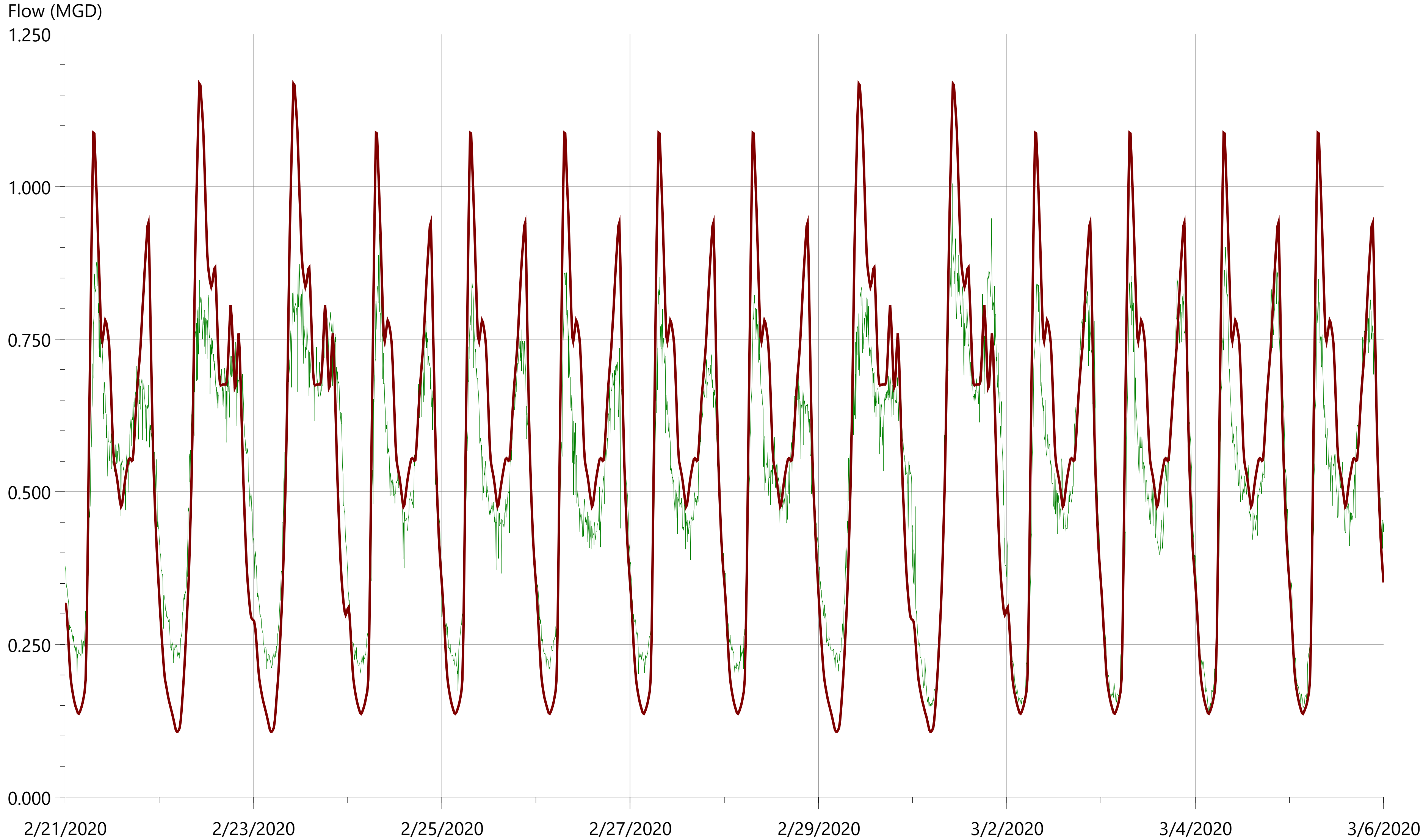
Flow Survey Location (Obs.) 19, Model Location (Pred.) D/S R19.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.020	0.335	1.884
... Rainfall event 2 (RGs 1,2,3) 5-min	0.032	0.286	1.951

Observed / Predicted Report Produced by shubli (1/8/2021 3:18:13 PM) Page 15 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

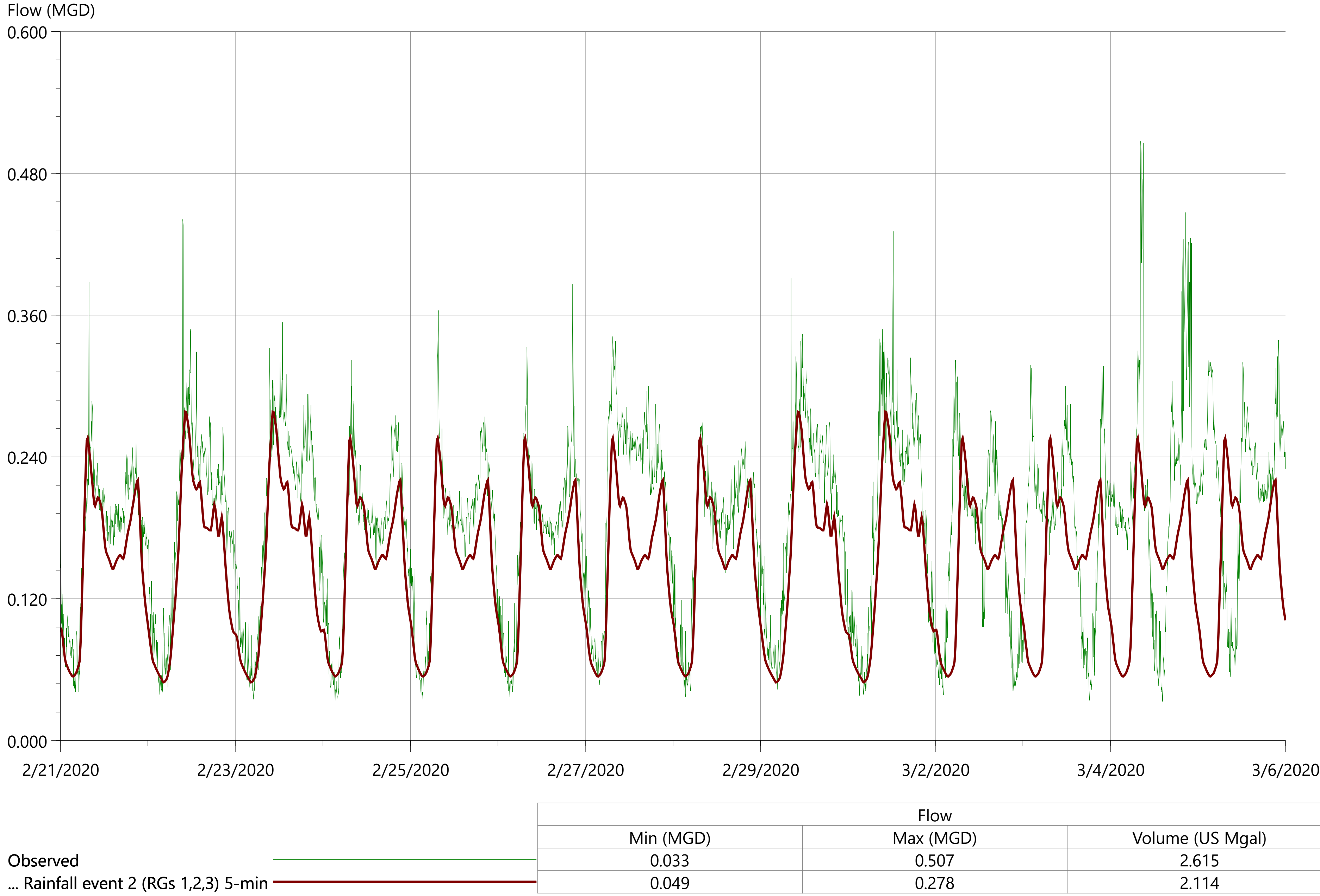
Flow Survey Location (Obs.) 20, Model Location (Pred.) D/S F44A.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.140	1.005	7.273
... Rainfall event 2 (RGs 1,2,3) 5-min	0.107	1.168	7.873

Observed / Predicted Report Produced by shubli (1/8/2021 3:18:55 PM) Page 16 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

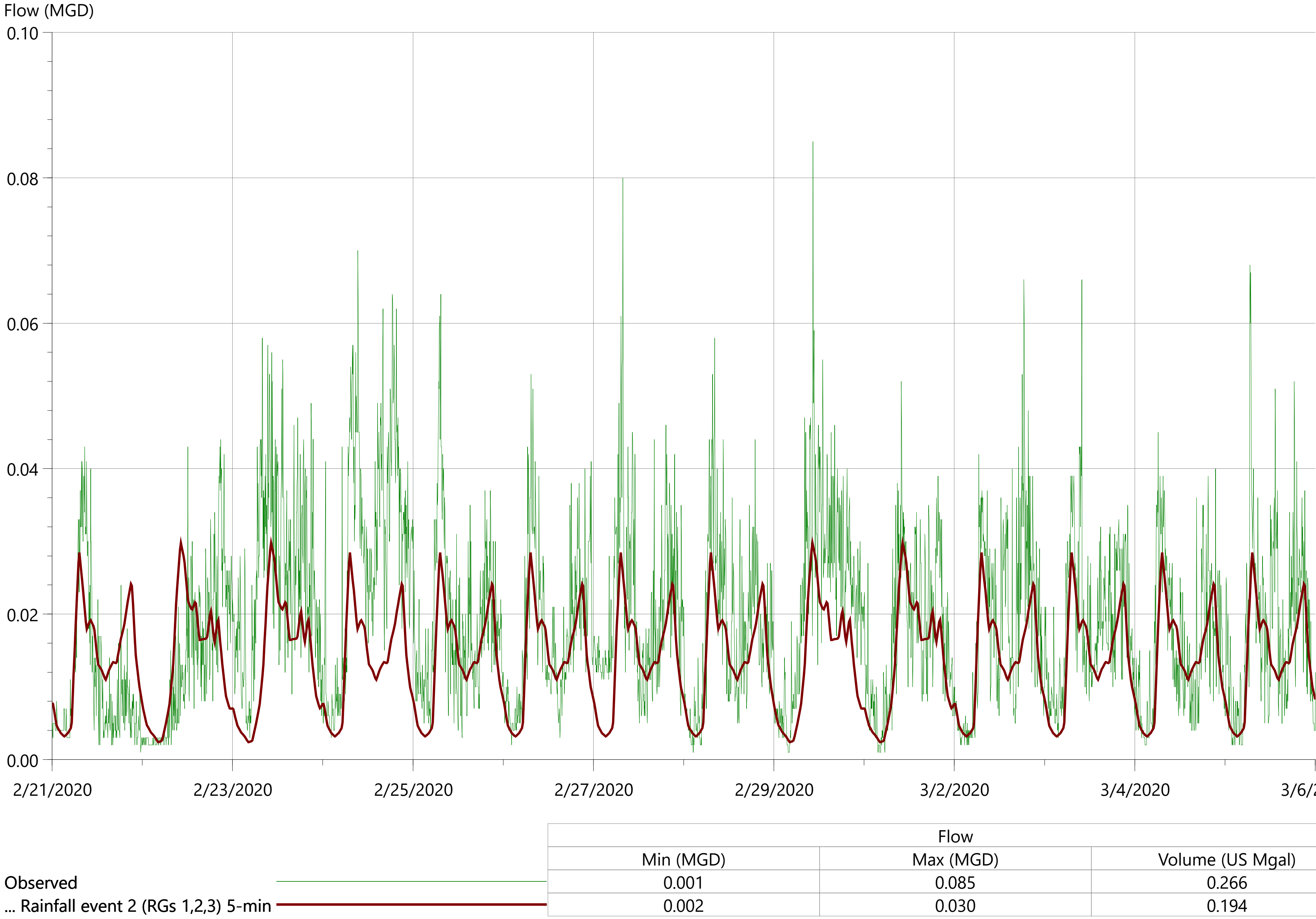
Flow Survey Location (Obs.) 21, Model Location (Pred.) D/S FW37.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.033	0.507	2.615
... Rainfall event 2 (RGs 1,2,3) 5-min	0.049	0.278	2.114

Observed / Predicted Report Produced by shubli (1/8/2021 3:19:38 PM) Page 17 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

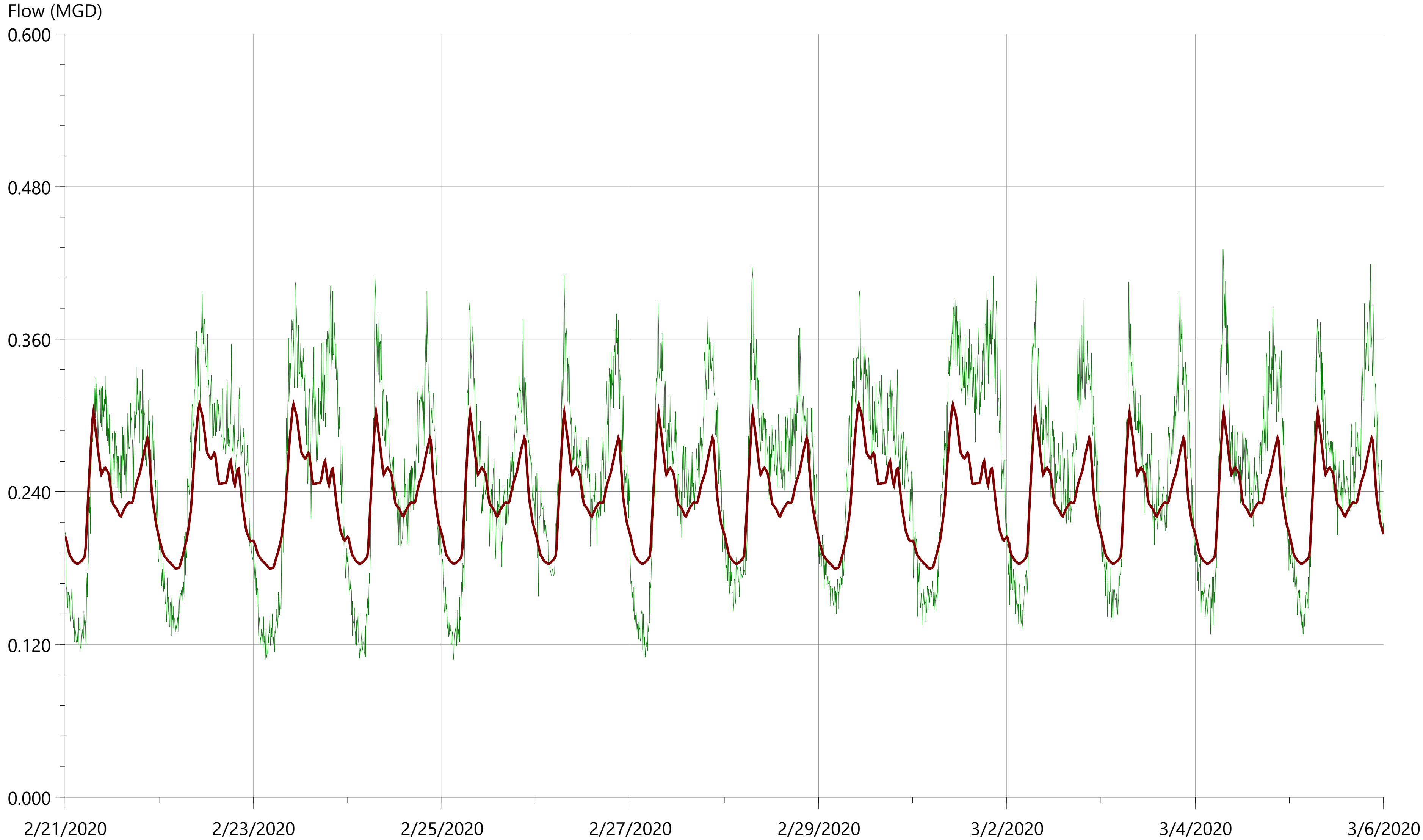
Flow Survey Location (Obs.) 22A, Model Location (Pred.) D/S RK23.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.001	0.085	0.266
... Rainfall event 2 (RGs 1,2,3) 5-min	0.002	0.030	0.194

Observed / Predicted Report Produced by shubli (1/8/2021 3:20:23 PM) Page 18 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

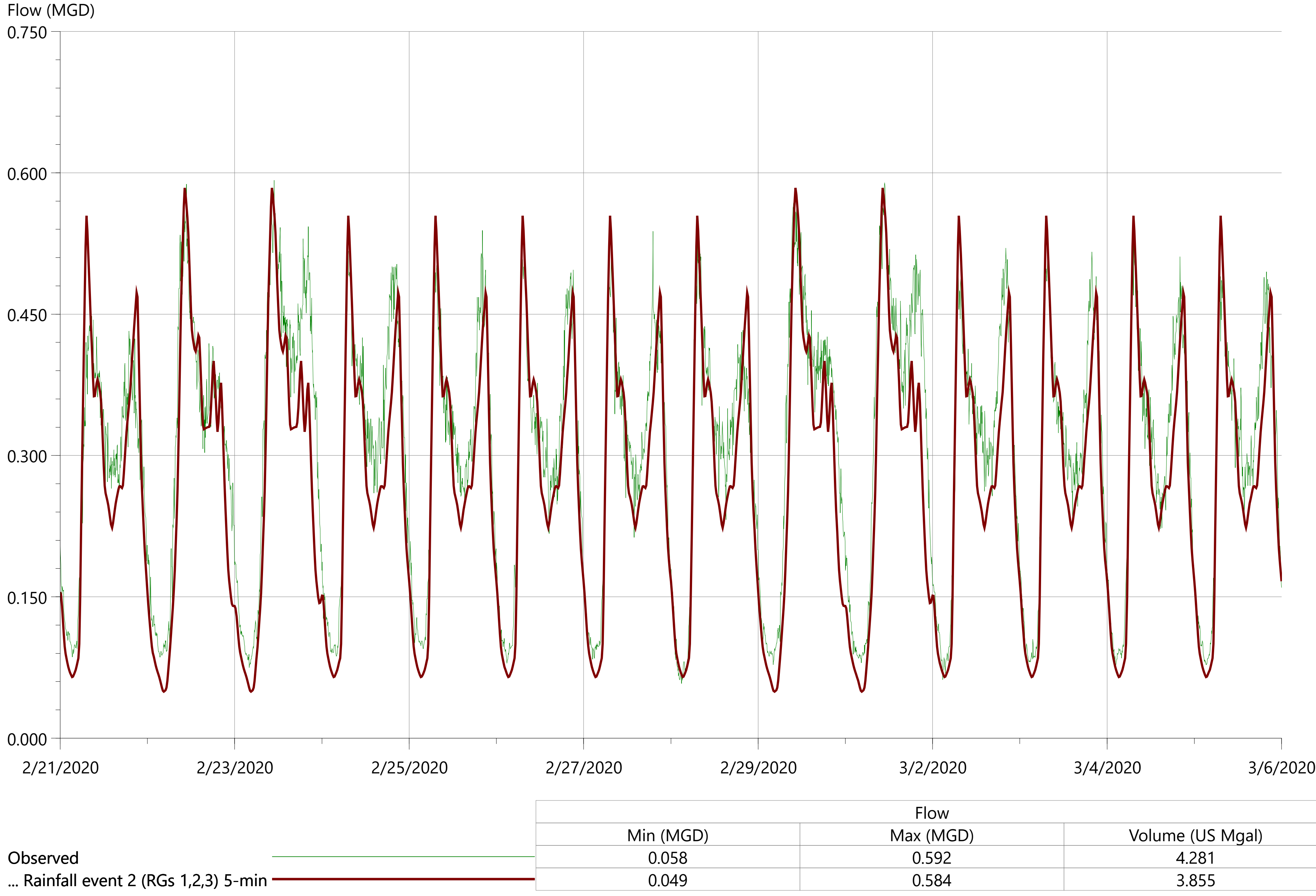
Flow Survey Location (Obs.) 23, Model Location (Pred.) D/S LLD24a.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.107	0.431	3.572
... Rainfall event 2 (RGs 1,2,3) 5-min	0.180	0.309	3.274

Observed / Predicted Report Produced by shubli (1/8/2021 3:21:09 PM) Page 19 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 2/21/20-3/6/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/8/2021 3:14:23 PM)

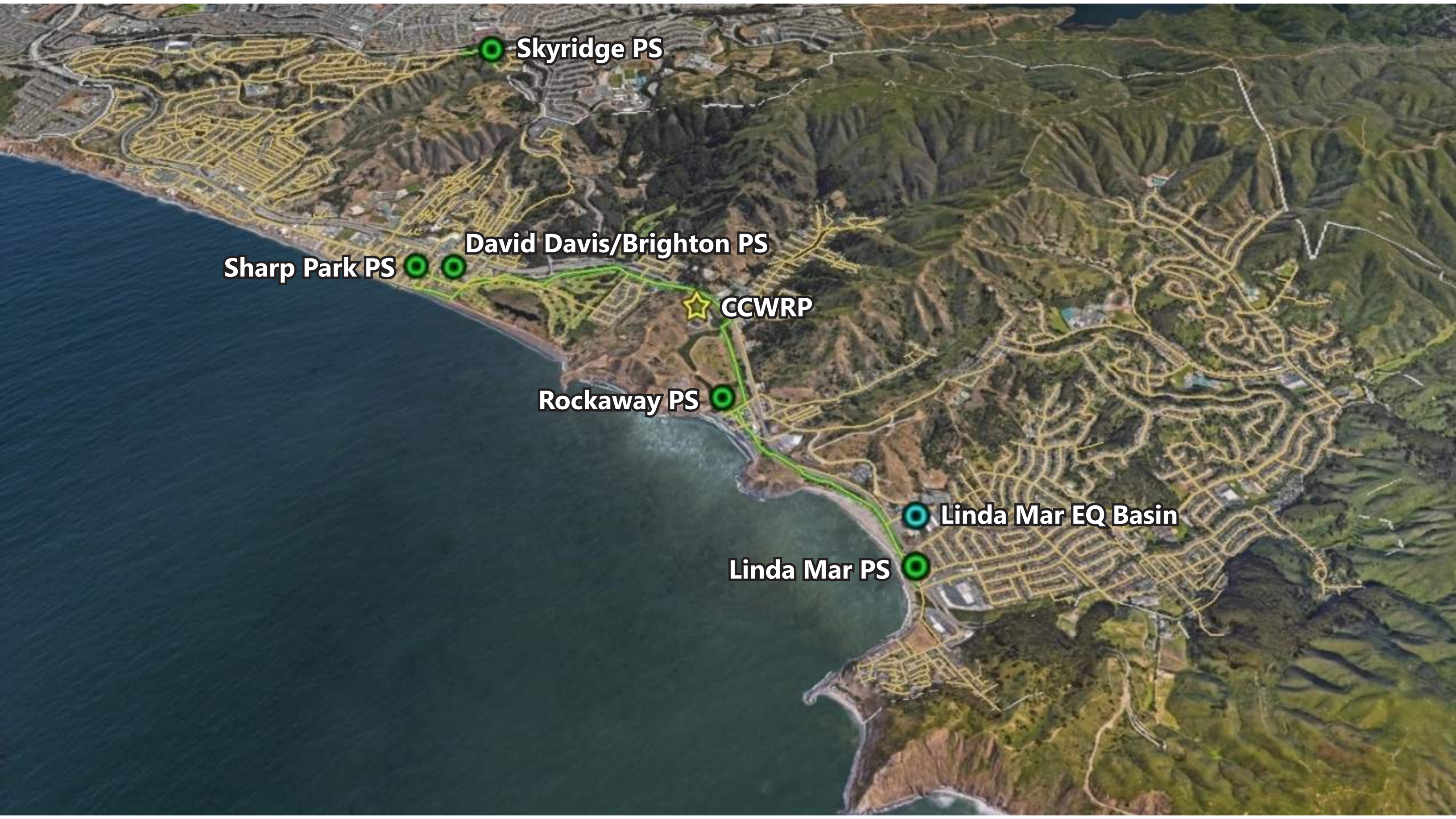
Flow Survey Location (Obs.) 24, Model Location (Pred.) D/S PP27.1



	Flow		
	Min (MGD)	Max (MGD)	Volume (US Mgal)
Observed	0.058	0.592	4.281
... Rainfall event 2 (RGs 1,2,3) 5-min	0.049	0.584	3.855

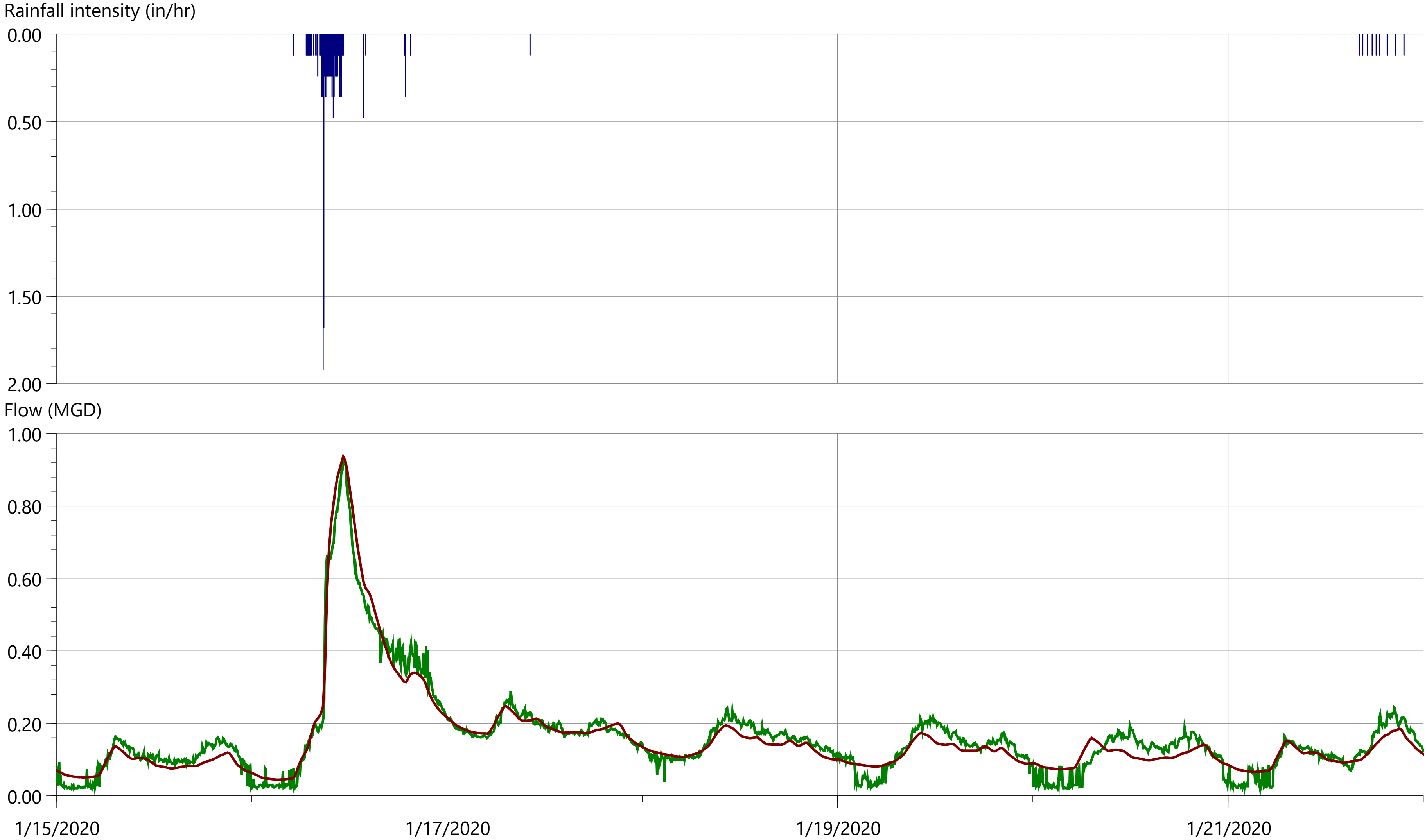
APPENDIX C

Wet Weather Model Calibration Plots



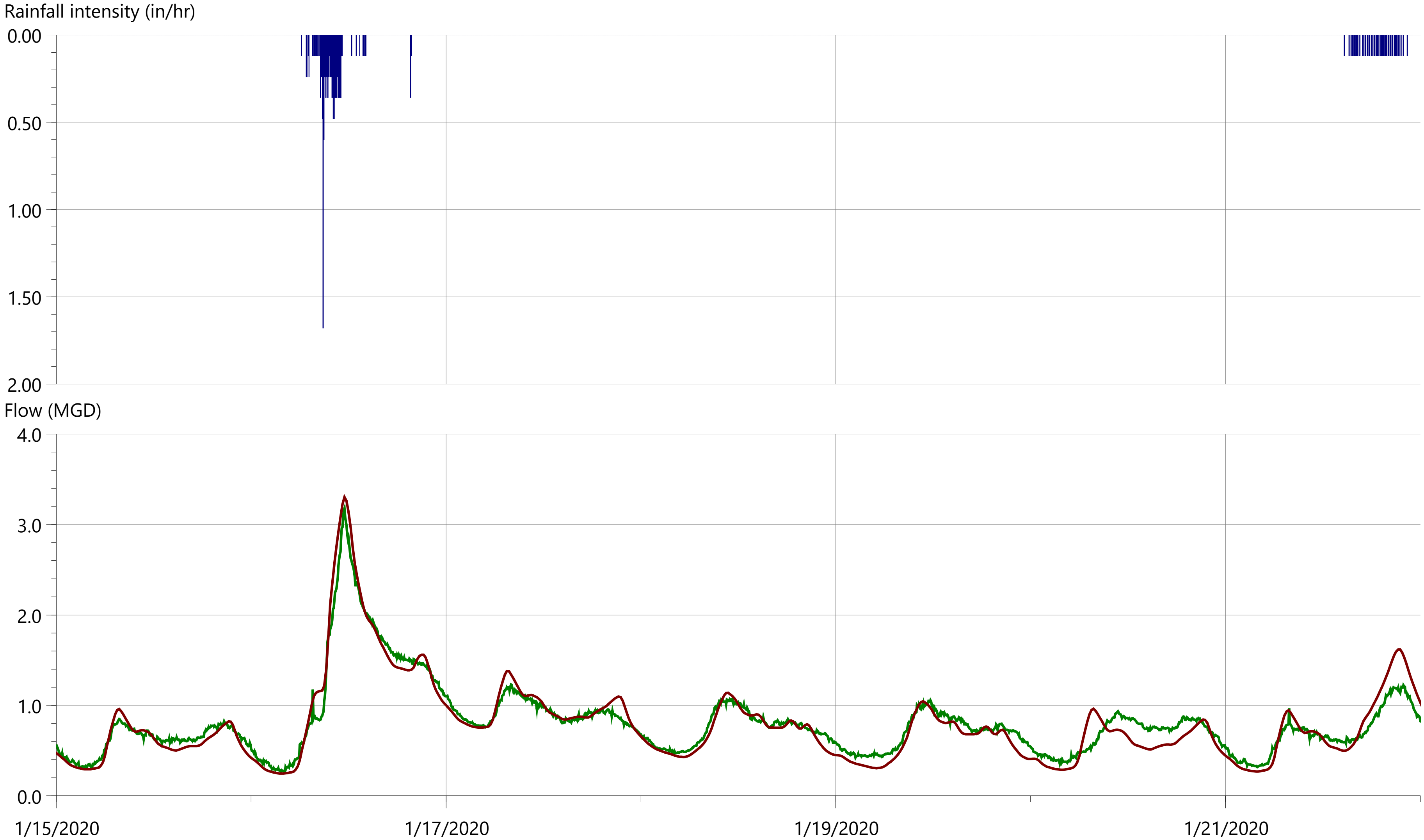
Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 1 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 3, Model Location (Pred.) D/S LLD36.1, Rainfall Profile: 2



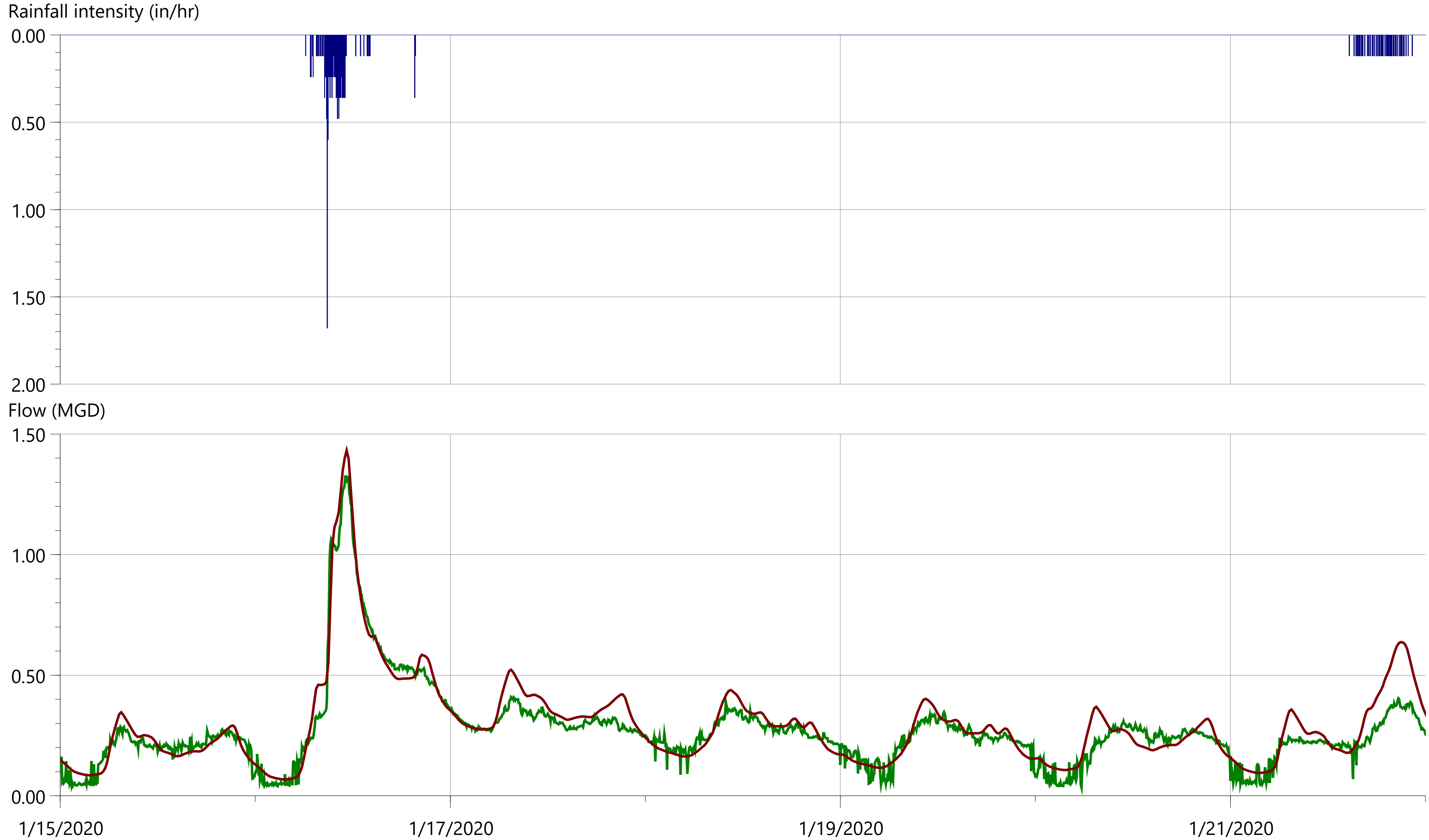
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.019	0.932	1.125
...t 2 (RGs 1,2,3) 5-min				0.044	0.937	1.094

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 2 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 4, Model Location (Pred.) D/S LL6.1, Rainfall Profile: 1



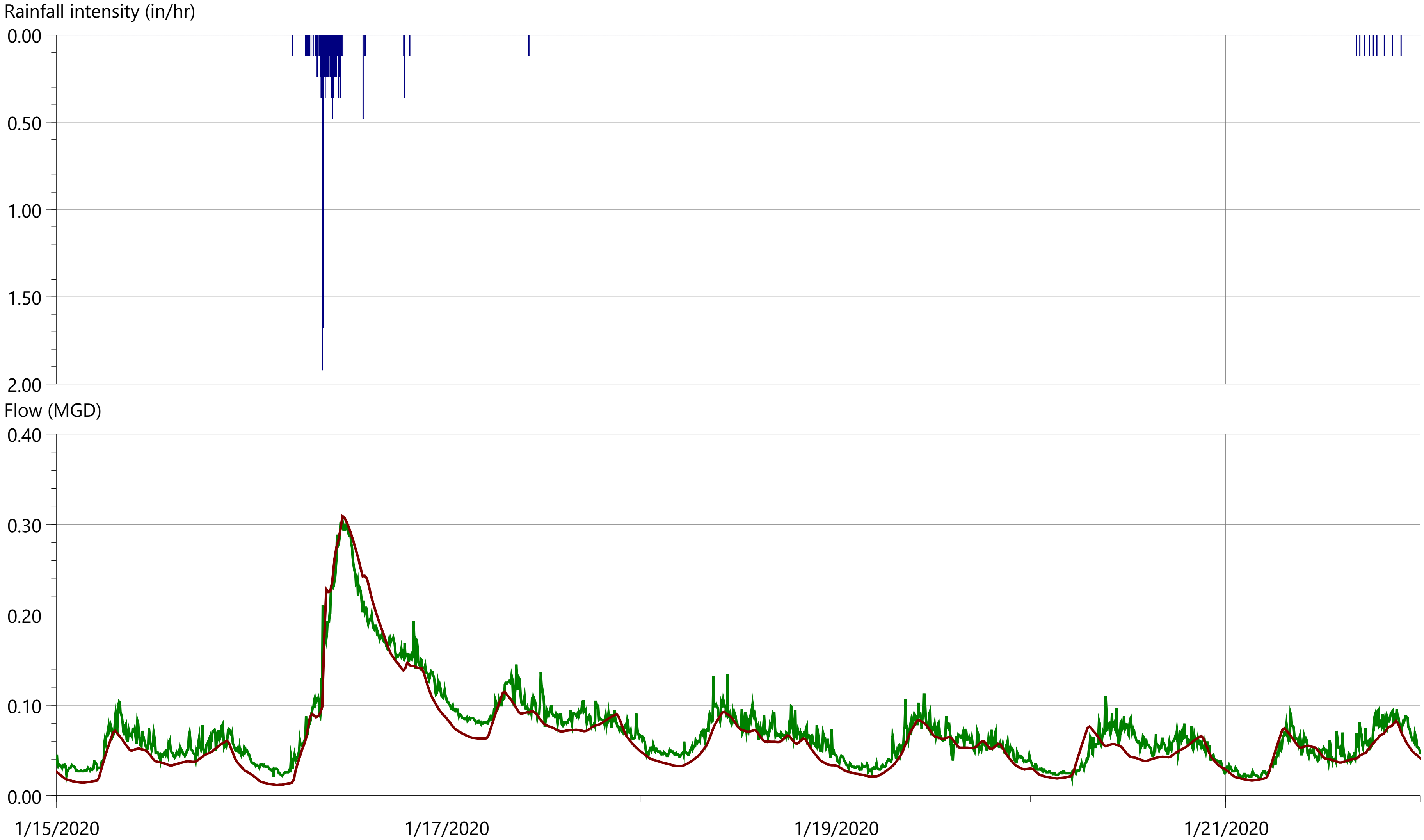
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.720	1.680	0.010			
Observed				0.267	3.175	5.637
...t 2 (RGs 1,2,3) 5-min				0.245	3.303	5.514

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 3 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 5A, Model Location (Pred.) D/S LLS11.1, Rainfall Profile: 1



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.720	1.680	0.010			
Observed				0.034	1.329	1.887
...t 2 (RGs 1,2,3) 5-min				0.067	1.432	2.060

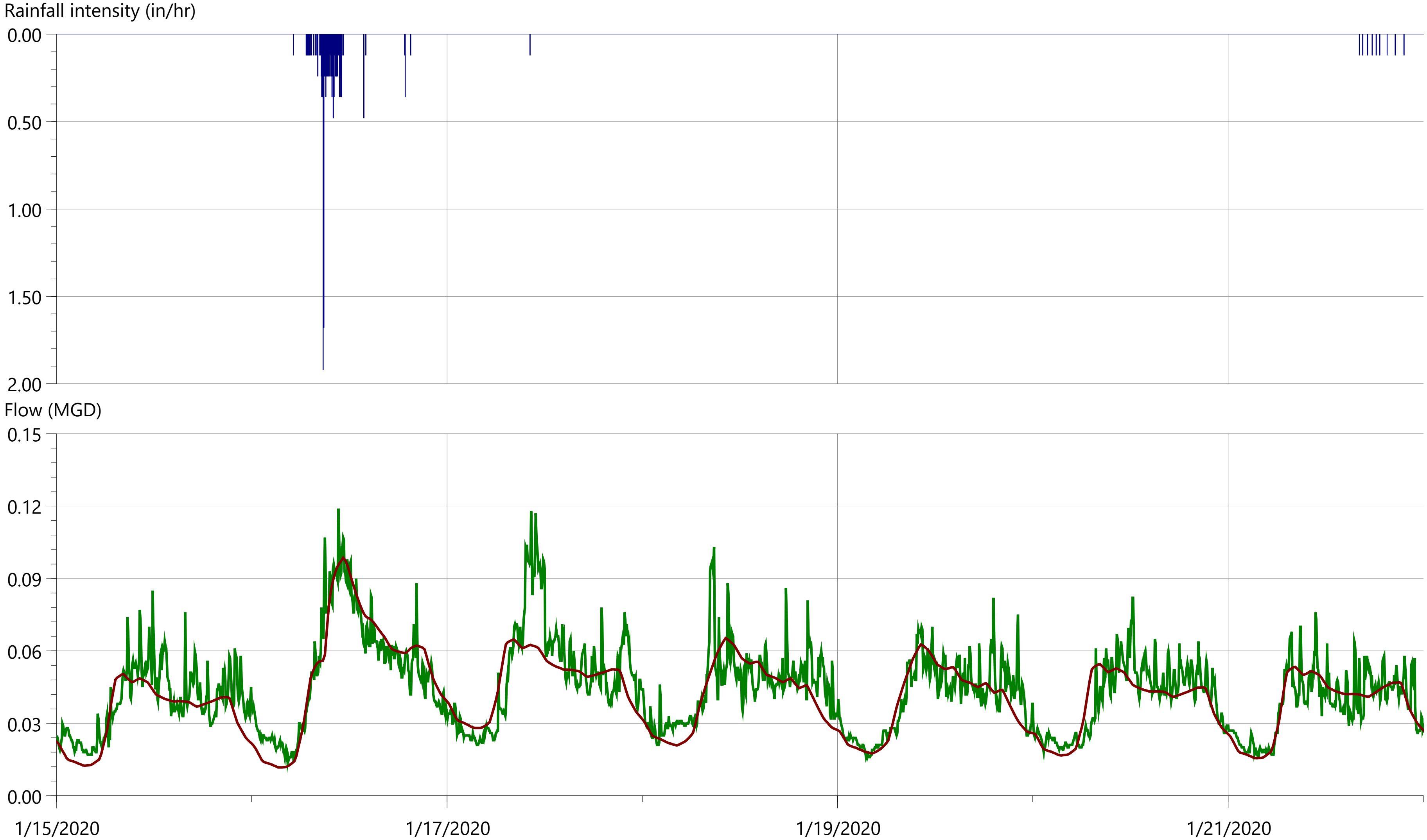
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 6, Model Location (Pred.) D/S PT10.1, Rainfall Profile: 2



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.019	0.304	0.505
...t 2 (RGs 1,2,3) 5-min				0.012	0.309	0.443

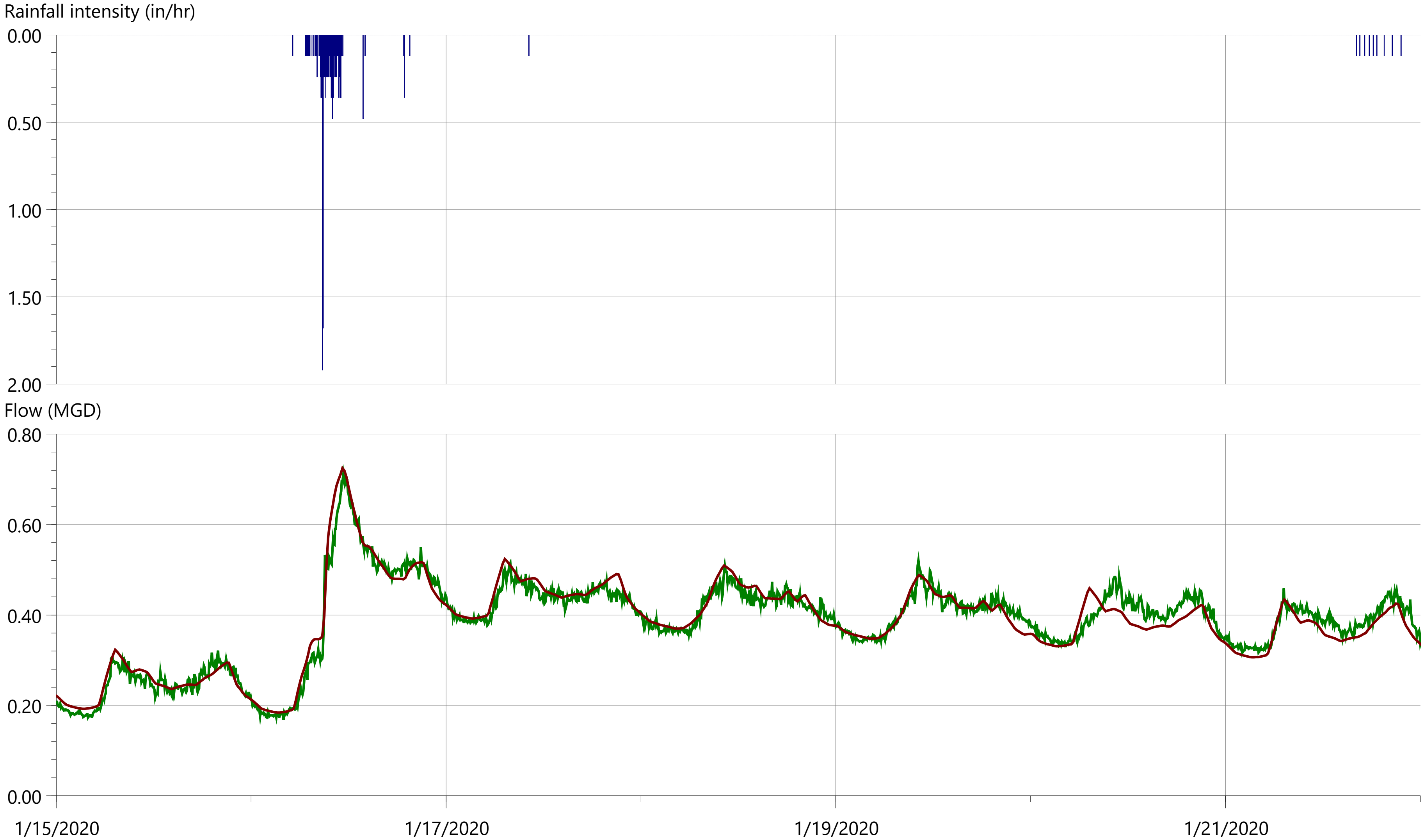
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 7, Model Location (Pred.) D/S LLZ2.1, Rainfall Profile: 2



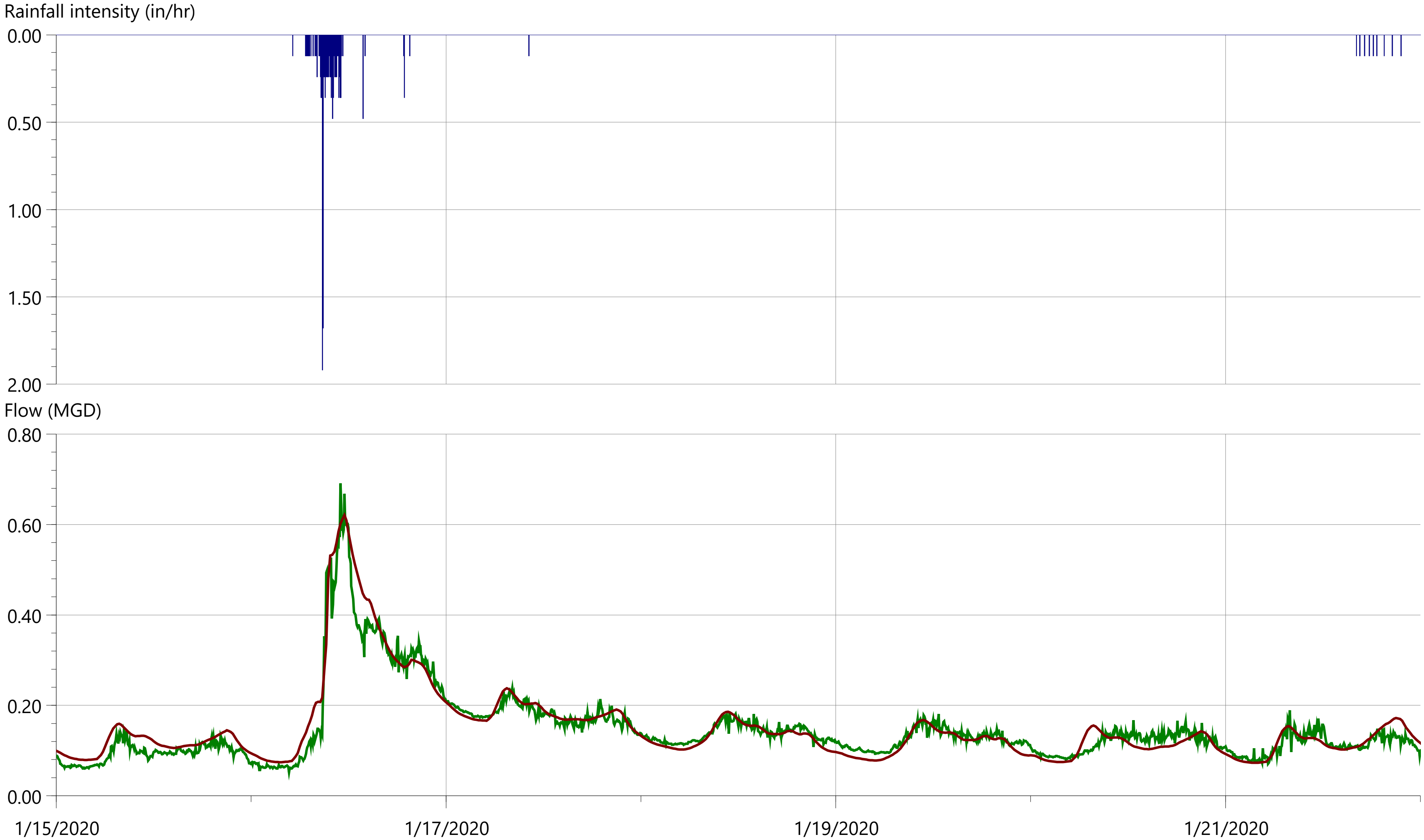
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.014	0.119	0.308
...t 2 (RGs 1,2,3) 5-min				0.012	0.099	0.289

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 6 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 8A, Model Location (Pred.) D/S V27.1, Rainfall Profile: 2



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.168	0.708	2.697
...t 2 (RGs 1,2,3) 5-min				0.184	0.725	2.692

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 7 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 9, Model Location (Pred.) D/S SPQ6A1.1, Rainfall Profile: 2



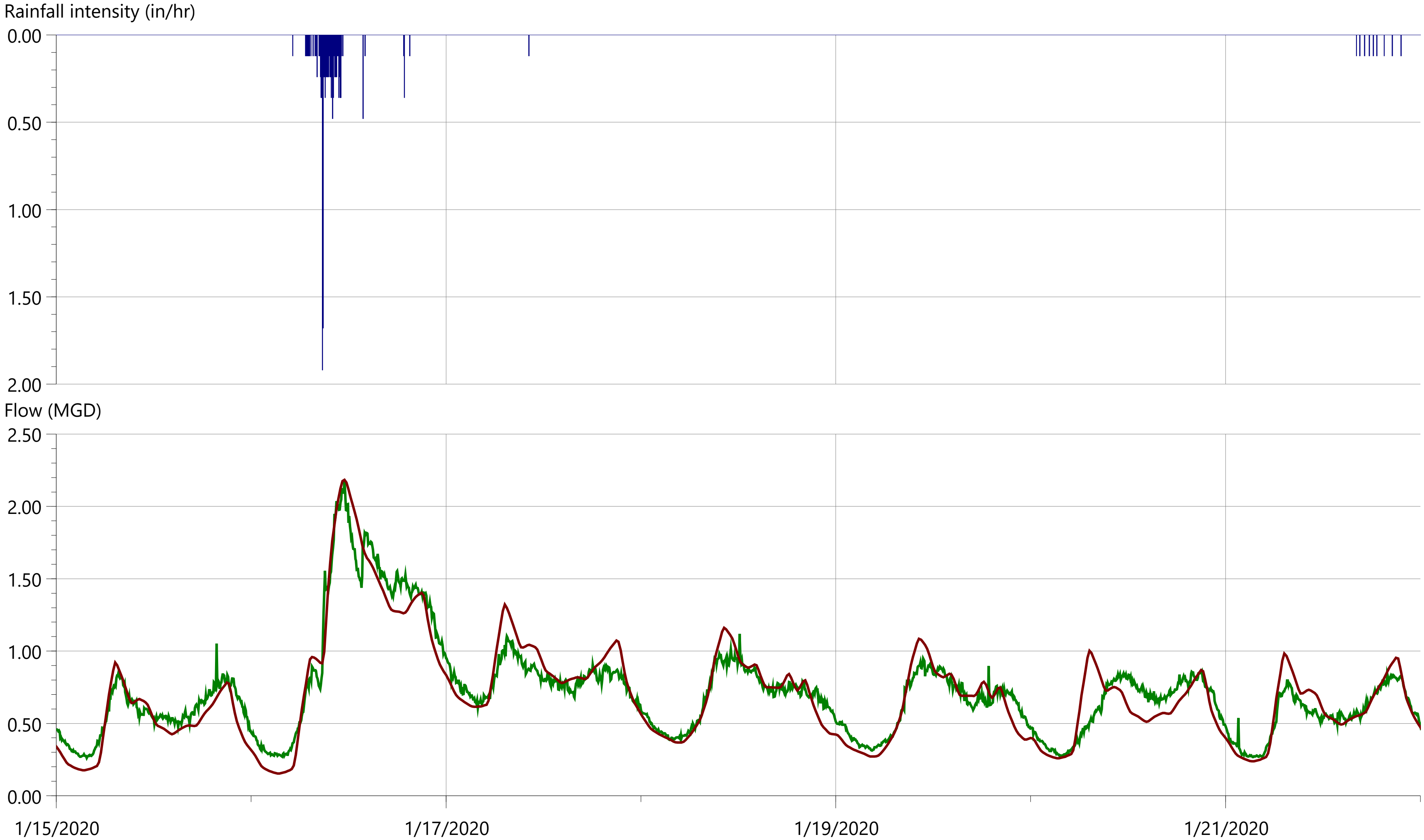
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.052	0.691	1.029
...t 2 (RGs 1,2,3) 5-min				0.073	0.621	1.053

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 8 of 19

Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)

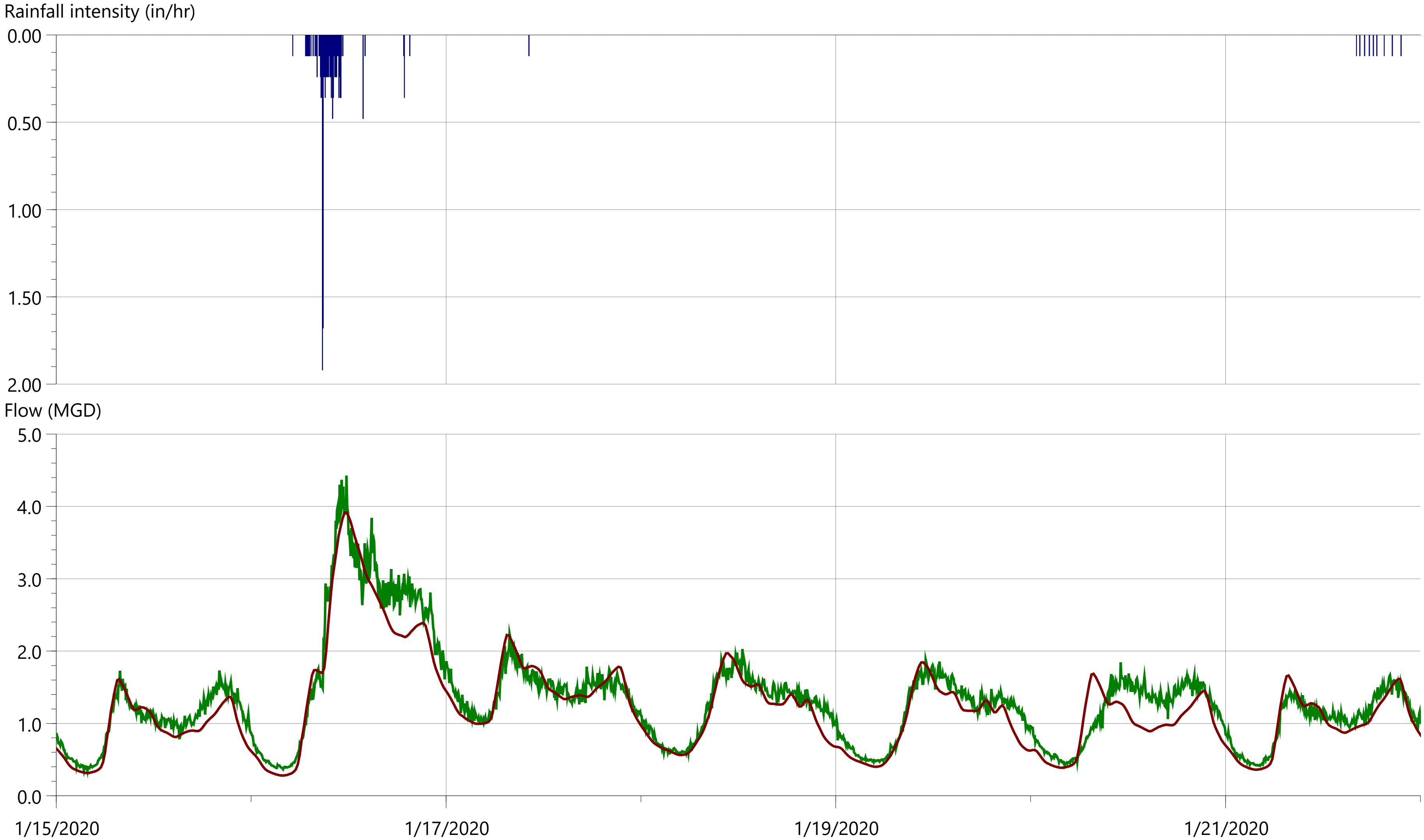
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 10, Model Location (Pred.) D/S F37.1, Rainfall Profile: 3



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.261	2.184	4.994
...t 2 (RGs 1,2,3) 5-min				0.154	2.184	4.914

Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 13+15, Model Location (Pred.) D/S FW54.1, Rainfall Profile: 2



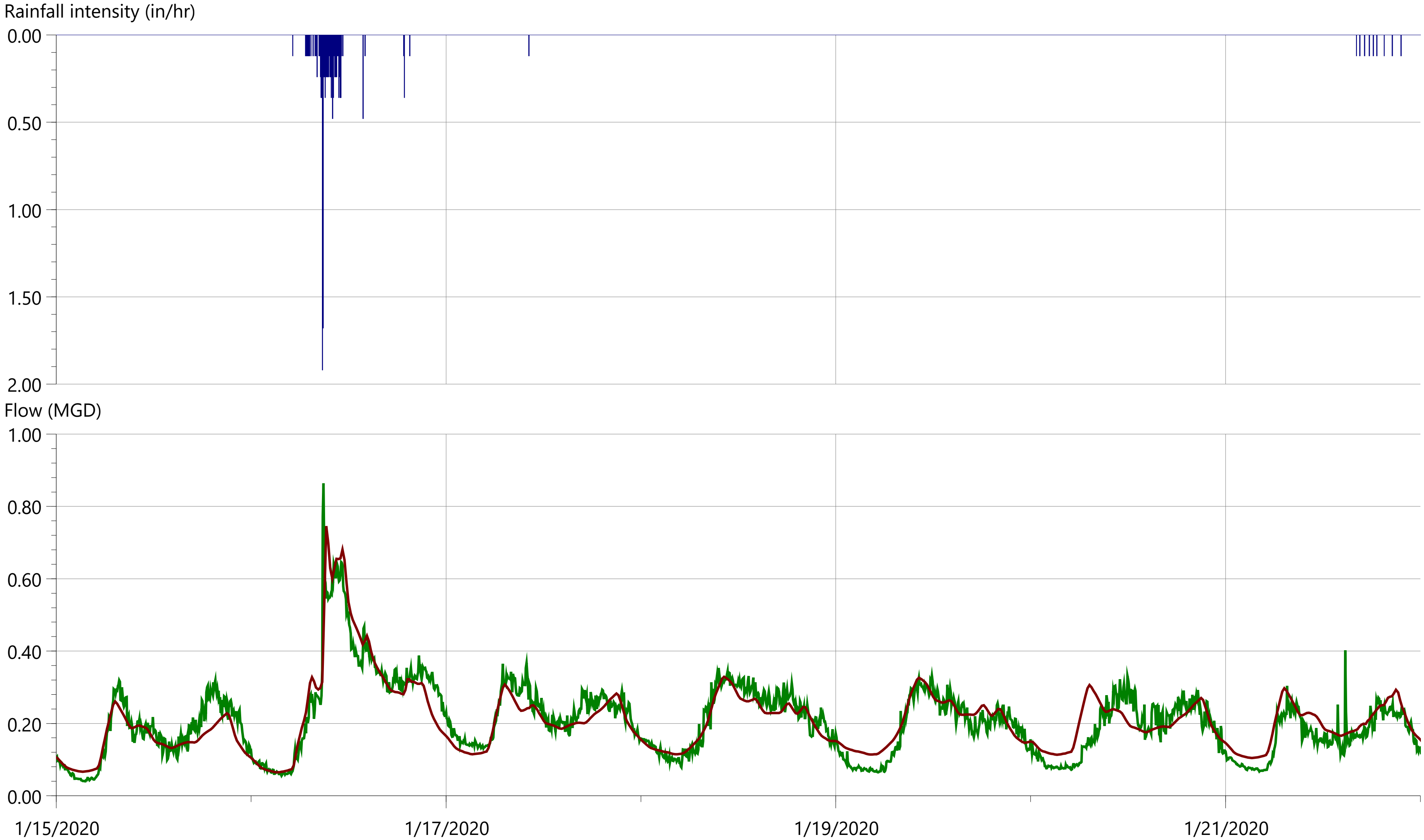
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.344	4.425	9.192
...t 2 (RGs 1,2,3) 5-min				0.279	3.919	8.428

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 10 of 19

Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)

Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 14, Model Location (Pred.) D/S SP34.1, Rainfall Profile: 2

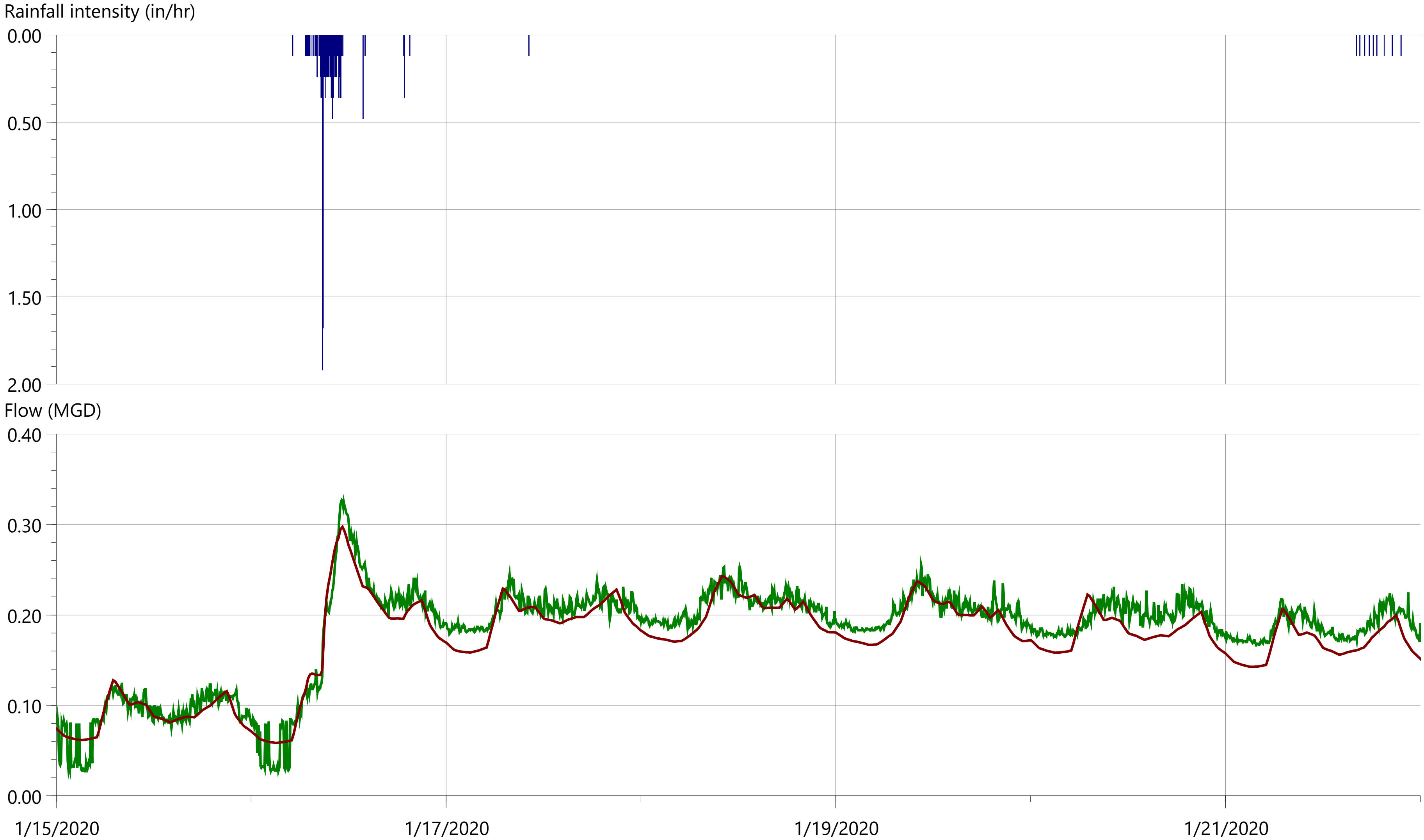


	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.040	0.864	1.440
...t 2 (RGs 1,2,3) 5-min				0.065	0.746	1.449

Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 16, Model Location (Pred.) D/S LLM14.1, Rainfall Profile: 2

	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.029	0.250	0.545
...t 2 (RGs 1,2,3) 5-min				0.022	0.238	0.486

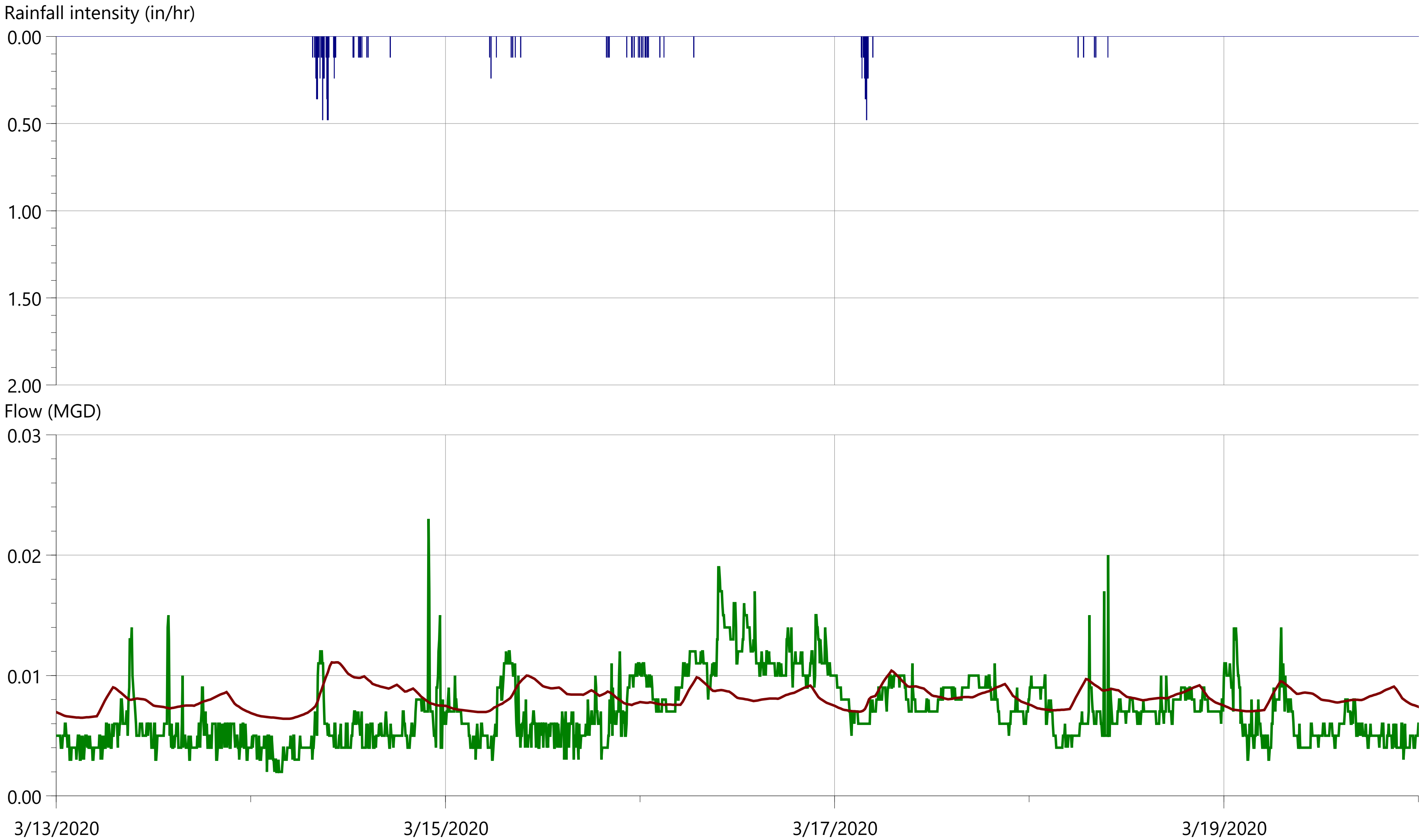
Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 12 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 17, Model Location (Pred.) D/S V13.1, Rainfall Profile: 2



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.027	0.327	1.270
...t 2 (RGs 1,2,3) 5-min				0.058	0.297	1.198

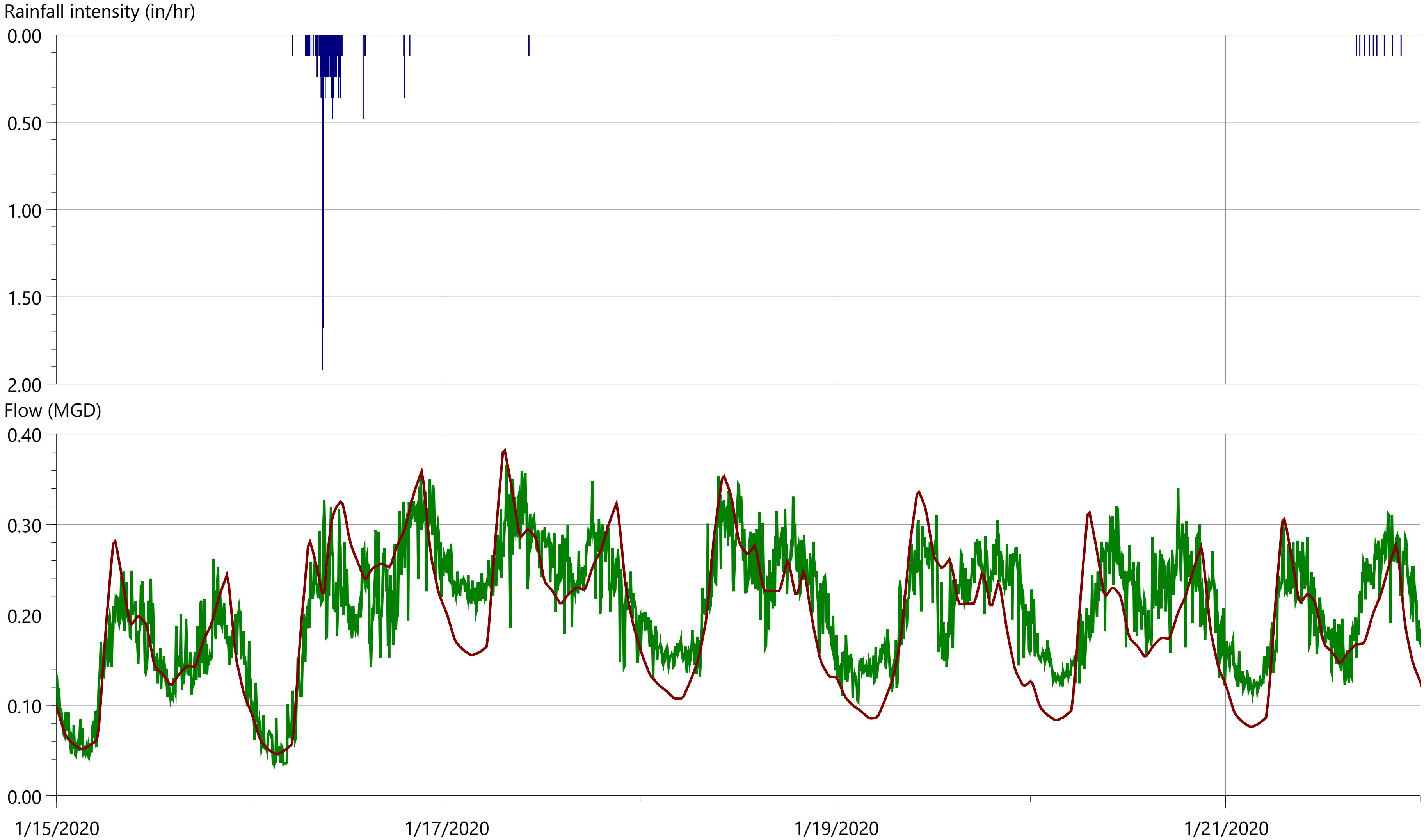
Observed / Predicted Report Produced by shubli (1/8/2021 2:53:48 PM) Page 13 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 18, Model Location (Pred.) D/S VF8.1, Rainfall Profile: 2



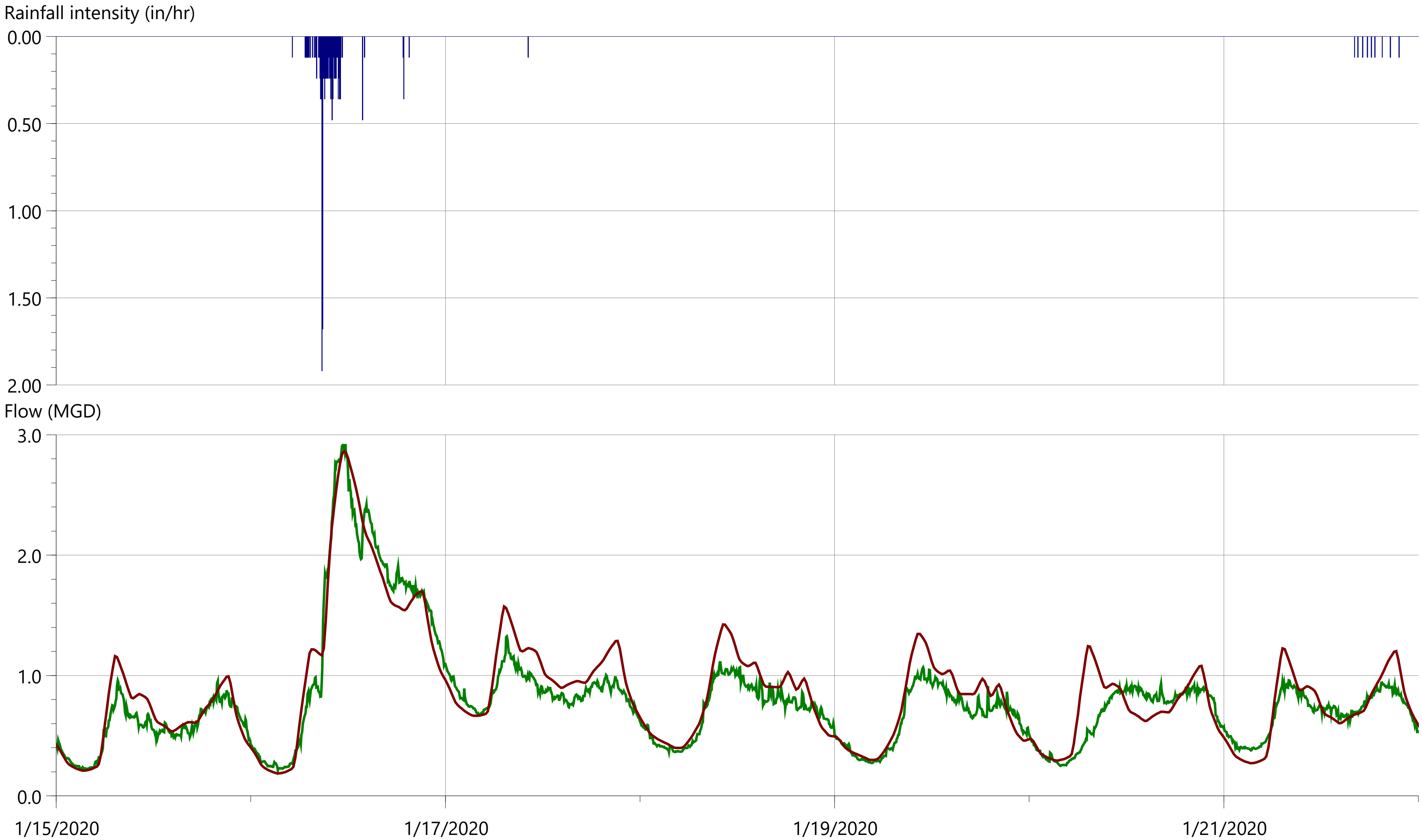
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.040	0.480	0.006			
Observed				0.002	0.023	0.049
...t 2 (RGs 1,2,3) 5-min				0.006	0.011	0.057

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 14 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 19, Model Location (Pred.) D/S R19.1, Rainfall Profile: 2



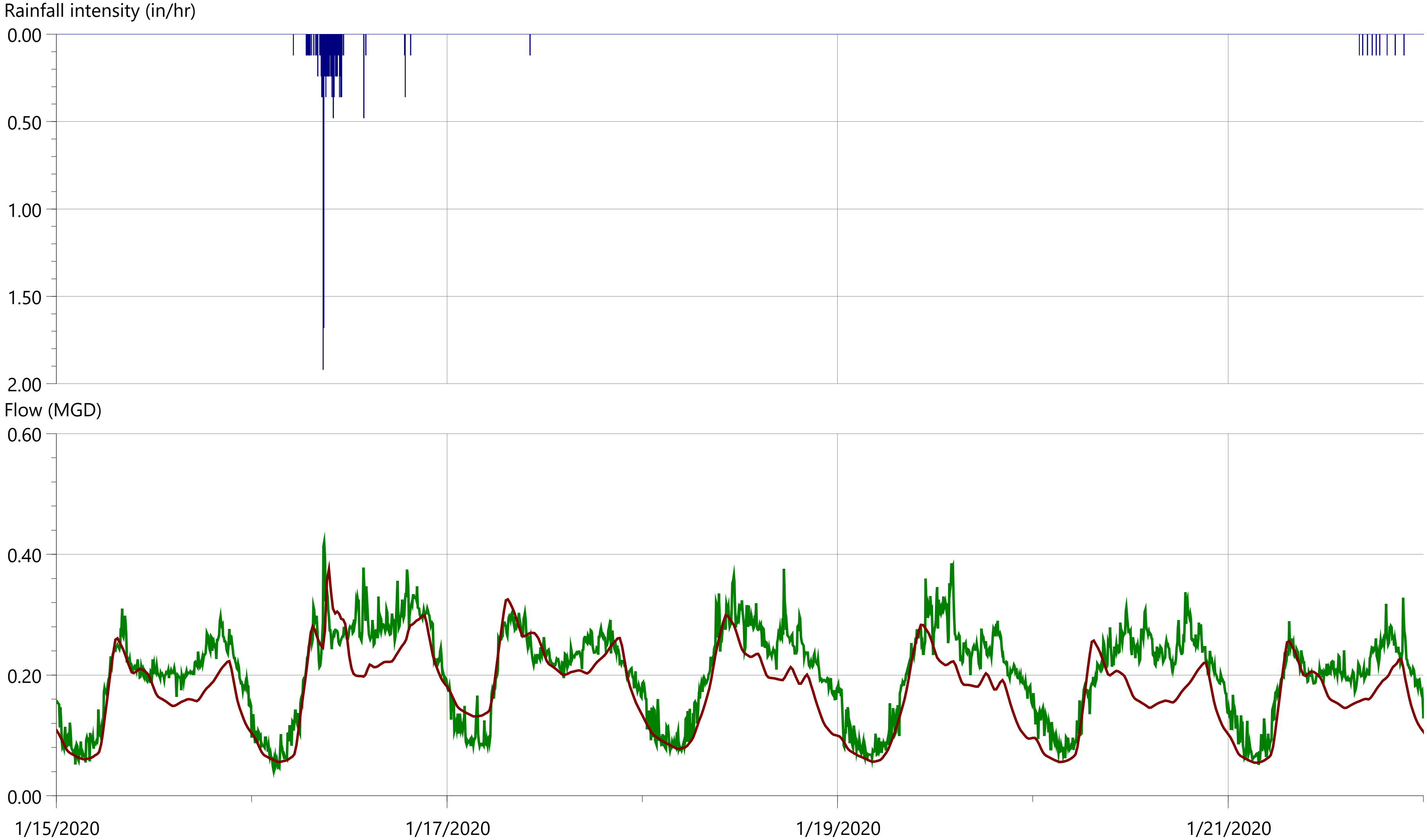
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.034	0.366	1.444
...t 2 (RGs 1,2,3) 5-min				0.046	0.382	1.362

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 15 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 20, Model Location (Pred.) D/S F44A.1, Rainfall Profile: 3



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.211	2.923	5.571
...t 2 (RGs 1,2,3) 5-min				0.186	2.865	5.995

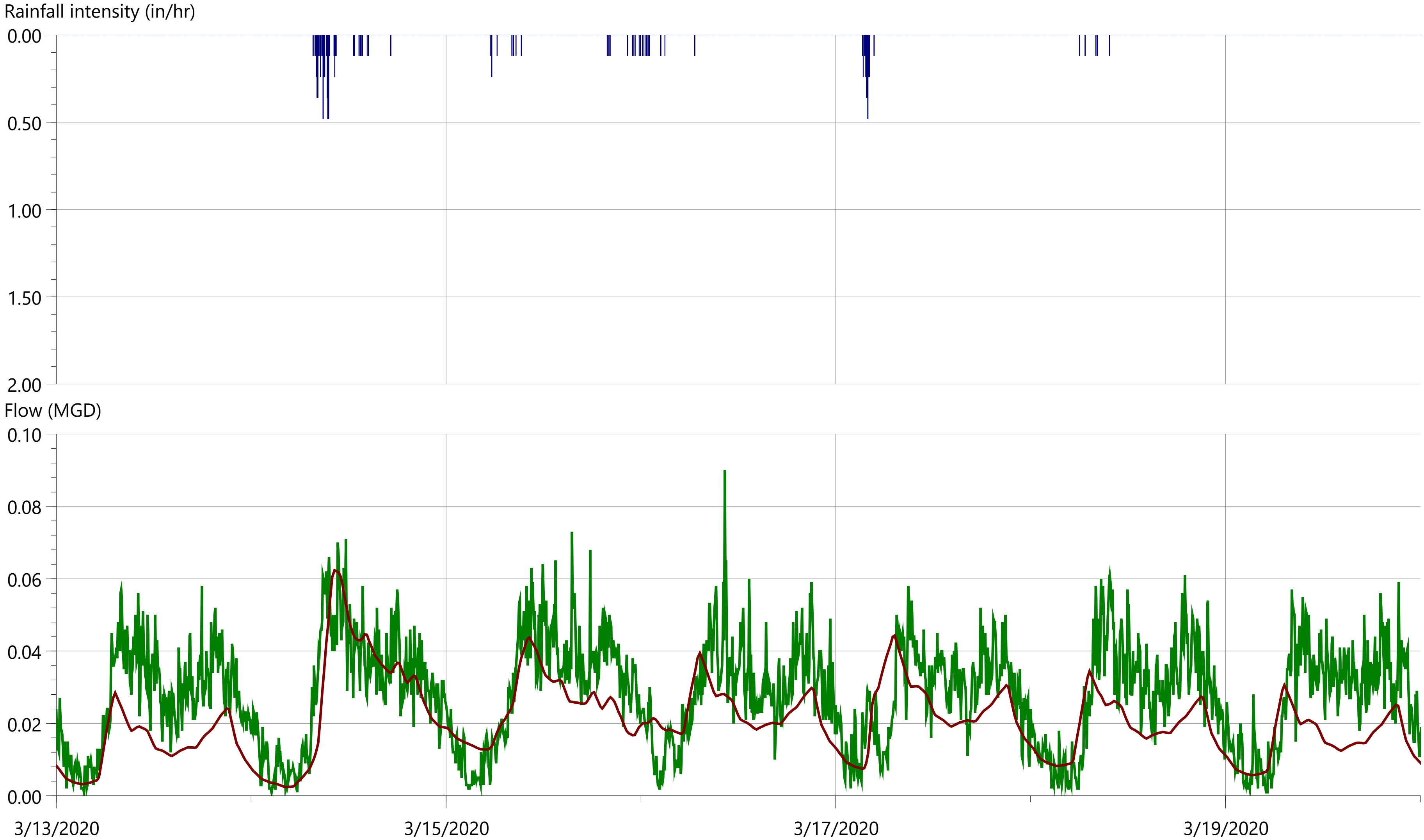
Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 16 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 21, Model Location (Pred.) D/S FW37.1, Rainfall Profile: 3



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.320	1.920	0.008			
Observed				0.044	0.420	1.429
...t 2 (RGs 1,2,3) 5-min				0.055	0.375	1.199

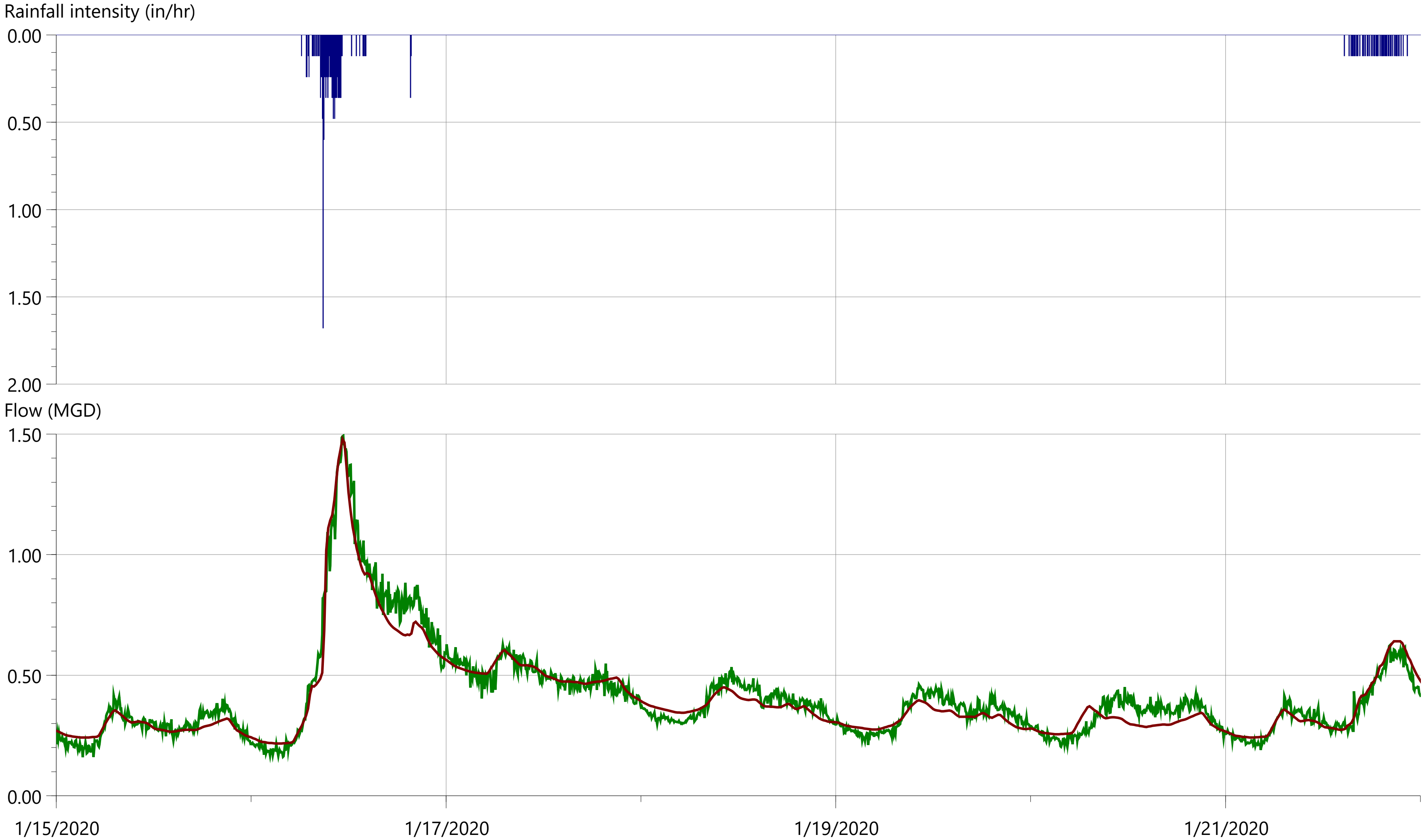
Observed / Predicted Report Produced by shubli (1/8/2021 2:53:48 PM) Page 17 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)

Flow Survey Location (Obs.) 22A, Model Location (Pred.) D/S RK23.1, Rainfall Profile: 2



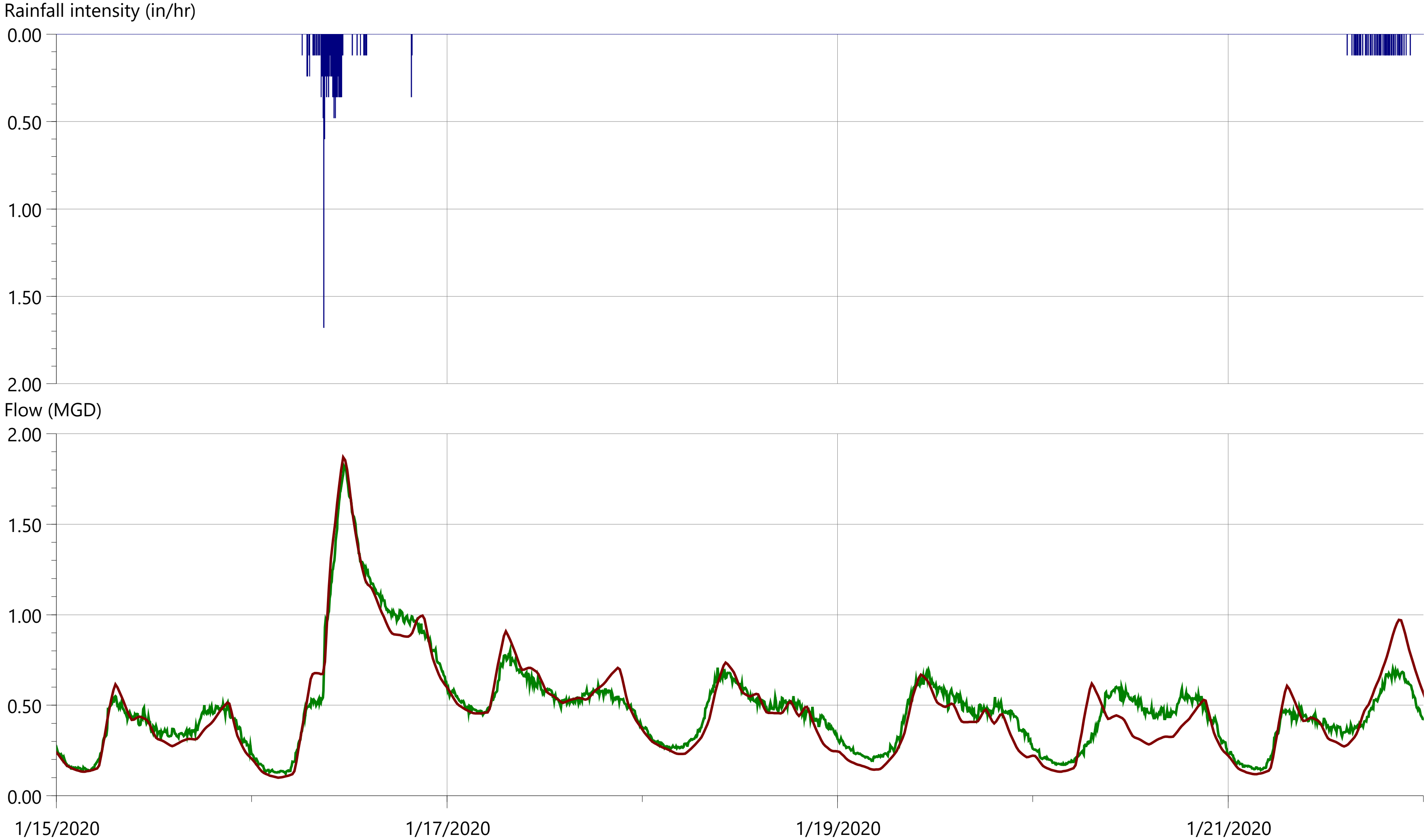
	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.040	0.480	0.006			
Observed				0.001	0.090	0.199
...t 2 (RGs 1,2,3) 5-min				0.002	0.062	0.146

Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 18 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 23, Model Location (Pred.) D/S LLD24a.1, Rainfall Profile: 1



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.720	1.680	0.010			
Observed				0.160	1.493	2.873
...t 2 (RGs 1,2,3) 5-min				0.216	1.480	2.792

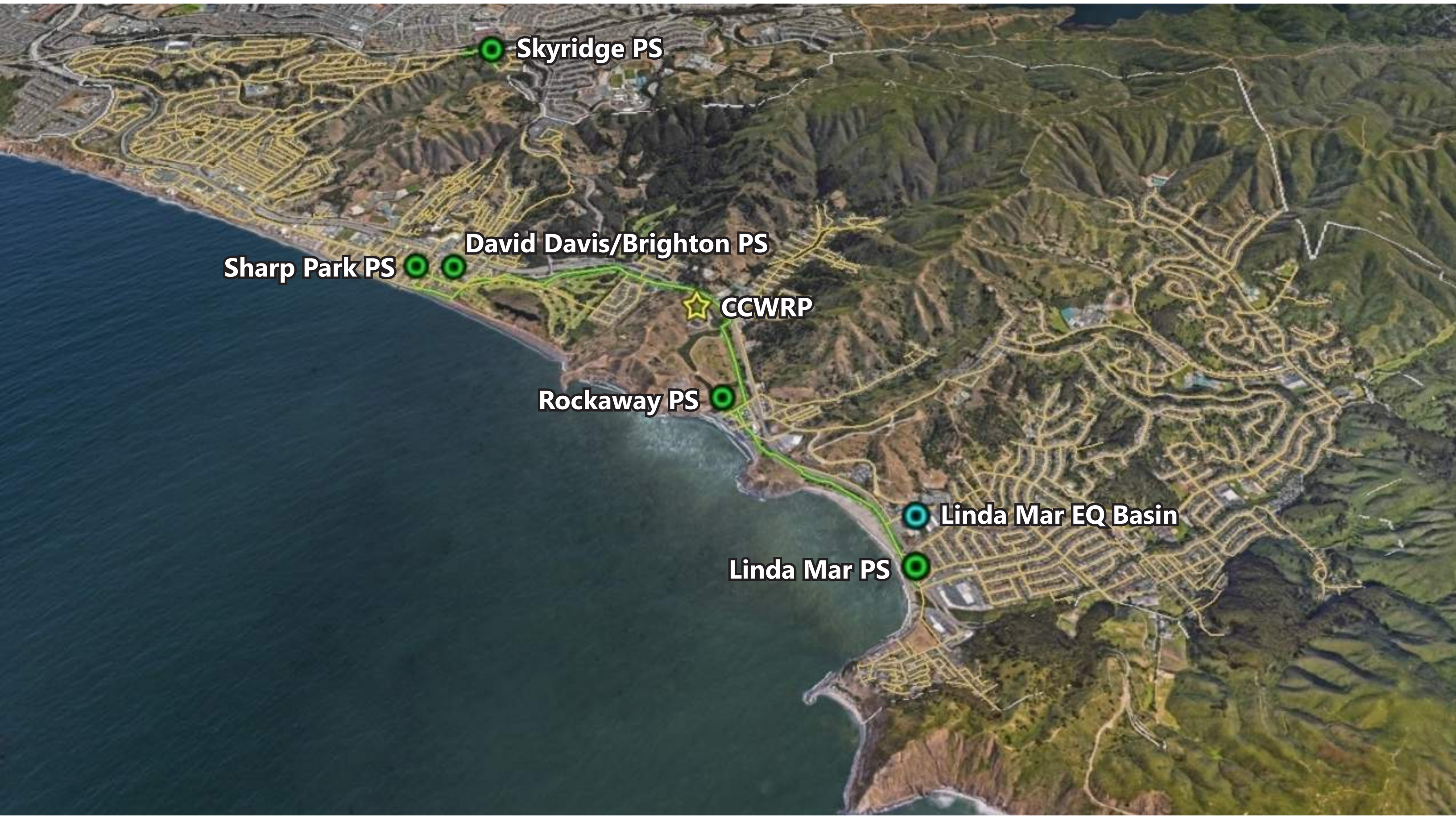
Observed / Predicted Report Produced by shubli (1/8/2021 2:44:12 PM) Page 19 of 19
Flow survey: >2020 Master Plan>F. Flow Survey Data _Calibration Graphs>2020 Flow Meter Data (6/9/2020 10:58:10 AM)
Sim: >2020 Master Plan>R. Runs>WWF Calibration>Wet Weather Flow long run 1/7/20-3/29/20>Calibration Rainfall event 2 (RGs 1,2,3) 5-min (1/5/2021 7:08:26 PM)
Flow Survey Location (Obs.) 24, Model Location (Pred.) D/S PP27.1, Rainfall Profile: 1



	Rainfall			Flow		
	Depth (in)	Peak (in/hr)	Average (in/hr)	Min (MGD)	Max (MGD)	Volume (US Mgal)
Rain	1.720	1.680	0.010			
Observed				0.121	1.821	3.390
...t 2 (RGs 1,2,3) 5-min				0.100	1.870	3.269

APPENDIX D

Capacity Improvement Project Details



Capacity Improvement Project Summary Table

Project ID	Project Name	Project Location	Estimated Construction Cost	Estimated Project Cost[1]
1	**Crespi Drive**	Crespi Dr. from Peralta Rd. to Barcelona Dr.	**$792,000**	**$1,069,000**
2	**Linda Mar Boulevard**	Linda Mar Blvd. between De Solo Dr. and Peralta Rd.	**$335,000**	**$453,000**
3	**Fremont Avenue**	Fremont Ave. between Nelson Ave. and Monterey Rd.	**$154,000**	**$207,000**
4	**Catalina Avenue**	Catalina Ave. and Beachview Ave. from Brookhaven Ct. to Crestmoor Cir.	**$547,000**	**$739,000**
			Total Cost:	**$ 2,468,000**

1. Includes construction costs (pipe installation, lateral reconnection, bypass pumping, traffic control, mobilization/demobilization, and contingencies) plus engineering, administration, and legal fees (estimated as 35 percent of construction costs).

Project: 1 - Crespi Drive

PROJECT DESCRIPTION	
Project ID	1 - Crespi Drive
Project Location	Crespi Dr. from Peralta Rd. to Barcelona Dr.
Description	Upsize 474 linear feet of 6-inch to 8-inch pipe and upsize 1,054 linear feet of 8-inch to 12-inch pipe
Estimated Capital Improvement Cost	$1,069,000
Comments	(i) Pipes are listed in order from upstream to downstream.
Assumptions	(i) New diameter based on pipe bursting. Proposed pipe sizes are based on standard sewer pipe diameters. If pipe bursting with HDPE, a pipe with an equivalent inside diameter would be used. (ii) Cost estimates are based on CCI of 13168.76 from the December 2020 ENR.
Alternatives	1. Complete upstream R&R project to reduce I/I and reassess capacity need with additional flow monitoring. 2. Open cut remove and replace or parallel sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)[1]	New Diameter (inches)[1]	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	(E) Pipe Capacity (mgd)	Installation Technology	Unit Cost ($/LF)		Total Cost ($)
LLD14	LLD15	6	8	308	4.7%	4.7	0.78	Pipe Burst	$200	$	61,520
LLD15	LLD16	6	8	167	4.9%	4.6	0.79	Pipe Burst	$200	$	33,320
LLD17	LLD18	8	12	357	4.2%	8.5	1.59	Pipe Burst	$260	$	92,716
LLD18	LLD19	8	12	122	4.0%	8.0	1.56	Pipe Burst	$260	$	31,590
LLD19	LLD20	8	12	161	2.8%	5.9	1.30	Pipe Burst	$260	$	41,730
LLD20	LLD21	8	12	225	4.1%	3.8	1.57	Pipe Burst	$260	$	58,500
LLD21	LLD22	8	12	190	3.4%	3.8	1.44	Pipe Burst	$260	$	49,400

Total Baseline Pipe Construction Cost	$	368,776
Lateral Connection, Approx. 50	$	125,000
Insertion Trenches for Pipebursting, Approx. 5	$	12,500
Baseline Construction Cost:	**$**	**506,276**
Bypass Pumping (10% of baseline construction cost)	$	36,878
Traffic Control (10% of baseline construction cost)	$	36,878
Subtotal:	**$**	**580,031**
Mobilization/Demobilization (5% of subtotal)	$	29,002
Estimated Construction Cost Subtotal:	**$**	**609,033**
Contingencies (30% of construction subtotal)	$	182,710
Estimated Construction Cost:	**$**	**791,743**
Engineering, Administration, Legal (35% of construction cost)	$	277,110
Estimated Capital Improvement Cost:	**$**	**1,069,000**

(Note: Cost estimates are based on December 2020 ENR CCI of 13168.76)

Project 1 Crespi Drive

Wastewater Collection System Master Plan

Legend

Capacity Improvement Project

Manholes

Sewers

(8-in) (Existing Diameter)
10-in Required Diameter

Modeled Sewers

Force Main

Unmodeled Sewers

0 75 150 300 Feet

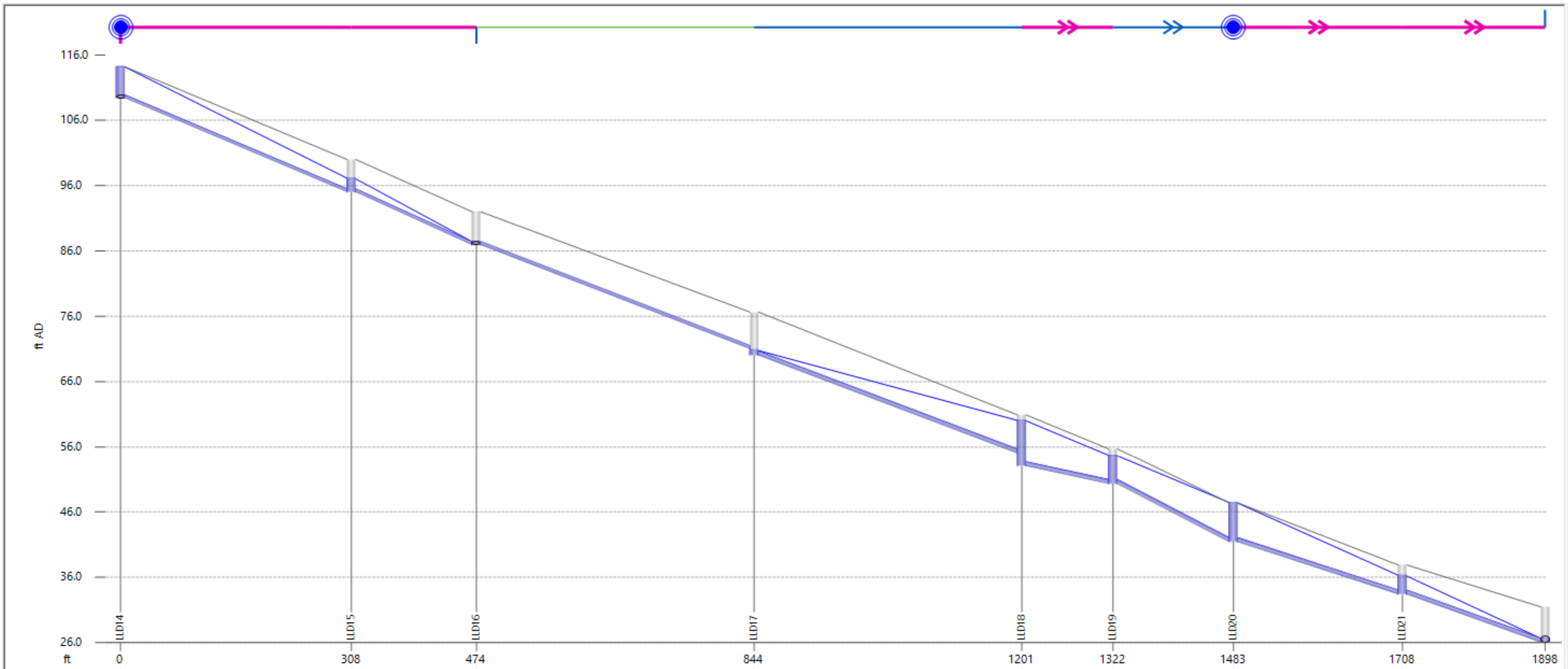
N

City of Pacifica

Woodard & Curran

Project #: 0011180.01
Map Created: August 2021

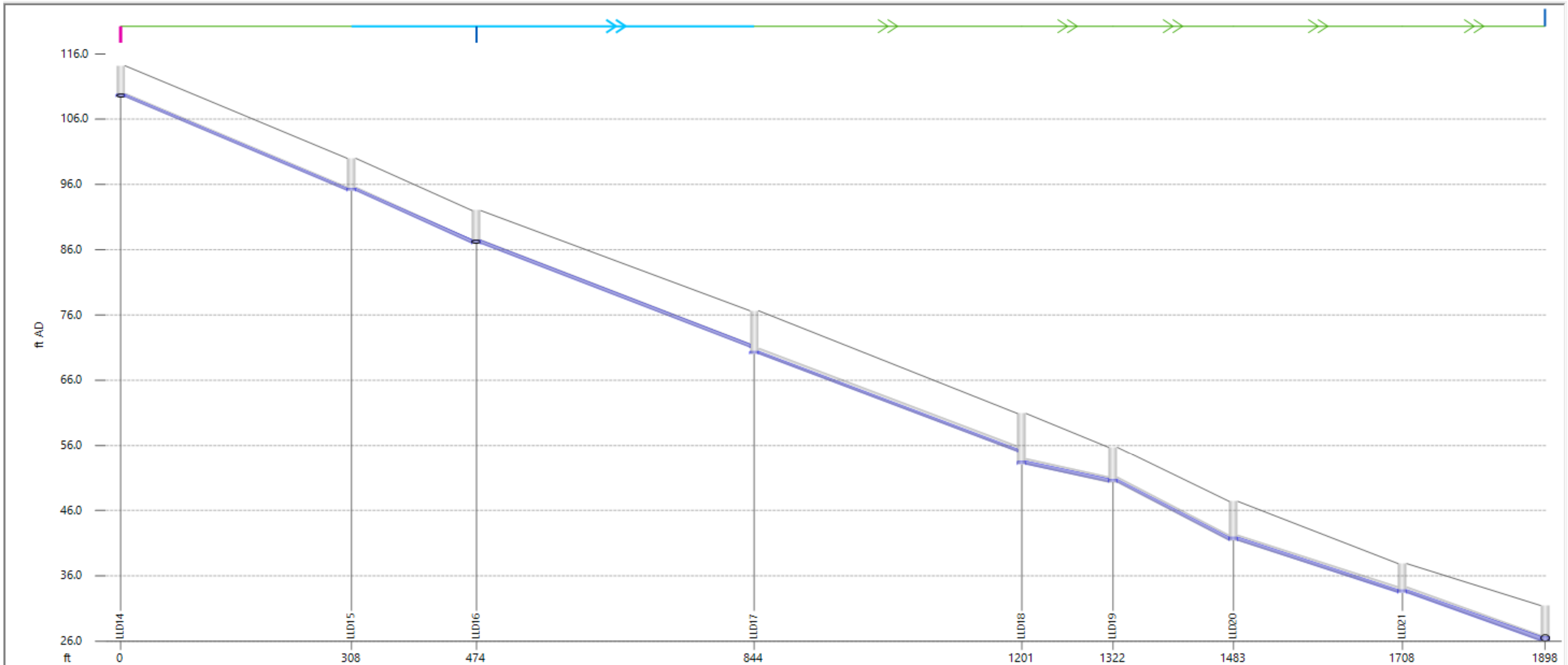
Project 1 – Crespi Drive (Deficiency)



Link	LLD14.1	LLD15.1	LLD16.1	LLD17.1	LLD18.1	LLD19.1	LLD20.1	LLD21.1
length (ft)	307.6	166.6	369.9	356.6	121.5	160.5	225.0	190.0
width (in)	6.0	6.0	8.0	8.0	8.0	8.0	8.0	8.0
us inv (ft AD)	109.400	95.000	86.900	70.000	53.000	50.300	41.390	33.360
ds inv (ft AD)	95.000	86.900	71.000	55.000	50.300	41.390	33.360	26.000
grad (%)	4.681	4.863	4.298	4.207	2.223	5.550	3.569	3.874
US flow (MGD)	0.8333	0.8431	1.2931	1.3206	1.6073	1.6134	1.7032	1.7183
r.pfc (MGD)	0.78	0.80	1.62	1.60	1.16	1.84	1.48	1.54
surc	2.00	2.00	0.70	1.00	2.00	1.00	2.00	2.00

Node	LLD14	LLD15	LLD16	LLD17	LLD18	LLD19	LLD20	LLD21	LLD22
ground (ft AD)	114.200	100.000	92.000	76.650	60.900	55.700	47.390	37.880	31.460
flood dep (ft)	-0.000	-2.877	-4.586	-5.779	-0.838	-1.012	0.000	-1.592	-4.820
level (ft AD)	114.200	97.123	87.414	70.871	60.062	54.688	47.390	36.288	26.640

Project 1 – Crespi Drive (Solution)



Link	LLD14.1	LLD15.1	LLD16.1	LLD17.1	LLD18.1	LLD19.1	LLD20.1	LLD21.1
length (ft)	307.6	166.6	369.9	356.6	121.5	160.5	225.0	190.0
width (in)	8.0	8.0	8.0	12.0	12.0	12.0	12.0	12.0
us inv (ft AD)	109.400	95.000	86.900	70.000	53.000	50.300	41.390	33.360
ds inv (ft AD)	95.000	86.900	71.000	55.000	50.300	41.390	33.360	26.000
grad (%)	4.681	4.863	4.298	4.207	2.223	5.550	3.569	3.874
US flow (MGD)	0.9776	0.9949	1.4446	1.4737	1.7602	1.7667	1.9923	2.0101
r.pfc (MGD)	1.69	1.72	1.62	4.72	3.43	5.43	4.35	4.53
surc	0.59	0.87	0.76	0.40	0.52	0.49	0.49	0.72

Node	LLD14	LLD15	LLD16	LLD17	LLD18	LLD19	LLD20	LLD21	LLD22
ground (ft AD)	114.200	100.000	92.000	76.650	60.900	55.700	47.390	37.880	31.460
flood dep (ft)	-4.410	-4.610	-4.525	-6.250	-7.380	-4.989	-5.508	-4.036	-4.740
level (ft AD)	109.790	95.390	87.475	70.400	53.520	50.711	41.882	33.844	26.720

Project: 2 - Linda Mar Boulevard

PROJECT DESCRIPTION

Project ID .... 2 - Linda Mar Boulevard

Project Location .... Linda Mar Blvd. between De Solo Dr. and Peralta Rd.

Description .... Upsize 307 linear feet of 20-inch to 27-inch pipe
Estimated Capital Improvement Cost $453,000
Comments .... (i) Pipes are listed in order from upstream to downstream.

Assumptions .... (i) New diameter based on open-cut remove and replace.
(ii) Cost estimates are based on CCI of 13168.76 from the December 2020 ENR.

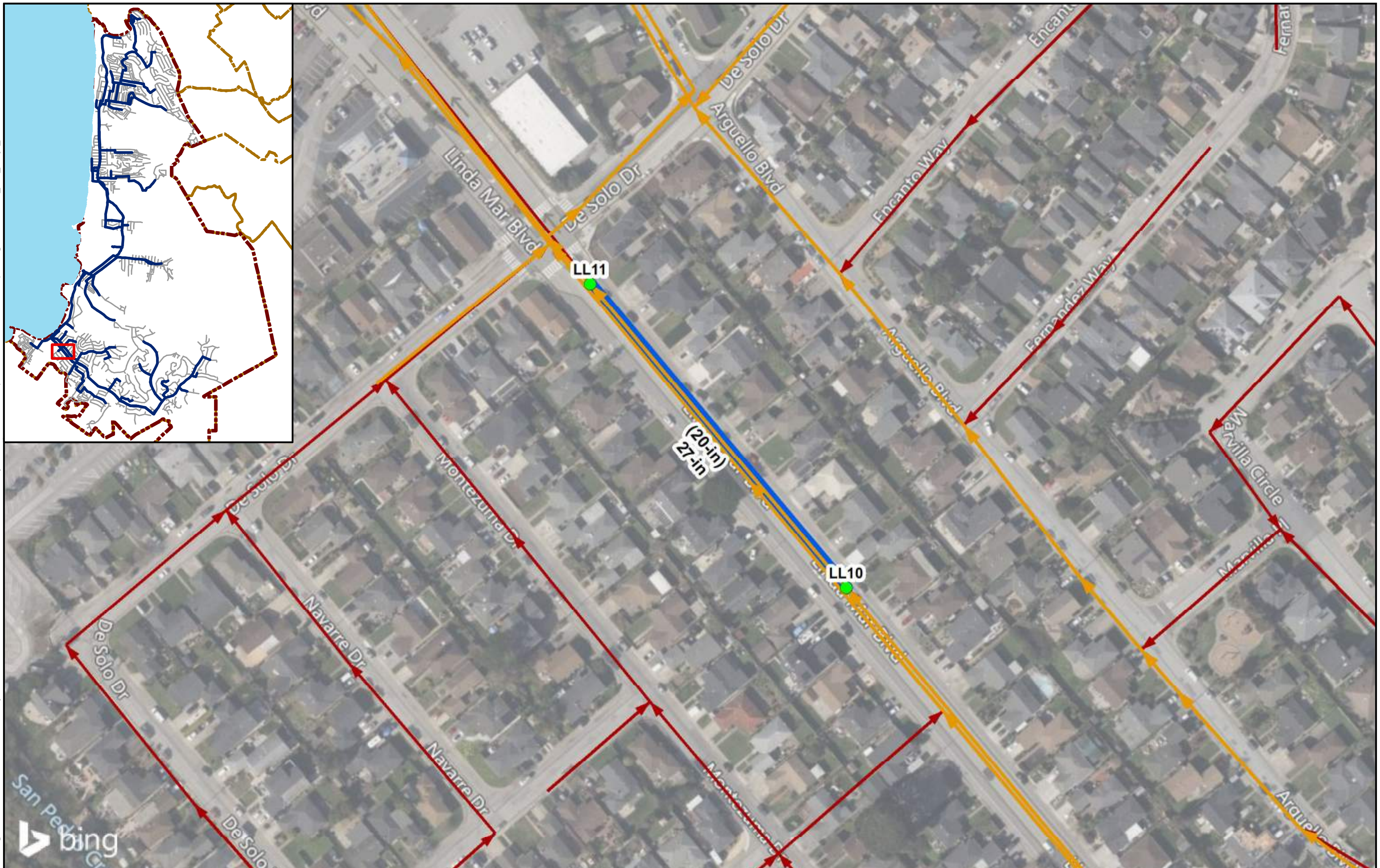
Alternatives .... 1. Complete upstream R&R project to reduce I/I and reassess capacity need with additional flow monitoring.
2. Parallel sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)[1]	New Diameter (inches)[1]	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	(E) Pipe Capacity (mgd)	Installation Technology	Unit Cost ($/LF)	Total Cost ($)
LL10	LL11	20	27	307	0.4%	5.5	5.97	Open Cut	$575	$ 176,546

Total Baseline Pipe Construction Cost	$	176,546
Lateral Reconnection, Approx. 10	$	25,000
Baseline Construction Cost:	**$**	**201,546**
Bypass Pumping (10% of baseline construction cost)		17,655
Remove & Replace Factor		8,827
Traffic Control (10% of baseline construction cost)		17,655
Subtotal:	**$**	**245,683**
Mobilization/Demobilization (5% of subtotal)	$	12,284
Estimated Construction Cost Subtotal:	**$**	**257,967**
Contingencies (30% of construction subtotal)	$	77,390
Estimated Construction Cost:	**$**	**335,357**
Engineering, Administration, Legal (35% of construction cost)	$	117,375
Estimated Capital Improvement Cost:	**$**	**453,000**

(Note: Cost estimates are based on December 2020 ENR CCI of 13168.76)



Project 2
Linda Mar Boulevard

Wastewater Collection System
Master Plan

Legend

Capacity Improvement Project

- Manholes
- Sewers
- **(8-in)** (Existing Diameter)
- **10-in** Required Diameter

- Modeled Sewers
- Force Main
- Unmodeled Sewers

0 50 100 200 Feet

N

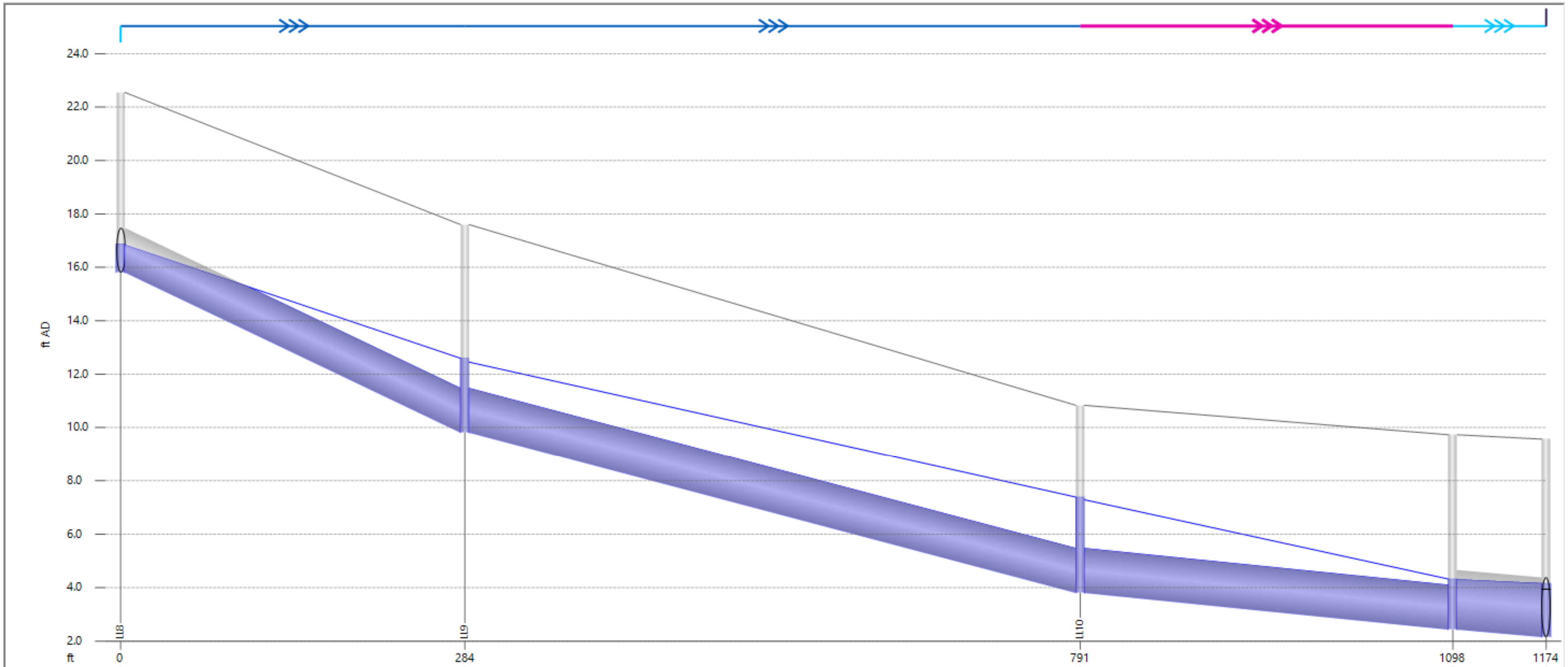
CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

Figure Exported: 9/22/2021 By: shubli Using: \\woodardcurran.net\shared\Projects\RMC\WCR\0297 Pacifica\0011180.01 Collection System Master Plan Update\G. GIS\2. MXDs\Report Figures\Pacifica_CIP_Proj2_LindaMar.mxd

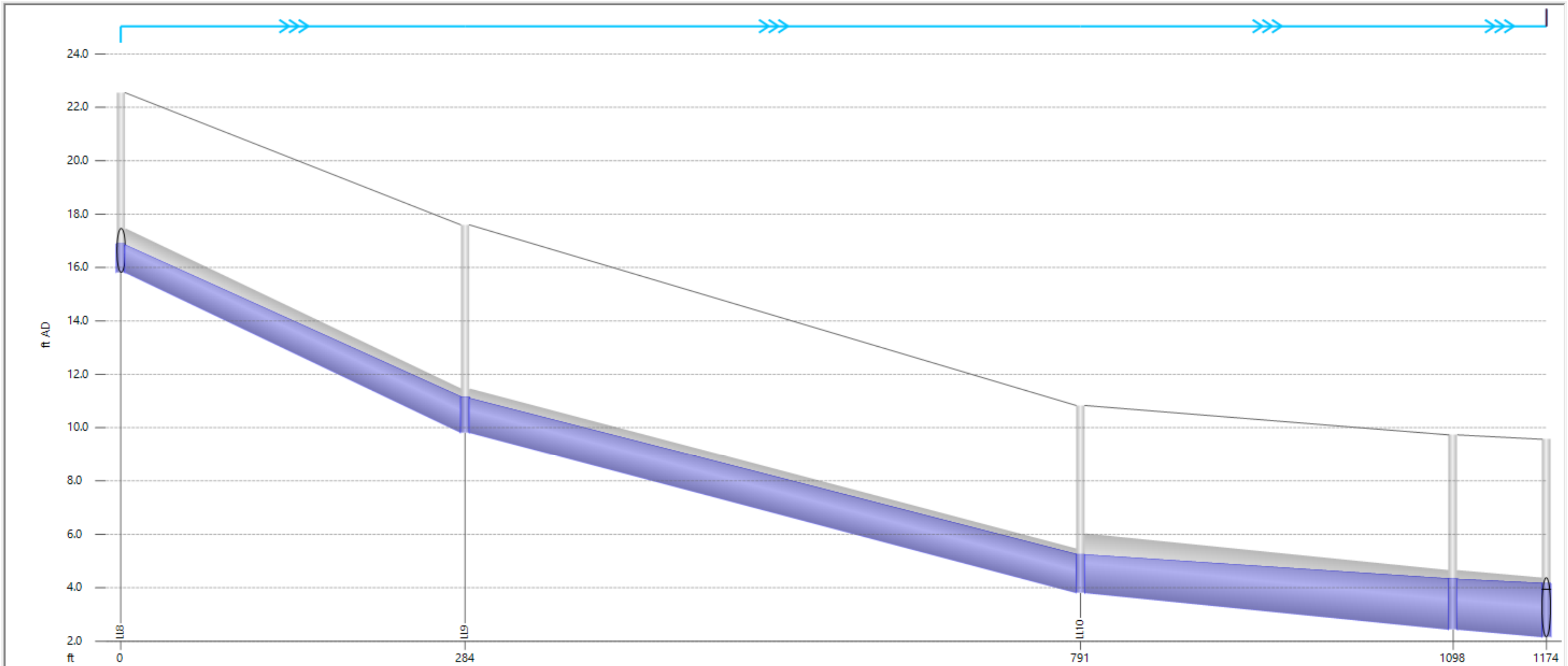
Project 2 – Linda Mar Boulevard (Deficiency)



Link	LL8.1	LL9.1	LL10.1	LL11.1
length (ft)	283.7	507.0	307.0	76.8
width (in)	20.0	20.0	20.0	27.0
us inv (ft AD)	15.800	9.800	3.800	2.430
ds inv (ft AD)	9.800	3.800	2.430	2.149
grad (%)	2.115	1.183	0.446	0.365
US flow (MGD)	8.7843	8.7897	8.7961	8.8024
r.pfc (MGD)	13.08	9.78	6.01	12.10
surc	1.00	1.00	2.00	0.89

Node	LL8	LL9	LL10	LL11	-
ground (ft AD)	22.550	17.600	10.833	9.730	9.567
flood dep (ft)	-5.678	-5.017	-3.458	-5.418	-5.415
level (ft AD)	16.872	12.583	7.375	4.312	4.152

Project 2 – Linda Mar Boulevard (Solution)



Link	LL8.1	LL9.1	LL10.1	LL11.1
length (ft)	283.7	507.0	307.0	76.8
width (in)	20.0	20.0	27.0	27.0
us inv (ft AD)	15.800	9.800	3.800	2.430
ds inv (ft AD)	9.800	3.800	2.430	2.149
grad (%)	2.115	1.183	0.446	0.365
US flow (MGD)	8.9654	8.9718	8.9778	8.9829
r.pfc (MGD)	13.08	9.78	13.37	12.10
surc	0.81	0.87	0.85	0.90

Node	LL8	LL9	LL10	LL11	-
ground (ft AD)	22.550	17.600	10.833	9.730	9.567
flood dep (ft)	-5.662	-6.448	-5.591	-5.399	-5.404
level (ft AD)	16.888	11.152	5.242	4.331	4.163

Project: 3 - Fremont Avenue

PROJECT DESCRIPTION

Project ID .... 3 - Fremont Avenue

Project Location .... Fremont Ave. between Nelson Ave. and Monterey Rd.

Description .... Upsize 278 linear feet of 12-inch to 15-inch pipe
Estimated Capital Improvement Cost $207,000
Comments .... (i) Pipes are listed in order from upstream to downstream.

Assumptions .... (i) New diameter based on pipe bursting.
(ii) Cost estimates are based on CCI of 13168.76 from the December 2020 ENR.

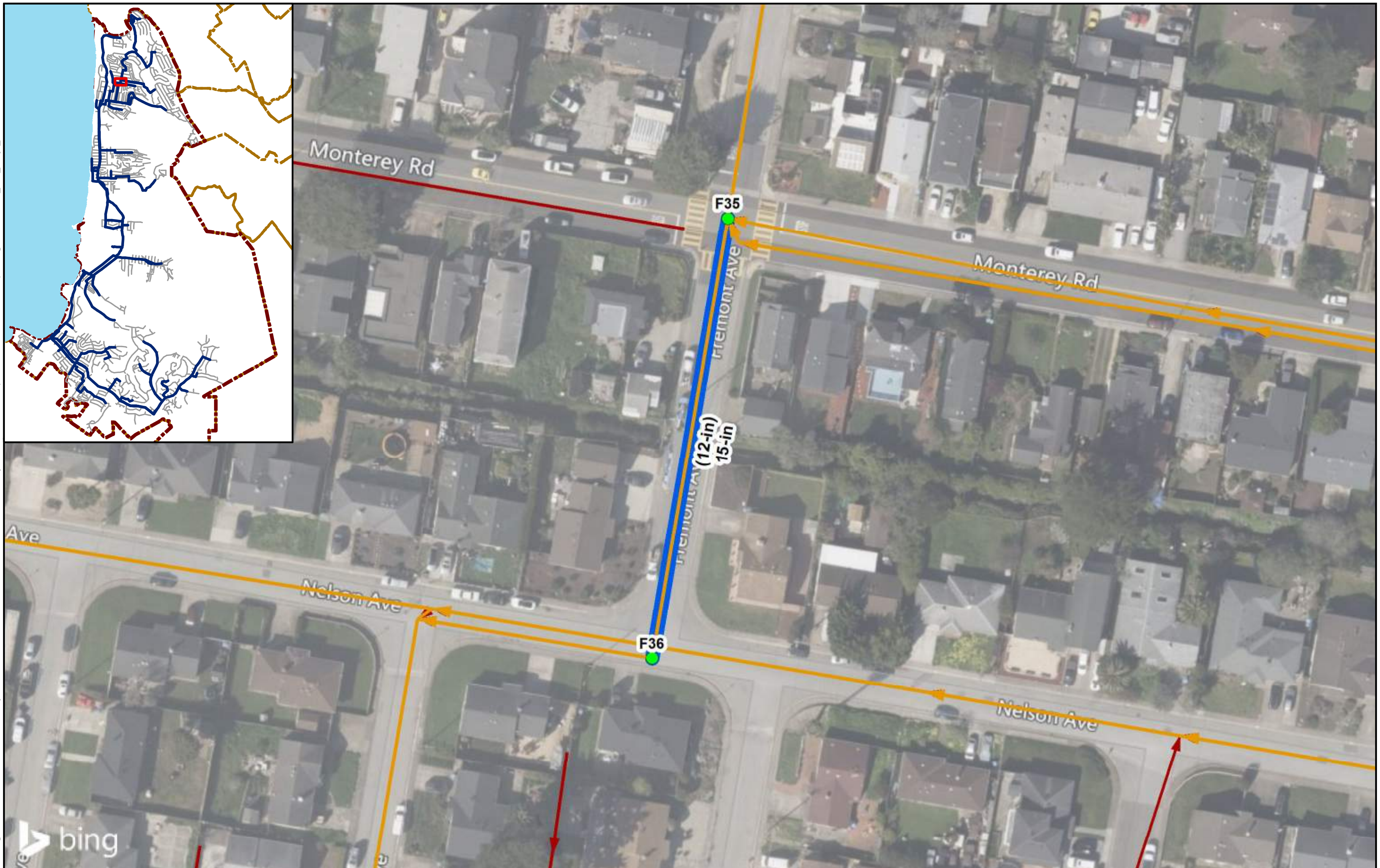
Alternatives .... 1. Perform additional flow monitoring to confirm the project need.
2. Open cut remove and replace or parallel sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)[1]	New Diameter (inches)[1]	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	(E) Pipe Capacity (mgd)	Installation Technology	Unit Cost ($/LF)	Total Cost ($)
F35	F36	12	15	278	1.0%	7.2	2.25	Pipe Burst	$300	$ 83,400

Total Baseline Pipe Construction Cost	$	83,400
Lateral Reconnection, Approx. 4	$	10,000
Insertion Trenches for Pipebursting, Approx. 1	$	2,500
Baseline Construction Cost:	**$**	**95,900**
Bypass Pumping (10% of baseline construction cost)	$	8,340
Traffic Control (10% of baseline construction cost)	$	8,340
Subtotal:	**$**	**112,580**
Mobilization/Demobilization (5% of subtotal)	$	5,629
Estimated Construction Cost Subtotal:	**$**	**118,209**
Contingencies (30% of construction subtotal)	$	35,463
Estimated Construction Cost:	**$**	**153,672**
Engineering, Administration, Legal (35% of construction cost)	$	53,785
Estimated Capital Improvement Cost:	**$**	**207,000**

(Note: Cost estimates are based on December 2020 ENR CCI of 13168.76)



Project 3
Fremont Avenue

Wastewater Collection System
Master Plan

Legend

Capacity Improvement Project

Manholes

Sewers

(8-in) (Existing Diameter)
10-in Required Diameter

Modeled Sewers

Force Main

Unmodeled Sewers

N

0 25 50 100 Feet

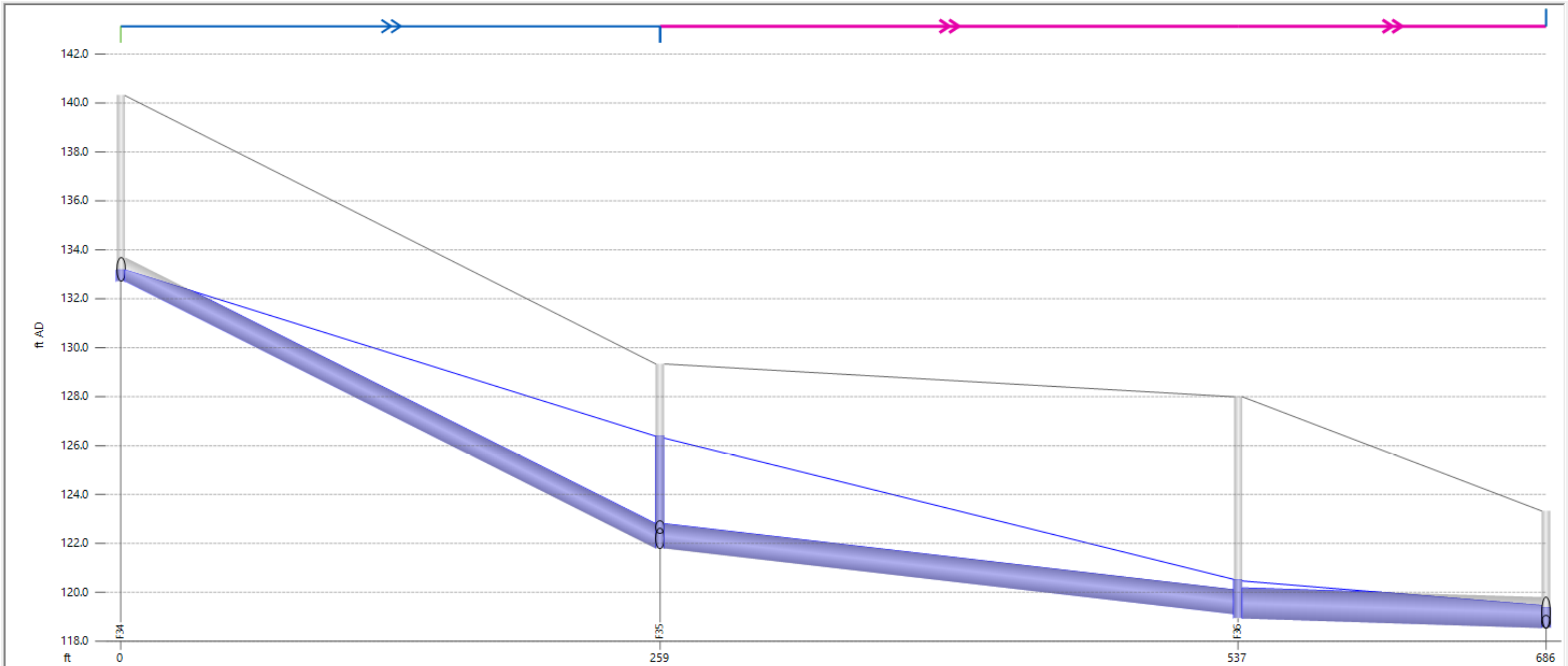
CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

Figure Exported: 9/22/2021 By: shubli Using: \\woodardcurran.net\shared\Projects\RMC\WCR\0297 Pacifica\0011180.01 Collection System Master Plan Update\G. GIS\2. MXDs\Report Figures\Pacifica_CIP_Proj3_Fremont.mxd

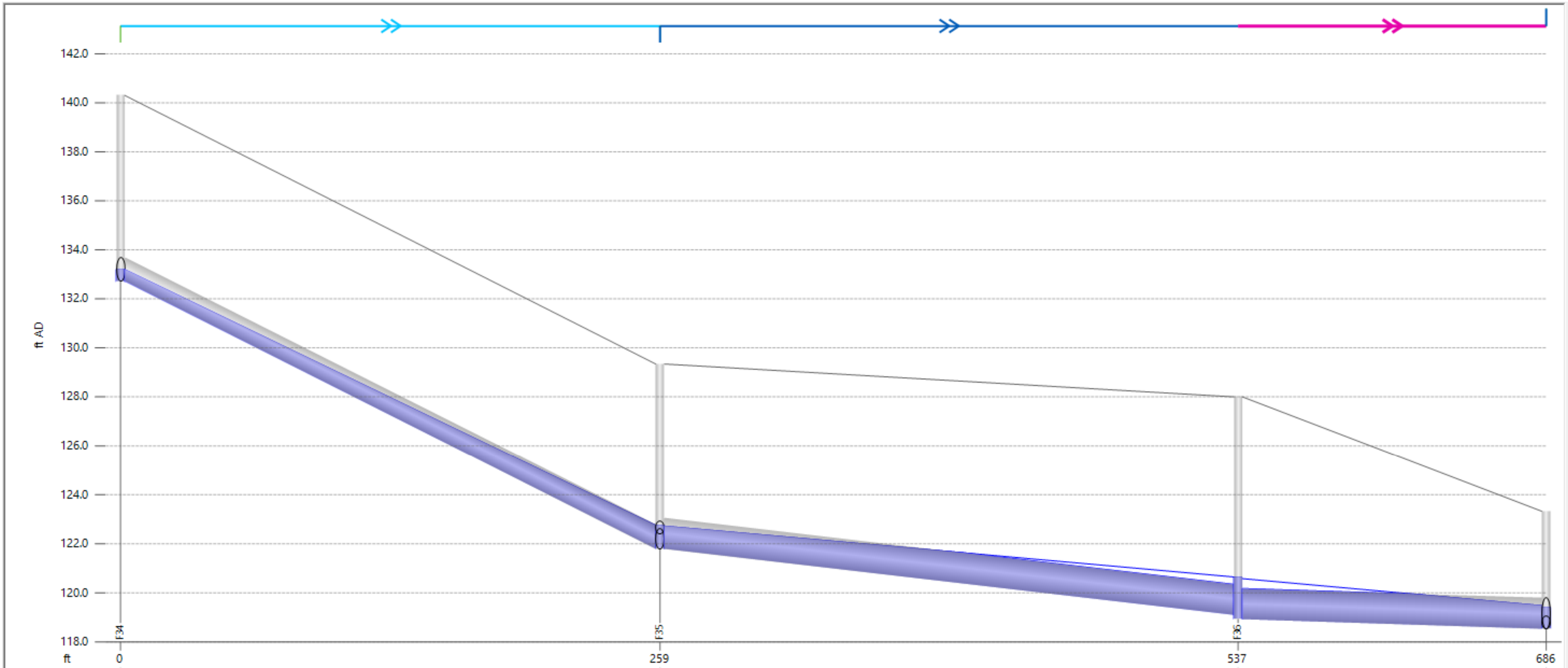
Project 3 – Fremont Avenue (Deficiency)



Link	F34.1	F35.1	F36.1
length (ft)	259.5	278.0	148.2
width (in)	12.0	12.0	15.0
us inv (ft AD)	132.700	121.800	118.930
ds inv (ft AD)	121.800	119.100	118.540
grad (%)	4.201	0.971	0.263
US flow (MGD)	2.0645	3.3026	3.3067
r.pfc (MGD)	4.72	2.27	2.14
surc	1.00	2.00	2.00

Node	F34	F35	F36	F37
ground (ft AD)	140.300	129.340	128.000	123.320
flood dep (ft)	-7.120	-2.953	-7.486	-3.948
level (ft AD)	133.180	126.387	120.514	119.372

Project 3 – Fremont Avenue (Solution)



Link	F34.1	F35.1	F36.1
length (ft)	259.5	278.0	148.2
width (in)	12.0	15.0	15.0
us inv (ft AD)	132.700	121.800	118.930
ds inv (ft AD)	121.800	119.100	118.540
grad (%)	4.201	0.971	0.263
US flow (MGD)	2.2425	3.4792	3.4832
r.pfc (MGD)	4.72	4.12	2.14
surc	0.95	1.00	2.00

Node	F34	F35	F36	F37
ground (ft AD)	140.300	129.340	128.000	123.320
flood dep (ft)	-7.100	-6.594	-7.356	-3.913
level (ft AD)	133.200	122.746	120.644	119.407

Project: 4 - Catalina Avenue

PROJECT DESCRIPTION

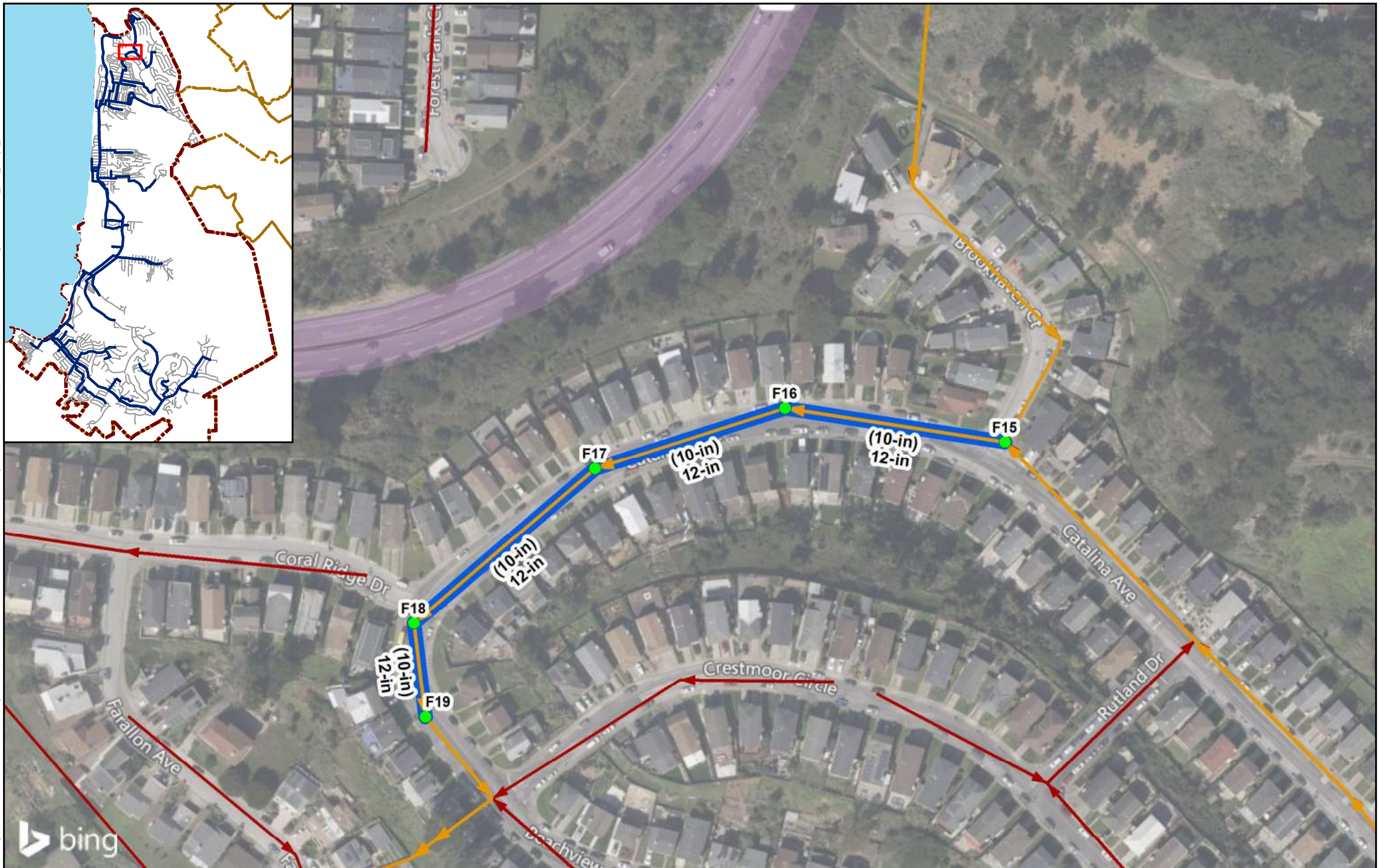
Project ID	4 - Catalina Avenue
Project Location	Catalina Ave. and Beachview Ave. from Brookhaven Ct. to Crestmoor Cir.
Description	Upsize 940 linear feet of 10-inch to 12-inch pipe
Estimated Capital Improvement Cost	$739,000
Comments	(i) Pipes are listed in order from upstream to downstream.
Assumptions	(i) New diameter based on pipe bursting. Proposed pipe sizes are based on standard sewer pipe diameters. If pipe bursting with HDPE, a pipe with an equivalent inside diameter would be used. (ii) Cost estimates are based on CCI of 13168.76 from the December 2020 ENR.
Alternatives	1. Perform additional flow monitoring to confirm the project need. 2. Open cut remove and replace or parallel sewer.

PROJECT COST DETAIL

U/S MH ID	D/S MH ID	Existing Diameter (inches)[1]	New Diameter (inches)[1]	Length (feet)	Slope (%)	Pipe Depth (feet BGL)	(E) Pipe Capacity (mgd)	Installation Technology	Unit Cost ($/LF)		Total Cost ($)
F15	F16	10	12	277	1.0%	5.2	1.39	Pipe Burst	$260	$	72,020
F16	F17	10	12	249	1.0%	5.2	1.41	Pipe Burst	$260	$	64,636
F17	F18	10	12	297	1.0%	5.4	1.40	Pipe Burst	$260	$	77,090
F18	F19	10	12	118	1.0%	9.9	1.40	Pipe Burst	$260	$	30,654

Total Baseline Pipe Construction Cost	$	244,400
Lateral Reconnection, Approx. 40	$	100,000
Insertion Trenches for Pipebursting, Approx. 3	$	7,500
Baseline Construction Cost:	**$**	**351,900**
Bypass Pumping (10% of baseline construction cost)	$	24,440
Traffic Control (10% of baseline construction cost)	$	24,440
Subtotal:	**$**	**400,780**
Mobilization/Demobilization (5% of subtotal)	$	20,039
Estimated Construction Cost Subtotal:	**$**	**420,819**
Contingencies (30% of construction subtotal)	$	126,246
Estimated Construction Cost:	**$**	**547,065**
Engineering, Administration, Legal (35% of construction cost)	$	191,473
Estimated Capital Improvement Cost:	**$**	**739,000**

(Note: Cost estimates are based on December 2020 ENR CCI of 13168.76)



Project 4
Catalina Avenue

Wastewater Collection System
Master Plan

Legend

Capacity Improvement Project

Manholes

Sewers

(8-in) (Existing Diameter)
10-in Required Diameter

Modeled Sewers

Force Main

Unmodeled Sewers

N

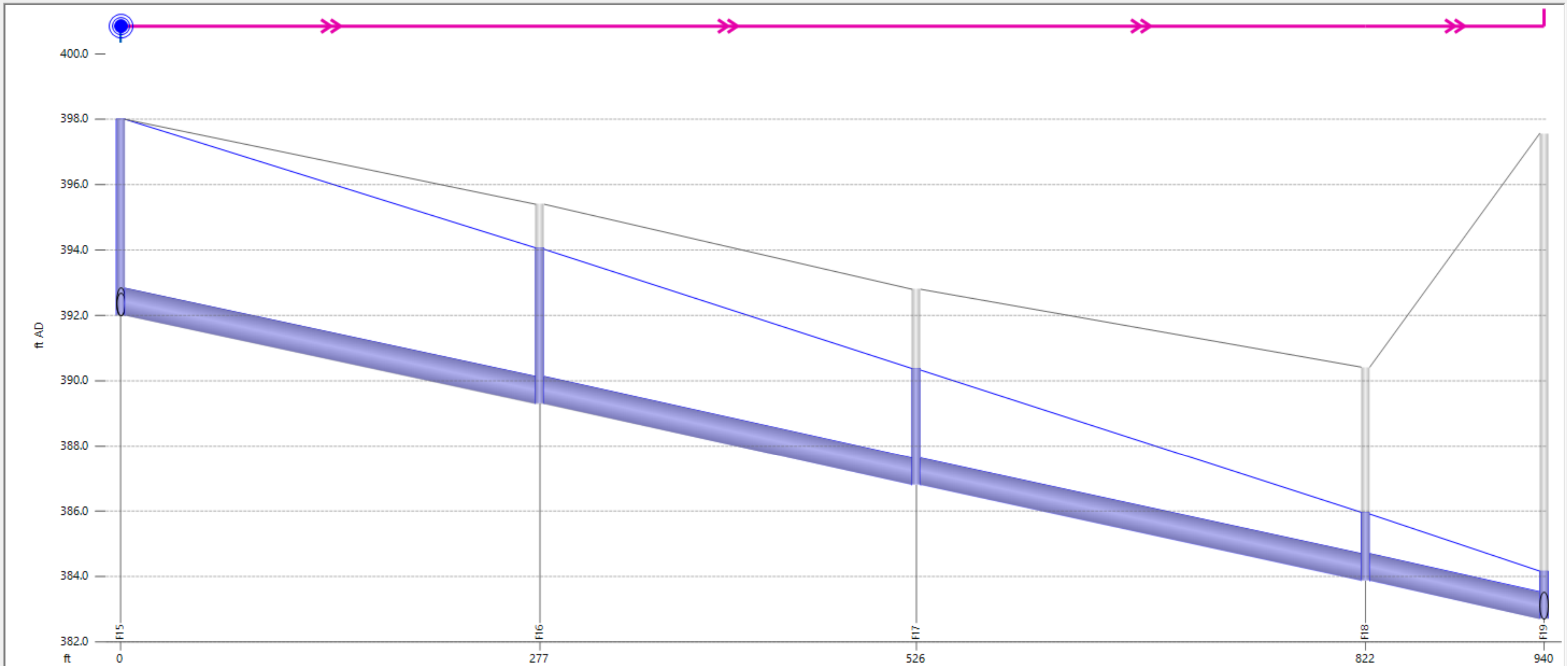
0 50 100 200 Feet

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021

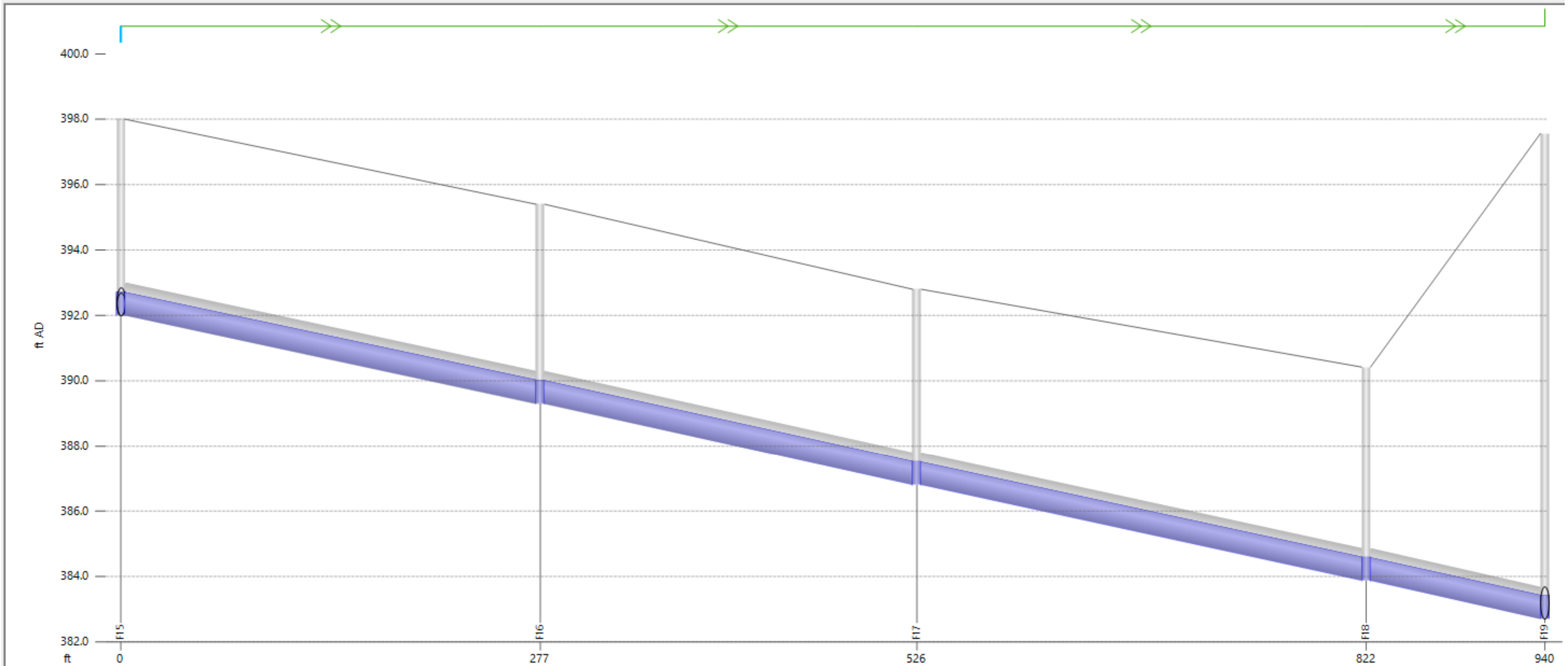
Project 4 – Catalina Avenue (Deficiency)



Link	F15.1	F16.1	F17.1	F18.1
length (ft)	277.0	248.6	296.5	117.9
width (in)	10.0	10.0	10.0	10.0
us inv (ft AD)	392.000	389.300	386.800	383.867
ds inv (ft AD)	389.300	386.800	383.867	382.700
grad (%)	0.975	1.006	0.989	0.989
US flow (MGD)	1.6819	1.6882	1.7000	1.7056
r.pfc (MGD)	1.40	1.42	1.41	1.41
surc	2.00	2.00	2.00	2.00

Node	F15	F16	F17	F18	F19
ground (ft AD)	398.000	395.400	392.800	390.420	397.570
flood dep (ft)	0.000	-1.338	-2.430	-4.460	-13.412
level (ft AD)	398.000	394.062	390.370	385.960	384.158

Project 4 – Catalina Avenue (Solution)

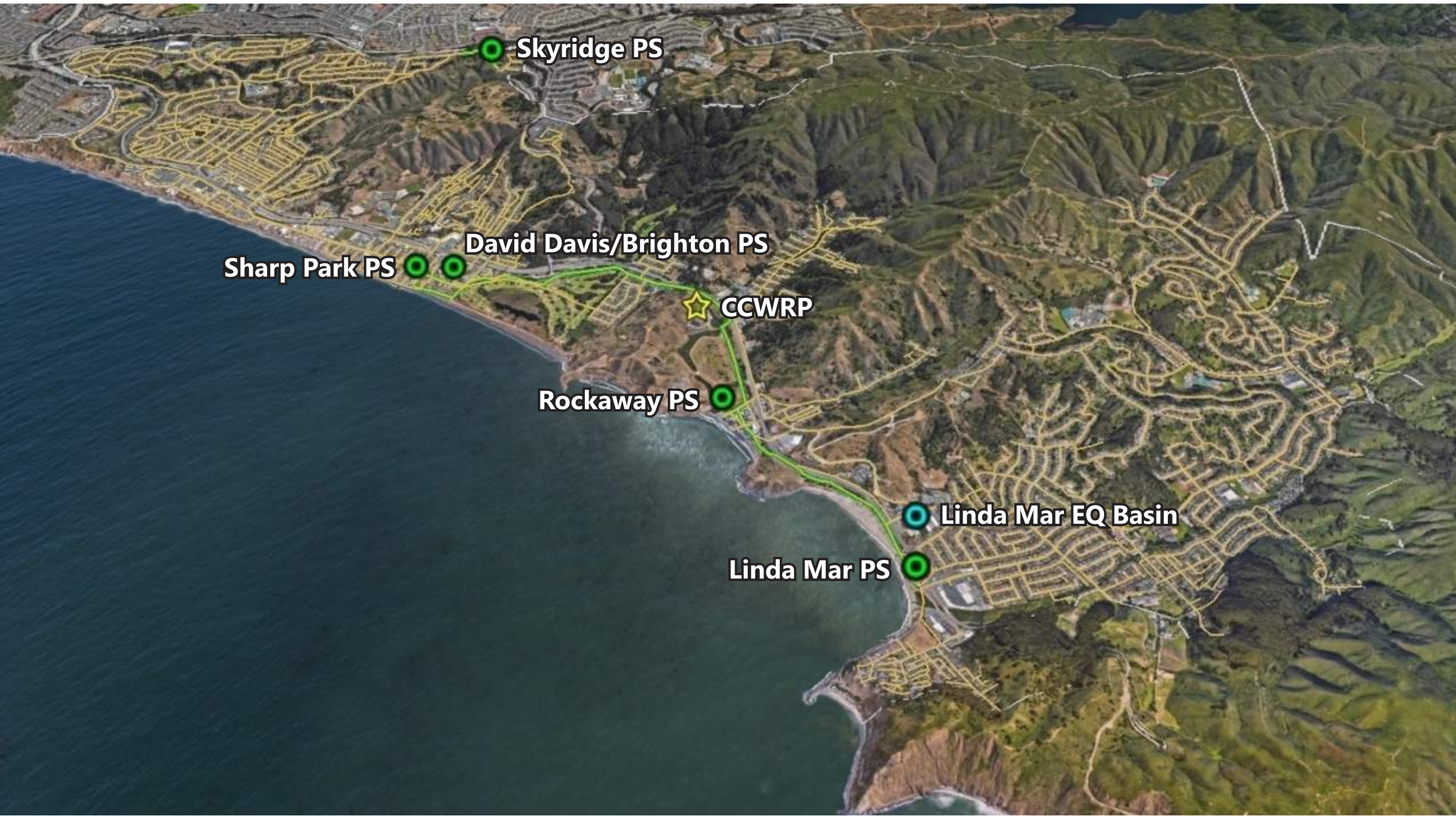


Link	F15.1	F16.1	F17.1	F18.1
length (ft)	277.0	248.6	296.5	117.9
width (in)	12.0	12.0	12.0	12.0
us inv (ft AD)	392.000	389.300	386.800	383.867
ds inv (ft AD)	389.300	386.800	383.867	382.700
grad (%)	0.975	1.006	0.989	0.989
US flow (MGD)	1.8499	1.8657	1.8791	1.8848
r.pfc (MGD)	2.27	2.31	2.29	2.29
surc	0.72	0.72	0.72	0.72

Node	F15	F16	F17	F18	F19
ground (ft AD)	398.000	395.400	392.800	390.420	397.570
flood dep (ft)	-5.286	-5.382	-5.281	-5.833	-14.148
level (ft AD)	392.714	390.018	387.519	384.587	383.422

APPENDIX E

Linda Mar EQ Basin Pumping Analysis (Technical Memorandum)



Technical Memorandum

City of Pacifica Collection System Master Plan

Subject: **EQ Basin Pumping Analysis**

Prepared For: Brian Martinez, Louis Sun (City of Pacifica)

Prepared by: Chris van Lienden (Woodard & Curran)

Reviewed by: Tony Valdivia (Woodard & Curran)

Date: August 13, 2021

Reference: 0011180.01

1 Introduction

The City of Pacifica (City) recently constructed the Linda Mar Equalization Basin (EQ Basin), which receives excess flow backing up from the Linda Mar Pump Station (Linda Mar PS) during large storm events. When flows to Linda Mar PS recede, pumps in the EQ Basin discharge water from the EQ Basin into the City's gravity sewer on Crespi Drive. As part of the City's 2020 Collection System Master Plan Update (Master Plan Update), an evaluation of the flowrate of the EQ Basin pumps and the capacity of the gravity sewer on Crespi Drive has been performed.

2 EQ Basin Pump Capacity

The EQ Basin includes six pumps, including four 10-hp pumps (large pumps), and a pair of 3.8 HP pumps (small pumps). Furthermore, the EQ Basin is split into the south basin and north basin, which are separated by a weir wall. The south basin and north basin each have three pumps (two large and one small). The City provided technical specifications for the pumps, which included pump curve data (provided as Attachment A). A system curve was developed to estimate pump flowrates under different pumping conditions.

The system curve includes both static head and friction loss components. The static head is the difference in elevation between the force main discharge at Crespi Drive and the water level in the EQ Basin. The City provided 100% design drawings for the Wet Weather EQ basin[1], which indicated that the force main discharge elevation is 11.0 feet. The drawings indicate that the maximum water elevation in the tank would be approximately -0.5 feet, while the tank bottom elevation is approximately -27.0 feet. The static head therefore can vary between 38 feet and 11.5 feet. For friction losses, the force main length is approximately 540 feet. Friction losses have been calculated assuming a Hazen-Williams coefficient of 130, and a minor loss (K) allowance of 4.0.

Based on this data, the Table 1 summarizes the predicted outflow rates with one or two small or large pumps. Pump and system curves are presented in Figure 1.

[1] City of Pacifica Wet Weather Equalization Basin Project 100% Submittal, Freyer & Laureta, Inc., January 2017.

Table 1 – Predicted Linda Mar EQ Basin Pump Flowrates

	Small Pump Flowrate (mgd)		Large Pump Flowrate (mgd)	
	1 Small Pump	2 Small Pumps	1 Large Pump	2 Large Pumps
Water Level @ Maximum (-0.5 ft)	0.25	0.55	1.25	1.95
Water Level @ Bottom of Tank (-27.0 ft)	0.15	0.30	0.75	1.25

Note that this calculation is an estimated flowrate that does not consider losses in the discharge piping, and flowrates have not been confirmed through testing. Pumping rates with additional pumps active (three or four large pumps) are not included in this table, as the projected flows would likely exceed the capacity of the downstream gravity sewer.

3 Gravity Sewer Capacity

The sewer on Crespi Drive downstream of the EQ Basin is part of the City's sewer model, and has been evaluated for available capacity as part of the Master Plan Update. For this evaluation, it has been assumed that flows to Linda Mar PS have reduced to approximately dry weather flow levels, and water levels in the Linda Mar PS wet well are no longer elevated. Figure 1 shows the profile of the sewer under peak dry weather flow conditions without any additional flow from Linda Mar EQ Basin.

Figure 2 shows the plan view of the sewer, and Figure 3, Figure 4, Figure 5, and Figure 6 show the hydraulic profile of the sewer under discharge rates of 0.25 mgd, 0.55 mgd, 1.25 mgd, and 1.95 mgd, respectively. As shown, moderate surcharge is predicted when a single large pump is operating, and overflows are predicted if both large pumps are in operation, if the water level is near the maximum water level.

It should be noted that the surcharge predicted is based on the invert elevations currently in the model; there is limited information available to confirm the invert elevations along Crespi Drive, which came from a GIS dataset during the original model development. Furthermore, the model assumes relatively clean pipe in good structural conditions. Roots or other blockages that would impede flow could reduce pipeline capacity and increase surcharge.

3.1 Force Main Extension to Linda Mar Boulevard.

The City has considered extending the 8-inch force main south along an easement on the east side of Highway 1, which would allow the force main to discharge into the 24-inch sewer on Linda Mar Boulevard. The extension would add approximately 1,700 feet. The ground elevation on Crespi Drive at the current force main discharge location is about 4 feet higher than the ground elevation on Linda Mar Boulevard, so the static head would decrease by about 4 feet.

The pump and system curves for this potential force main configuration are presented in Figure 6, and potential outflow rates are summarized in Table 2.

Table 1 – Predicted Linda Mar EQ Basin Pump Flowrates

	Small Pump Flowrate (mgd)		Large Pump Flowrate (mgd)	
	1 Small Pump	2 Small Pumps	1 Large Pump	2 Large Pumps
Water Level @ Maximum (-0.5 ft)	0.25	0.55	1.05	1.35
Water Level @ Bottom of Tank (-27.0 ft)	0.18	0.30	0.70	0.95

The 24-inch gravity sewer on Linda Mar Boulevard has sufficient capacity for flows from the Linda Mar EQ basin (pipeline capacity is greater than the pump station capacity of about 9.7 mgd). This approach is likely to be more expensive than continuing to utilize the Crespi Drive sewer; if pump outflows need to be limited to protect the Crespi Drive sewer, other options are available which could serve a similar purpose.

4 Conclusions

Based on the analysis above, the gravity sewer's capacity is approximately 1.25 mgd based on the City's current master planning design criteria. The flowrate for two large pumps could be as high as 1.95 mgd (if both pumps were used simultaneously at maximum tank water levels) and would result in overflows. A single large pump in operation is not predicted to result in overflows, though it does reach sewer capacity. As noted previously, sewer capacity could be reduced by debris, roots, or other obstructions in the gravity sewer.

Based on conversations with Freyer & Laureta, the pump designer cautions against running pumps outside of manual control, and only when the downstream sewer flows allow for sufficient capacity, as running multiple pumps carries the risk of overloading the downstream sewer. The downstream sewer should be monitored when beginning discharge and at all times if more than one pump is operating.

Precise control of the outflow rate is not an option with the current configuration. Several options are available which could provide additional flexibility:

- The force main could be extended to Linda Mar Boulevard. This would eliminate capacity concerns for the Crespi Drive sewer and allow all pumps to be used. This is the most expensive option, however.
- A variable frequency drive (VFD) could be used to reduce motor speed on one of the pumps to allow for more specific outflow rates.
- A partially closed valve downstream of the pumps could be used to artificially increase TDH and decrease the outflow from each pump.

Figure 1 – Linda Mar EQ Basin Pump and System Curves

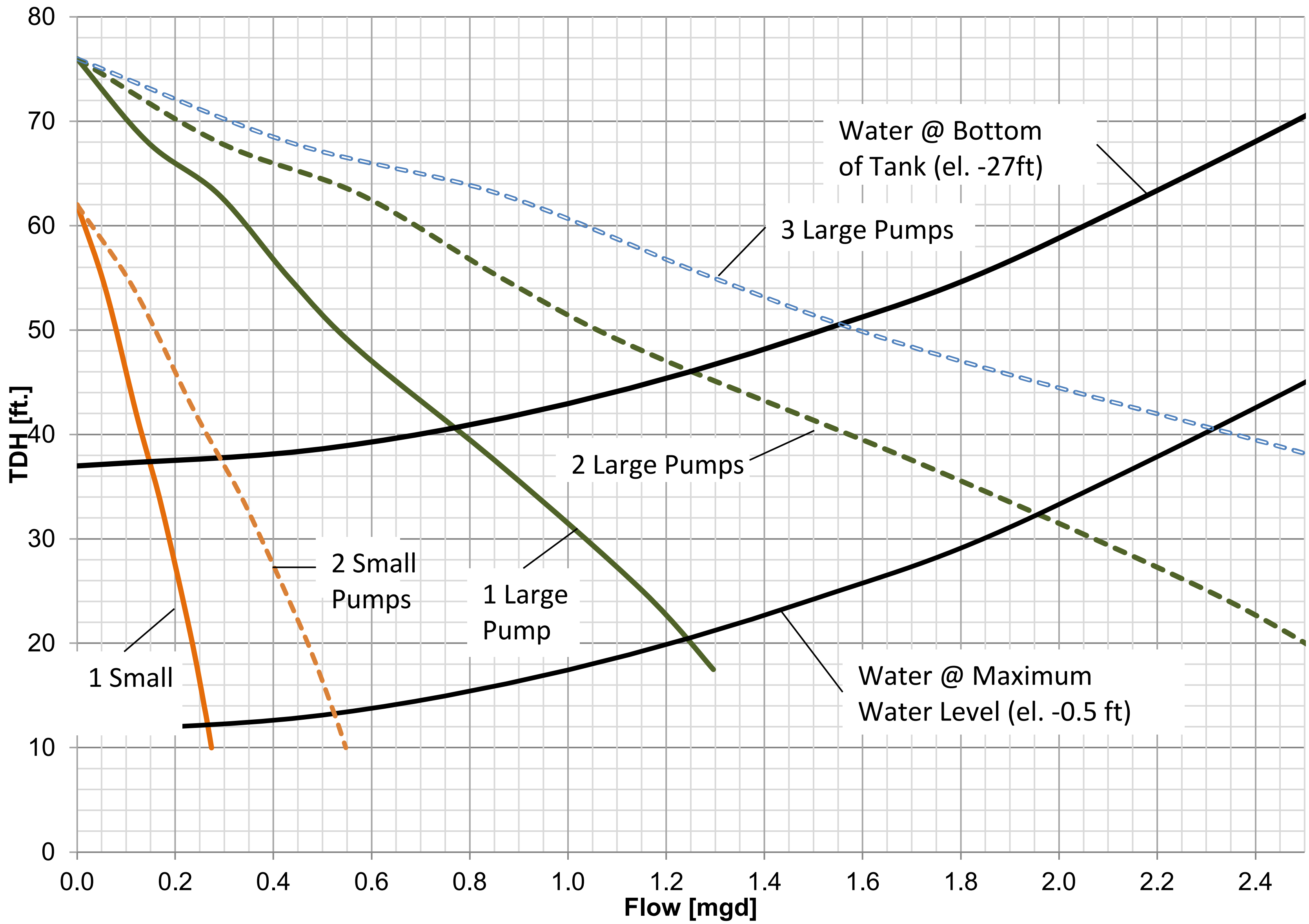
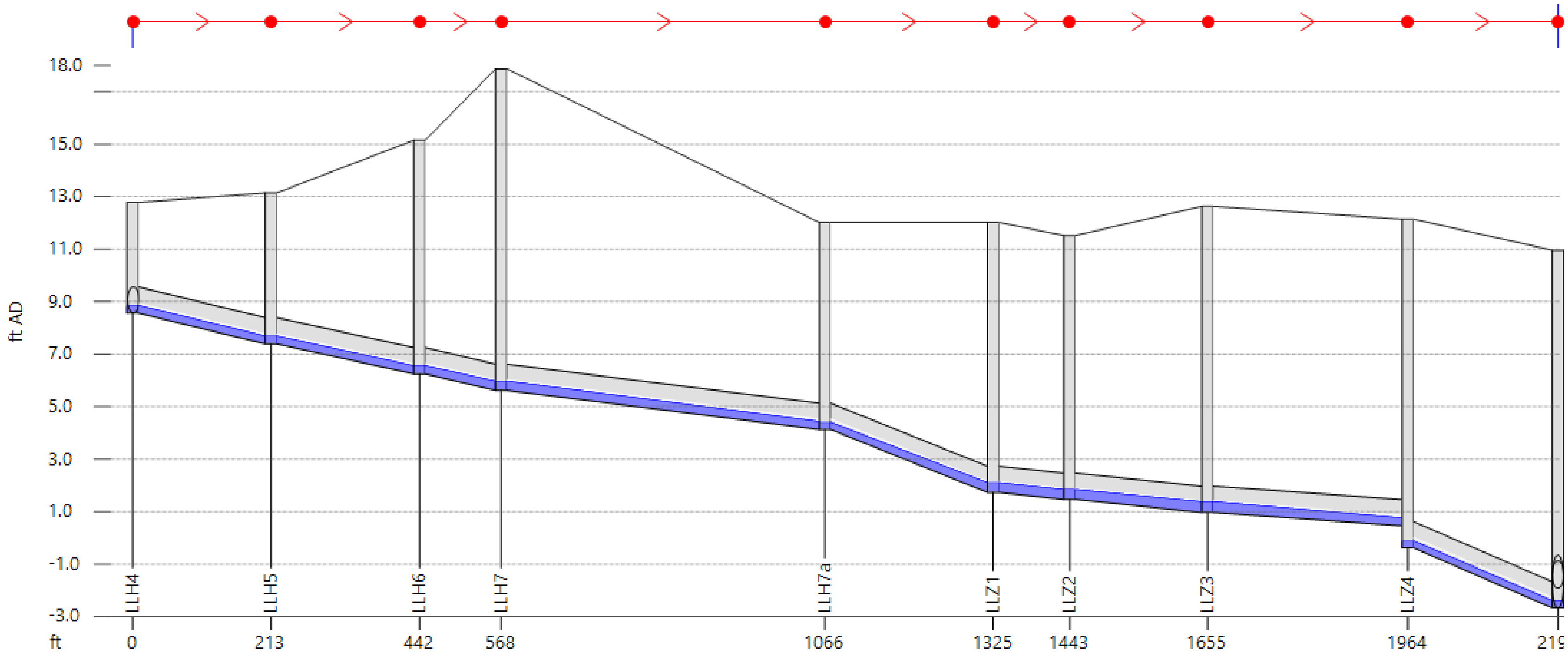


Figure 2 – Crespi Drive Sewer to Linda Mar Equalization Basin Plan View

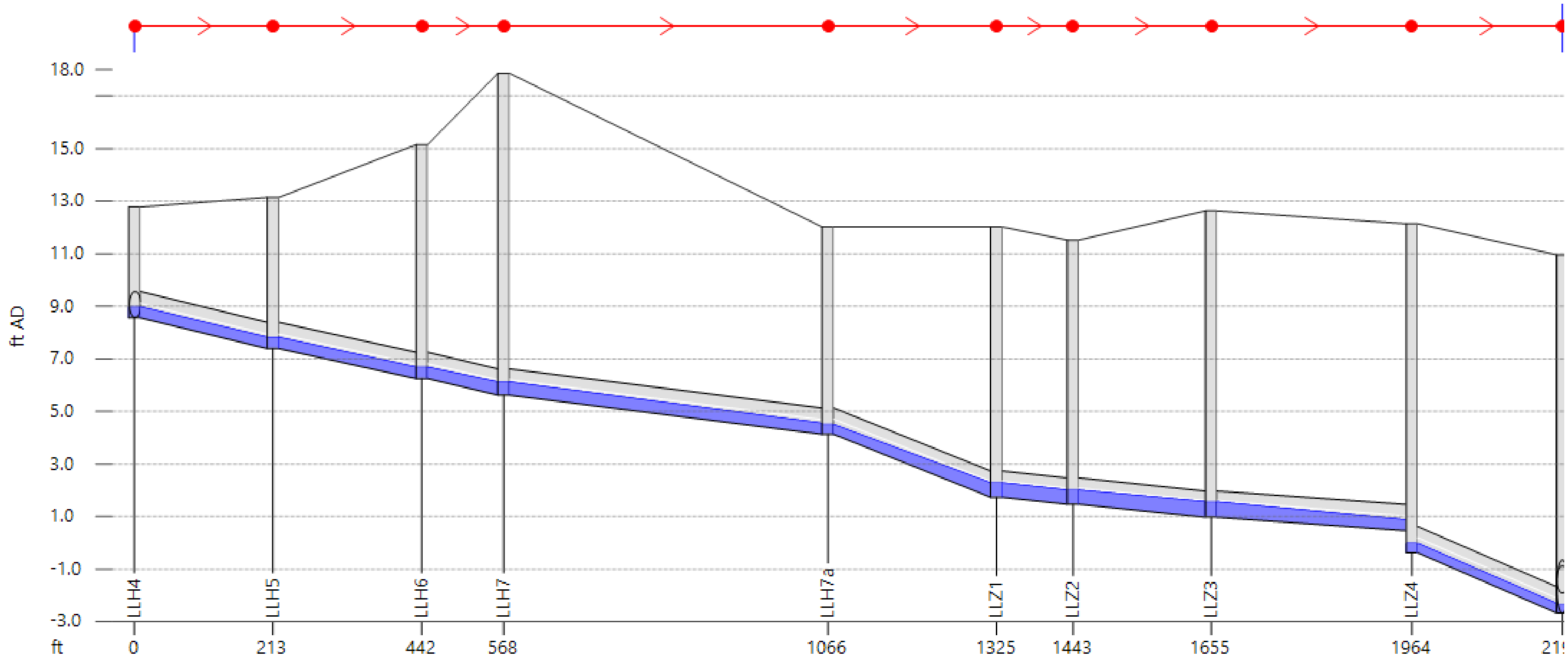
Figure 3 – Hydraulic Profile from Linda Mar EQ Basin Discharge to Linda Mar PS at 0.25 MGD Discharge Rate



Link	LLH4.1	LLH5.1	LLH6.1	LLH7.1	LLH7a.1	LLZ1.1	LLZ2.1	LLZ3.1	LLZ4.1
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
grad (%)	0.550	0.499	0.499	0.299	0.926	0.221	0.235	0.165	0.990
pfc (MGD)	1.71	1.63	1.63	1.26	2.22	1.08	1.12	0.94	2.29
surc	0.29	0.30	0.34	0.34	0.37	0.37	0.40	0.40	0.27
US flow (MGD)	0.2854	0.2870	0.3046	0.3046	0.3046	0.3046	0.3046	0.3046	0.3055

Node	LLH4	LLH5	LLH6	LLH7	LLH7a	LLZ1	LLZ2	LLZ3	LLZ4	LLD38
ground (ft AD)	-	13.140	15.150	17.870	12.020	12.020	11.520	12.630	12.140	10.960
level (ft AD)	8.844	7.680	6.547	5.964	4.390	2.096	1.832	1.369	-0.126	-2.403
flood dep (ft)	-	-5.460	-8.603	-11.906	-7.630	-9.924	-9.688	-11.261	-12.266	-

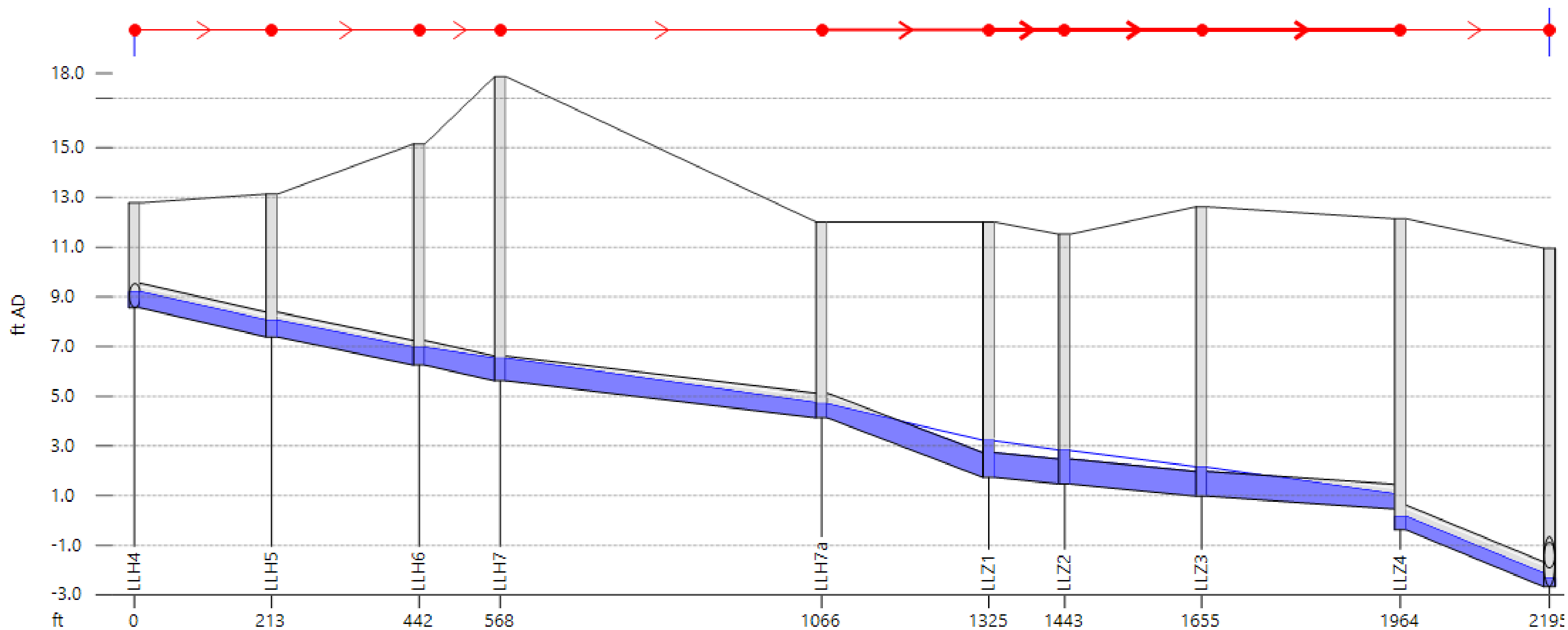
Figure 4 – Hydraulic Profile from Linda Mar EQ Basin Discharge to Linda Mar PS at 0.55 MGD Discharge Rate



Link	LLH4.1	LLH5.1	LLH6.1	LLH7.1	LLH7a.1	LLZ1.1	LLZ2.1	LLZ3.1	LLZ4.1
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
grad (%)	0.550	0.499	0.499	0.299	0.926	0.221	0.235	0.165	0.990
pfc (MGD)	1.71	1.63	1.63	1.26	2.22	1.08	1.12	0.94	2.29
surc	0.42	0.43	0.50	0.50	0.54	0.54	0.58	0.58	0.36
US flow (MGD)	0.5854	0.5870	0.6047	0.6046	0.6046	0.6046	0.6046	0.6046	0.6055

Node	LLH4	LLH5	LLH6	LLH7	LLH7a	LLZ1	LLZ2	LLZ3	LLZ4	LLD38
ground (ft AD)	-	13.140	15.150	17.870	12.020	12.020	11.520	12.630	12.140	10.960
level (ft AD)	8.973	7.813	6.677	6.115	4.492	2.270	2.003	1.553	-0.025	-2.370
flood dep (ft)	-	-5.327	-8.473	-11.755	-7.528	-9.750	-9.517	-11.077	-12.165	-

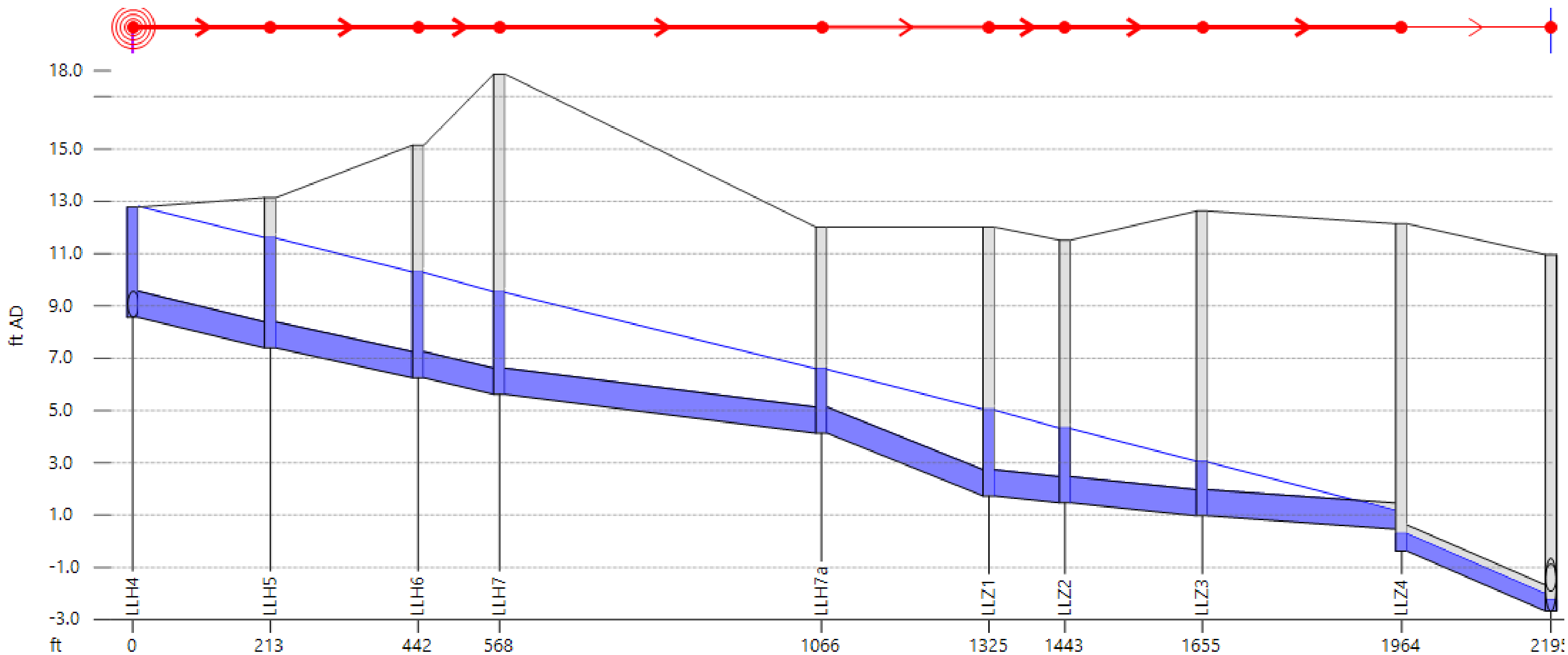
Figure 5 – Hydraulic Profile from Linda Mar EQ Basin Discharge to Linda Mar PS at 1.25 MGD Discharge Rate



Link	LLH4.1	LLH5.1	LLH6.1	LLH7.1	LLH7a.1	LLZ1.1	LLZ2.1	LLZ3.1	LLZ4.1
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
grad (%)	0.550	0.499	0.499	0.299	0.926	0.221	0.235	0.165	0.990
pfc (MGD)	1.71	1.63	1.63	1.26	2.22	1.08	1.12	0.94	2.29
surc	0.67	0.72	0.91	0.90	1.00	2.00	2.00	2.00	0.54
US flow (MGD)	1.2610	1.2616	1.2684	1.2684	1.2684	1.2684	1.2684	1.2684	1.2688

Node	LLH4	LLH5	LLH6	LLH7	LLH7a	LLZ1	LLZ2	LLZ3	LLZ4	LLD38
ground (ft AD)	-	13.140	15.150	17.870	12.020	12.020	11.520	12.630	12.140	10.960
level (ft AD)	9.210	8.060	6.966	6.530	4.687	3.226	2.838	2.162	0.159	-2.316
flood dep (ft)	-	-5.080	-8.184	-11.340	-7.333	-8.794	-8.682	-10.468	-11.981	-

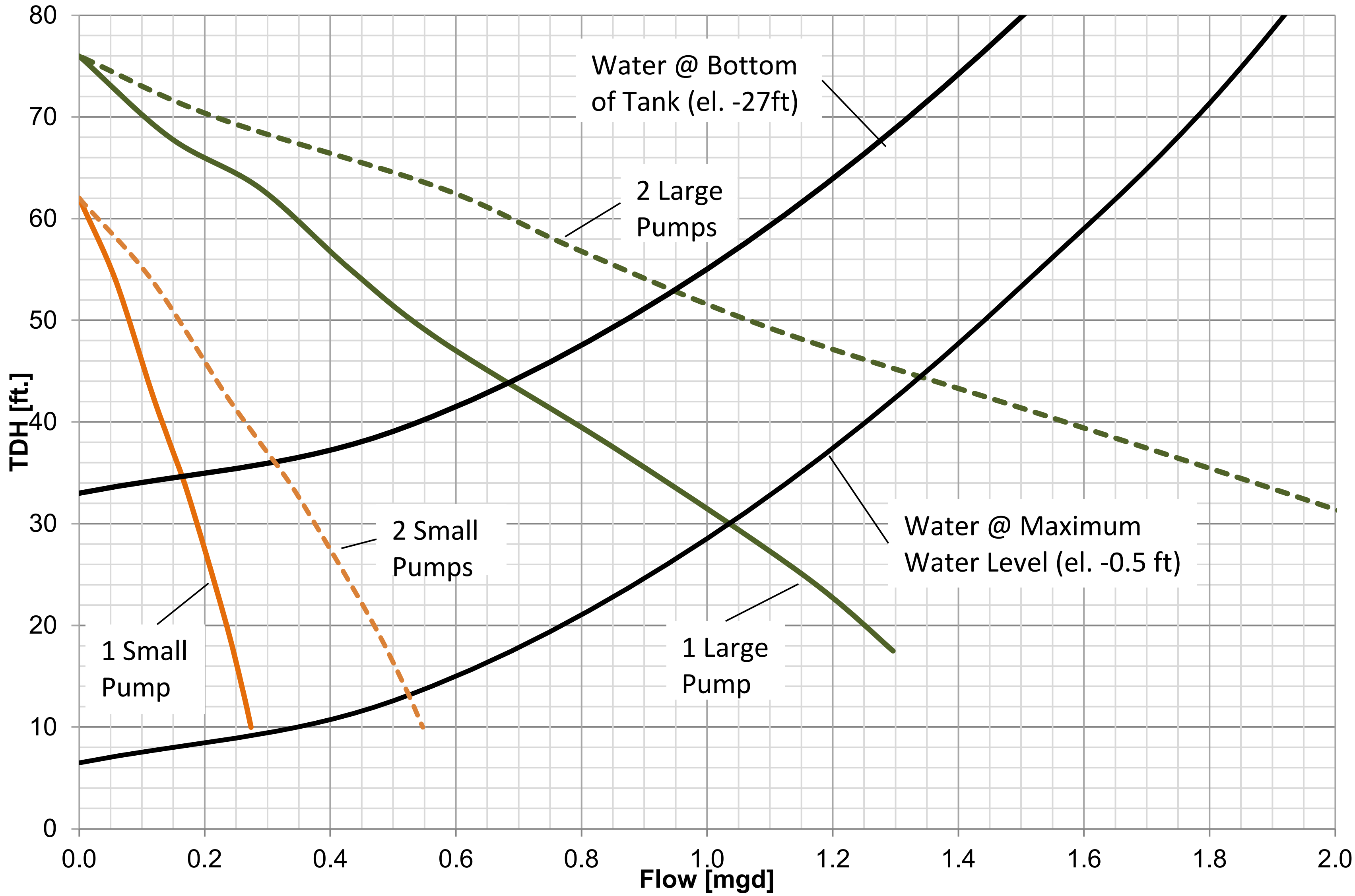
Figure 6 – Hydraulic Profile from Linda Mar EQ Basin Discharge to Linda Mar PS at 1.95 MGD Discharge Rate



Link	LLH4.1	LLH5.1	LLH6.1	LLH7.1	LLH7a.1	LLZ1.1	LLZ2.1	LLZ3.1	LLZ4.1
width (in)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
grad (%)	0.550	0.499	0.499	0.299	0.926	0.221	0.235	0.165	0.990
pfc (MGD)	1.71	1.63	1.63	1.26	2.22	1.08	1.12	0.94	2.29
surc	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	0.65
US flow (MGD)	1.7345	1.7348	1.7495	1.7495	1.7495	1.7495	1.7495	1.7495	1.7520

Node	LLH4	LLH5	LLH6	LLH7	LLH7a	LLZ1	LLZ2	LLZ3	LLZ4	LLD38
ground (ft AD)	-	13.140	15.150	17.870	12.020	12.020	11.520	12.630	12.140	10.960
level (ft AD)	-	11.615	10.304	9.541	6.595	5.042	4.327	3.056	0.286	-2.245
flood dep (ft)	0.000	-1.525	-4.846	-8.329	-5.425	-6.978	-7.193	-9.574	-11.854	-

Figure 7 – Linda Mar EQ Basin Pump and System Curves with FM Extension to Linda Mar Blvd.



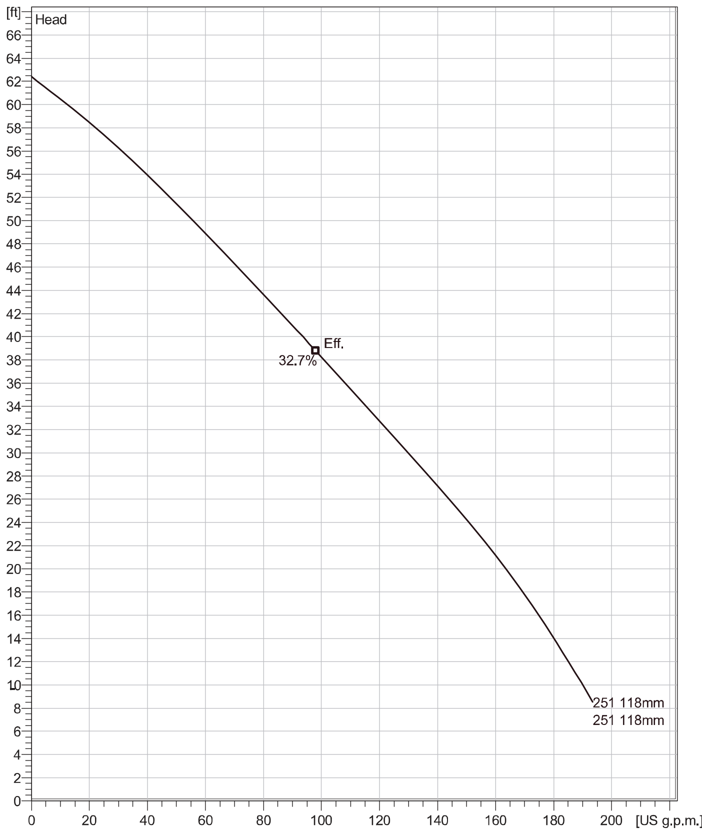
Attachment A – Pump Curves

xylem

DP 3069 HT 3~ 251

Technical specification

FLYGT

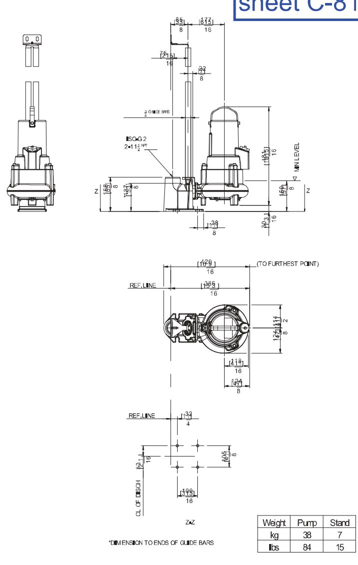


Water, pure *Curve ISO*

Note: Picture might not correspond to the current configuration.

Installation: P - Semi permanent, Wet

Discharge pipe shall be a 3" per design plans sheet C-81.



Weight	Pump	Stand
kg	38	7
lbs	84	15

General

Portable pumps with vortex impellers ideal for applications in which the water or liquid contains concentrations of abrasives when clogging problems can occur.

Impeller

Impeller material	Grey cast iron
Discharge Flange Diameter	1 15/16 inch
Suction Flange Diameter	1 7/8 inch
Impeller diameter	118 mm
Number of blades	6
Throughlet diameter	1 7/8 inch

Motor

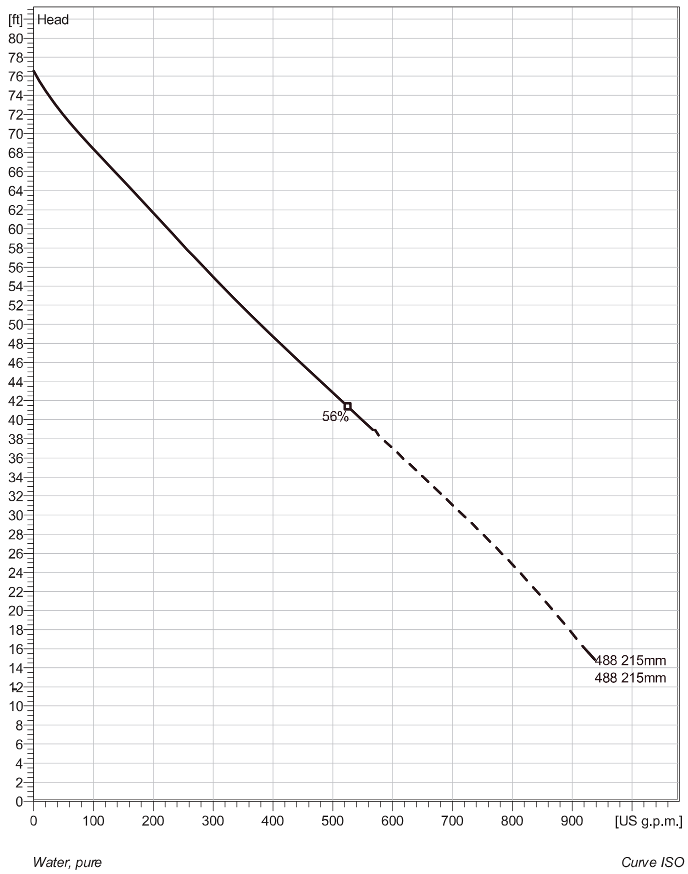
Motor #	D3069.180 13-10-2BB-W 3.8hp Standard
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	2
Phases	3~
Rated power	3.8 hp
Rated current	4.9 A
Starting current	29 A
Rated speed	3370 rpm
Power factor	
1/1 Load	0.88
3/4 Load	0.84
1/2 Load	0.74
Motor efficiency	
1/1 Load	82.0 %
3/4 Load	84.6 %
1/2 Load	85.5 %

Configuration

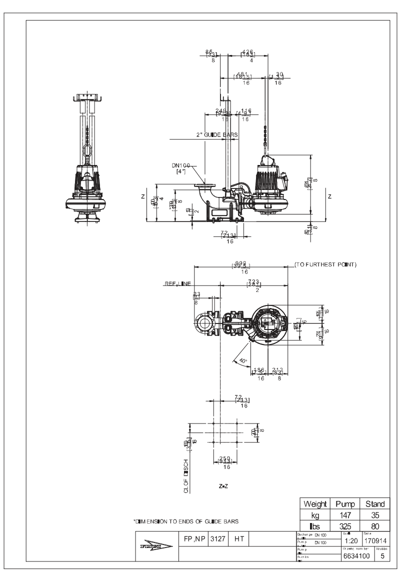
Project	Project ID	Created by	Created on	Last update
			1/12/2018	

FP 3127 HT 3~ 488

Technical specification



Installation: P - Semi permanent, Wet



Note: Picture might not correspond to the current configuration.

General

Open screw type cutting impellers and single volute casing for liquids containing long fibres and large solids. F3153 and F3171 are new designs with high efficiency combined with excellent cutting performance.

Impeller

Impeller material	Hard-Iron ™
Discharge Flange Diameter	3 15/16 inch
Suction Flange Diameter	3 15/16 inch
Impeller diameter	215 mm
Number of blades	2

Motor

Motor #	F3127.390 21-12-4AL-W 10hp FM
Stator variant	38
Frequency	60 Hz
Rated voltage	460 V
Number of poles	4
Phases	3~
Rated power	10 hp
Rated current	13 A
Starting current	79.9 A
Rated speed	1735 rpm
Power factor	
1/1 Load	0.87
3/4 Load	0.83
1/2 Load	0.75
Motor efficiency	
1/1 Load	84.5 %
3/4 Load	85.0 %
1/2 Load	83.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			4/3/2018	

Attachment B – Linda Mar EQ Basin Tank and FM Elevations

NOTES

1. INSTALL PIPES 3' FROM FINISHED SURFACE ELEVATION
2. SANITARY SEWER END OF LINE UNKNOWN
3. ALL UTILITY LINES SHALL BE INSTALLED USING OPEN CUT EXCAVATION METHODS UNLESS OTHERWISE STATED IN PLANS.
4. TRENCH DEWATERING WILL LIKELY BE NEEDED DUE TO A RELATIVELY SHALLOW GROUNDWATER ELEVATION. WATER GENERATED DURING DEWATERING SHALL BE HANDLED AS OUTLINED IN SPECIFICATIONS SECTION 31 23 19.

ABBREVIATIONS

ABAND	ABANDONED
CO	CLEAN OUT
EX	EXISTING
FL	FLOW LINE
GR	GRATE
INV	INVERT
LF	LINEAR FEET
OFI	OVERFLOW INLET
R	RADIUS
SD	STORM DRAIN
SDI	STORM DRAIN INLET
SS	SANITARY SEWER
SSMH	SANITARY SEWER MANHOLE
TYP	TYPICAL
W	WATER
WM	WATER METER

LEGEND

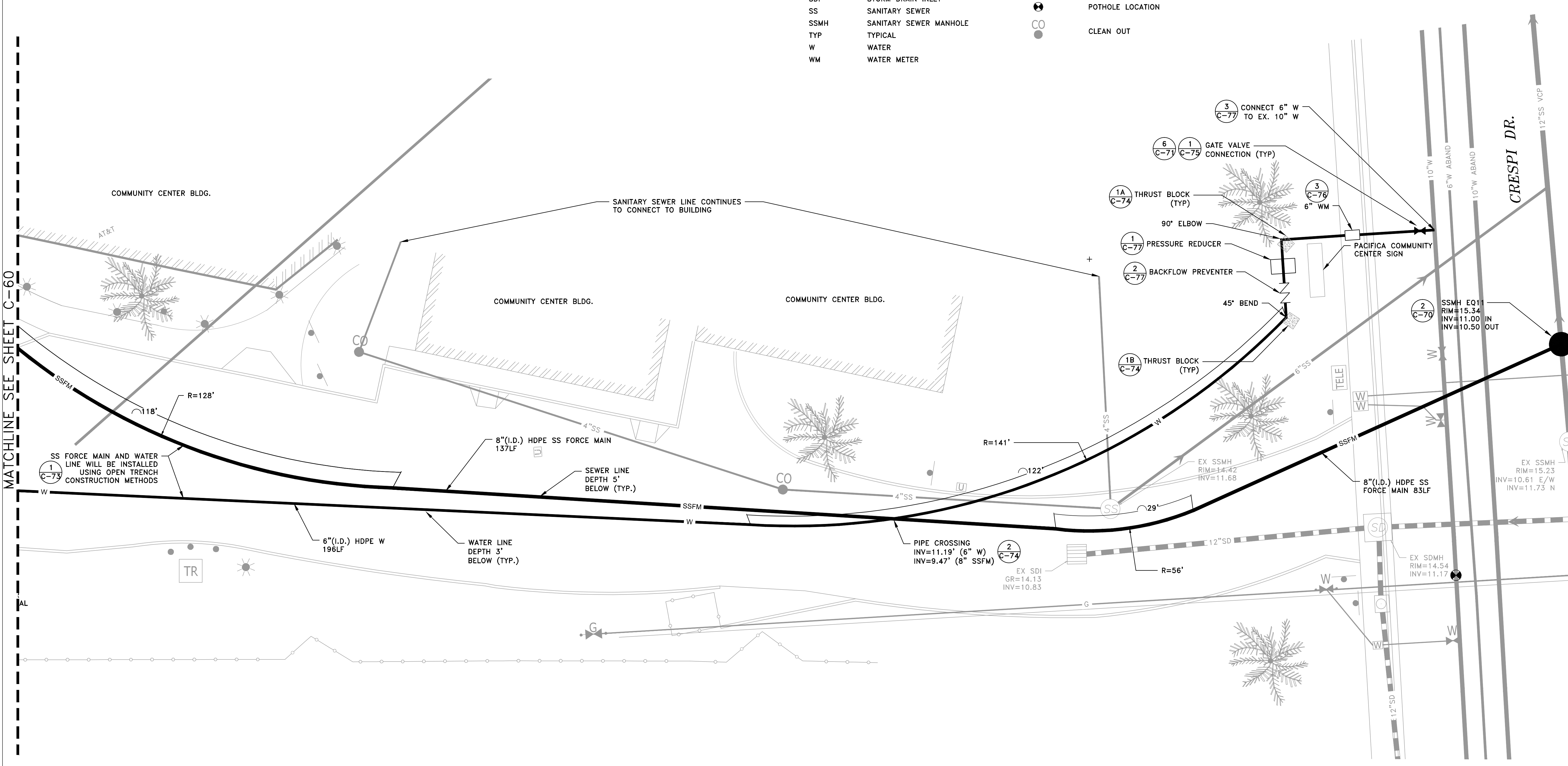
NEW MANHOLE
GATE VALVE
INLET
THRUST BOX
PARKING LOT LIGHT
EXISTING BUILDING
DETAIL CALLOUT (1 / C-15)
BACKFLOW PREVENTER
POTHOLE LOCATION
CLEAN OUT (CO)

NORTH

GRAPHIC SCALE

10 0 5 10 20 40

(IN FEET)
1 inch = 10 ft.



SCALE: AS NOTED		05/06/16	BASIS OF DESIGN	
DESIGNED: RJL		08/05/16	60% SUBMITTAL	
DRAWN: AJR		10/03/16	90% SUBMITTAL	
CHECKED: MQ		11/23/16	95% SUBMITTAL	
PROJ. ENGR: RJL		01/18/17	100% SUBMITTAL	
	BY	DATE	DESCRIPTION OF REVISIONS	APP'D

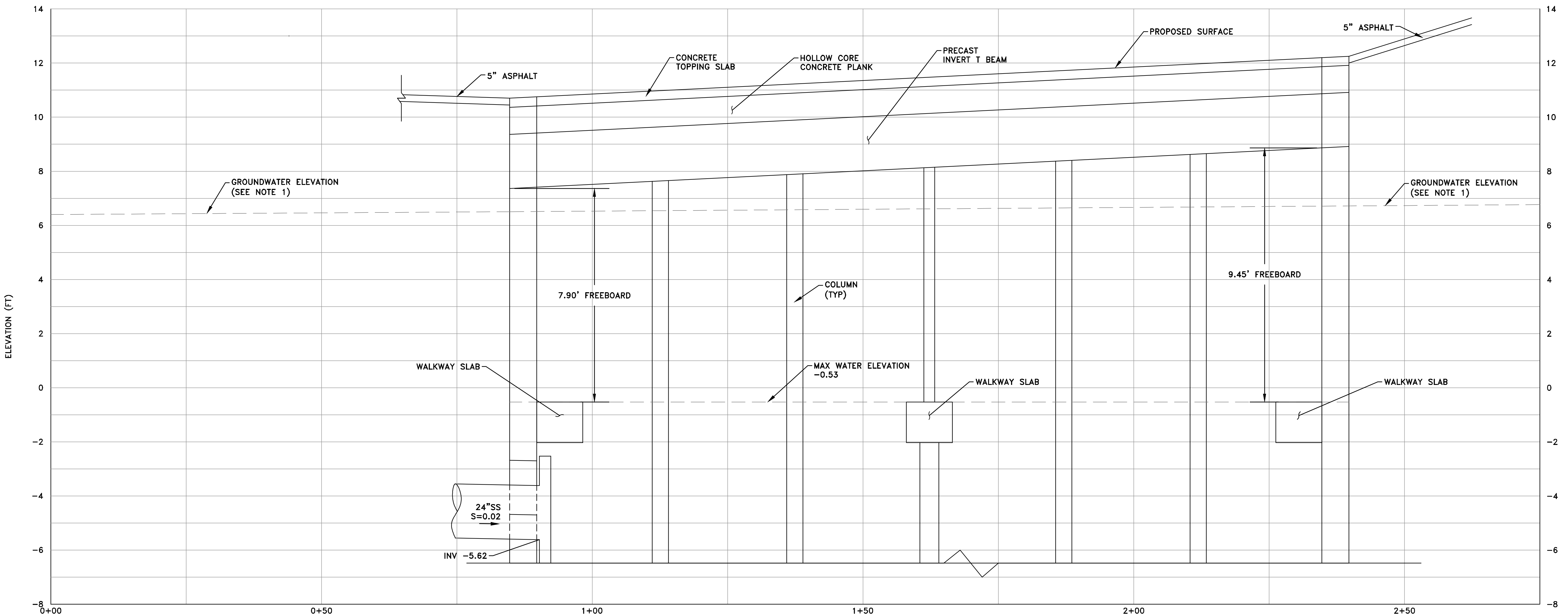
FREYER & LAURETA, INC.
CIVIL ENGINEERS • SURVEYORS • CONSTRUCTION MANAGERS

CITY OF PACIFICA
DEPARTMENT OF PUBLIC WORKS, WWTP
170 SANTA MARIA BOULEVARD
PACIFICA CALIFORNIA 94044

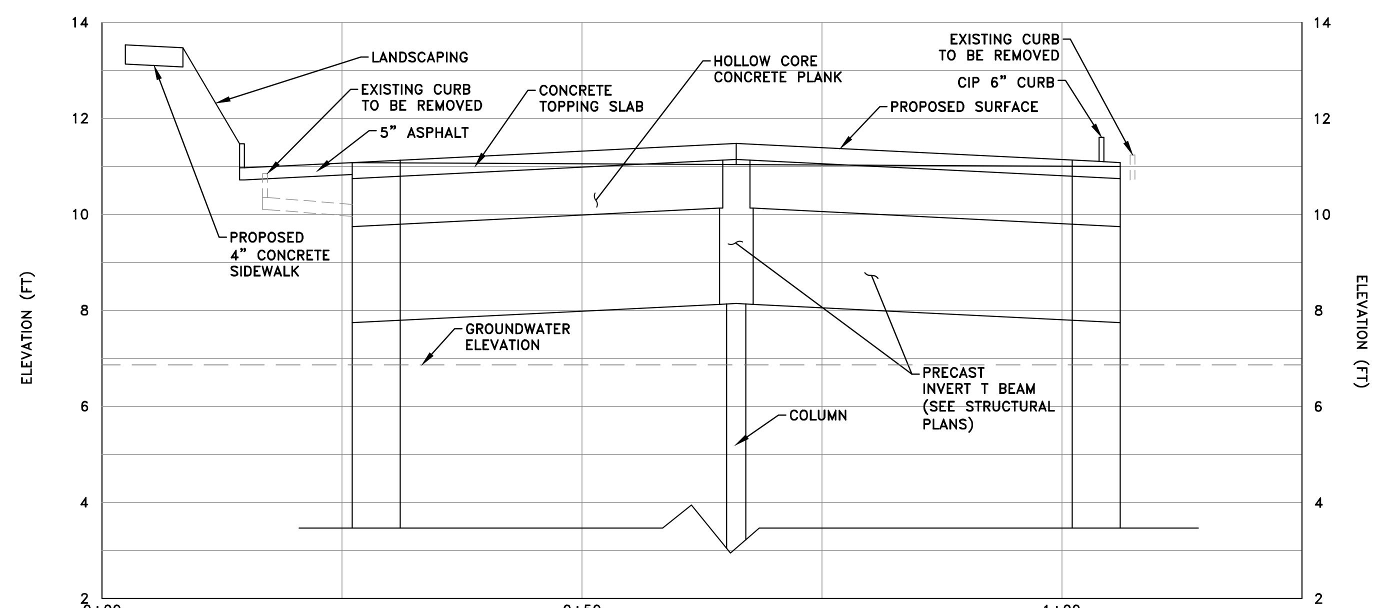
WET WEATHER EQUALIZATION BASIN
UTILITY PLAN COMMUNITY CENTER
CITY OF PACIFICA, CALIFORNIA

SHEET C-61

JOB NO. 240001



1 SECTION



2 SECTION

NOTES

1. APPROXIMATE GROUNDWATER ELEVATION AS INDICATED FROM SOILS REPORT AND POTHOLING INFORMATION. ACTUAL GROUNDWATER ELEVATION MAY VARY.
2. SEE STRUCTURAL PLANS FOR TANK DESIGN.

PROFILE VIEW
HORIZ: 1" = 10'
VERT: 1" = 2'

SCALE: AS NOTED		05/06/16	BASIS OF DESIGN	
DESIGNED: RJL		08/05/16	60% SUBMITTAL	
DRAWN: AJR		10/03/16	90% SUBMITTAL	
CHECKED: MQ		11/23/16	95% SUBMITTAL	
PROJ. ENGR: RJL		01/18/17	100% SUBMITTAL	
	BY	DATE	DESCRIPTION OF REVISIONS	APP'D

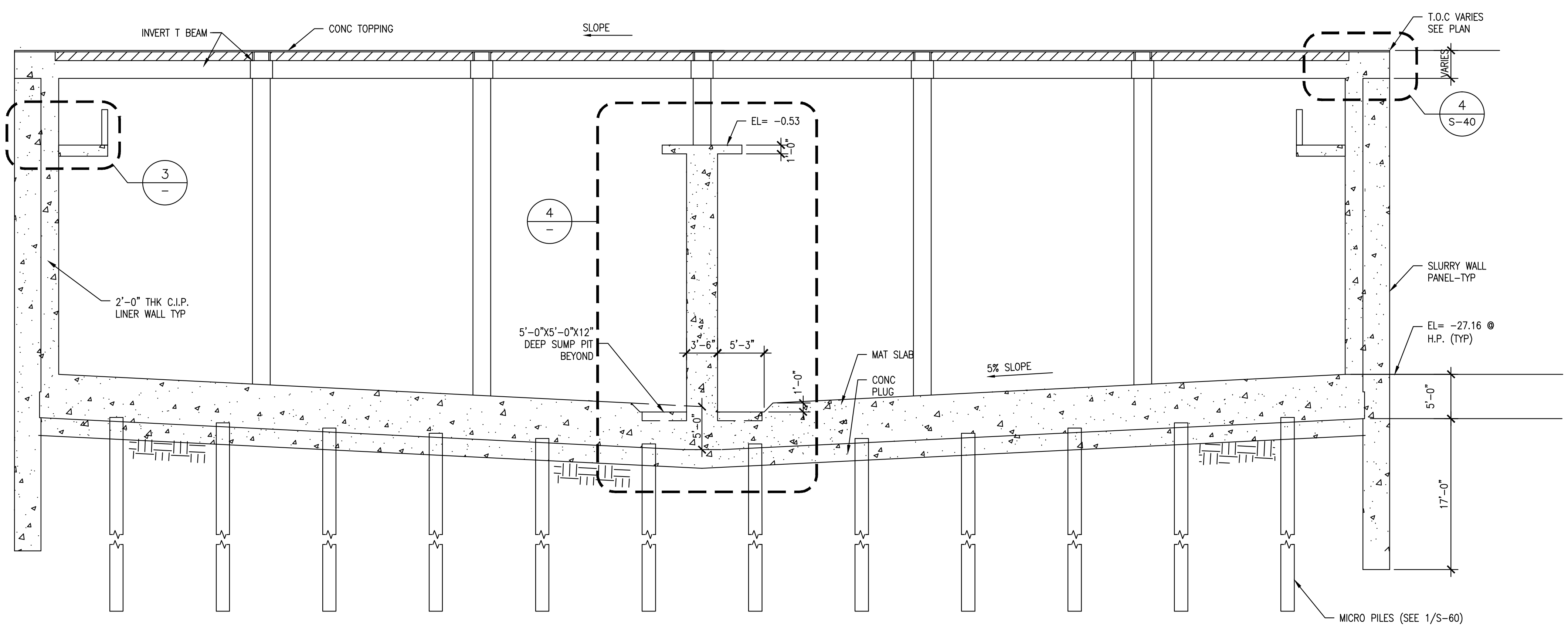
FREYER & LAURETA, INC.
CIVIL ENGINEERS • SURVEYORS • CONSTRUCTION MANAGERS

CITY OF PACIFICA
DEPARTMENT OF PUBLIC WORKS, WWTP
170 SANTA MARIA BOULEVARD
PACIFICA CALIFORNIA 94044

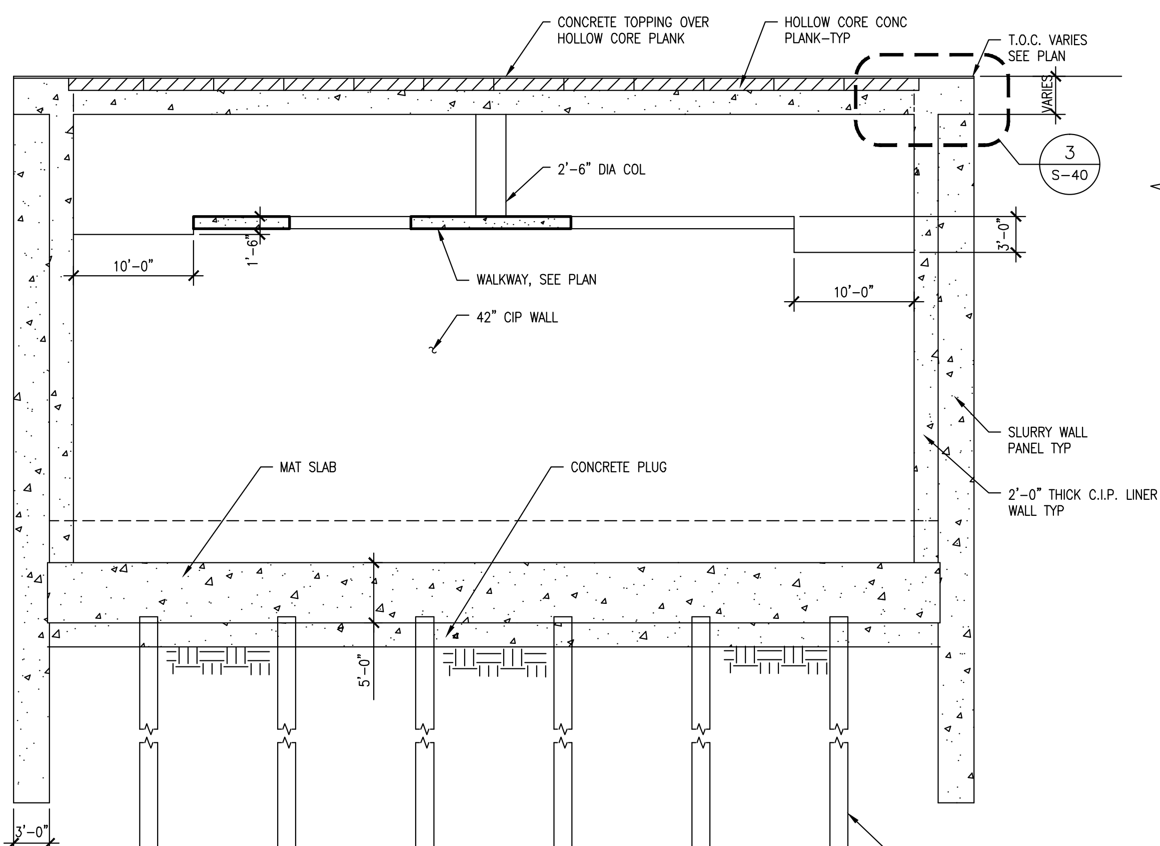
WET WEATHER EQUALIZATION BASIN
SECTION DETAIL PARKING LOT
CITY OF PACIFICA, CALIFORNIA

SHEET C-41

JOB NO. 240001



2 SECTION
Scale: 1/8"=1'-0"



1 SECTION
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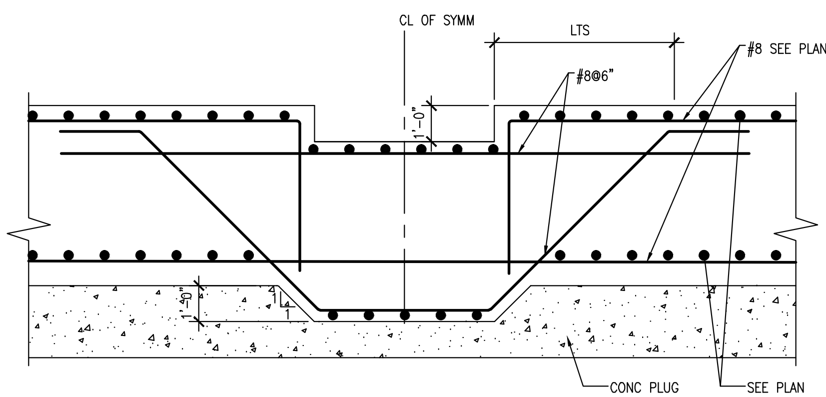
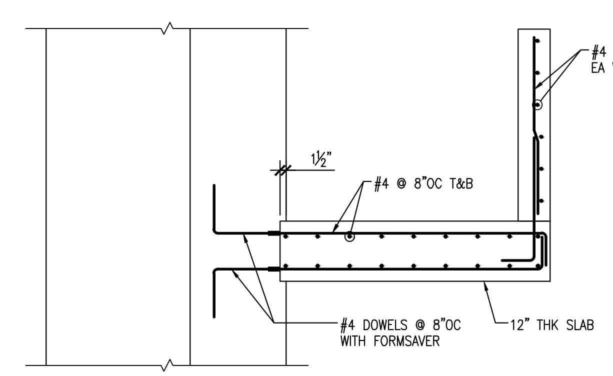
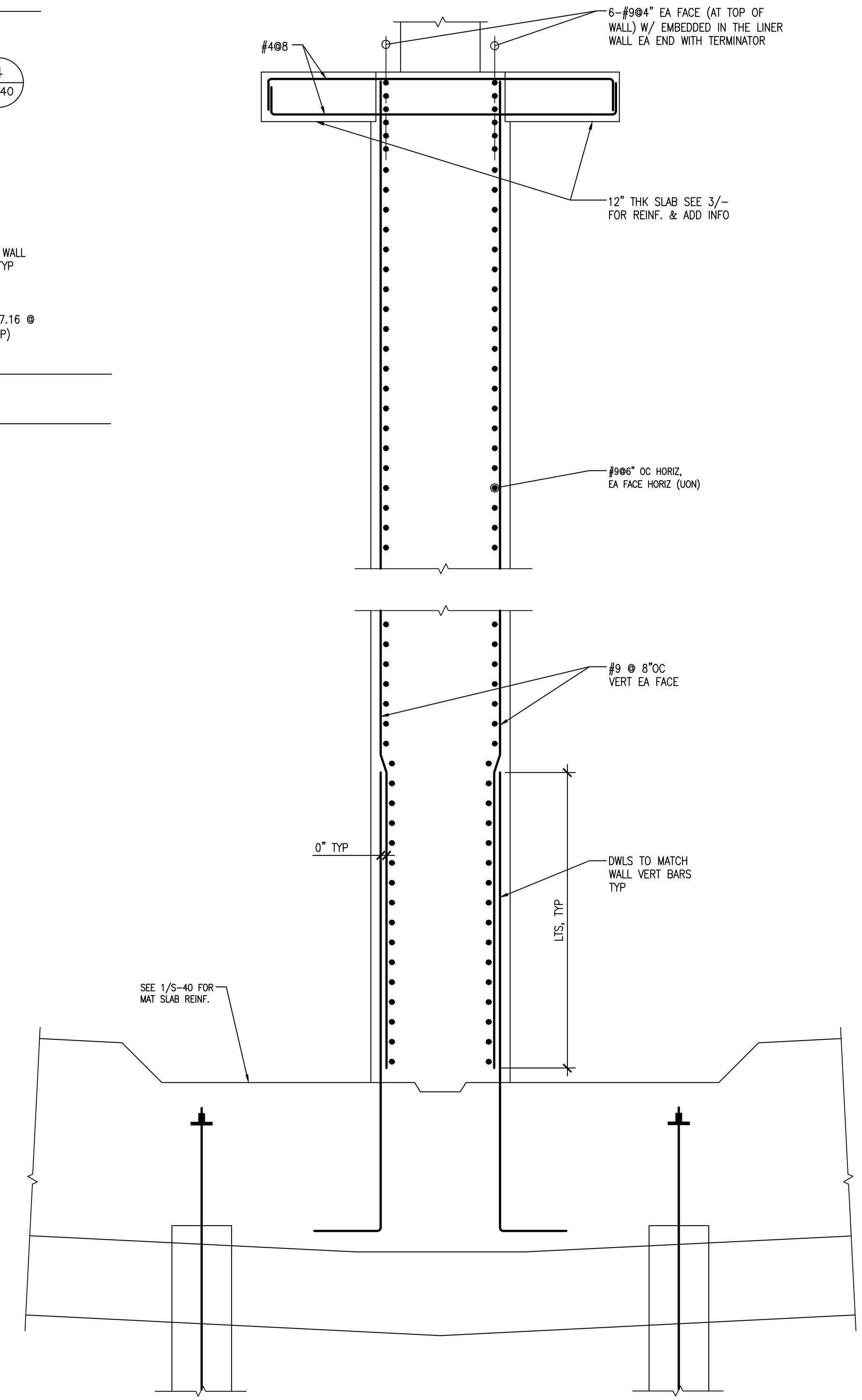


5 SECTION
SCALE: 3/8"=1'-0"



3 SECTION
SCALE: 1/2"=1'-0"



4 SECTION
SCALE: 1/2"=1'-0"

SCALE: AS NOTED		05/06/16	BASIS OF DESIGN
DESIGNED: DK		08/05/16	60% SUBMITTAL
DRAWN:		10/03/16	90% SUBMITTAL
CHECKED: AC		11/23/16	95% SUBMITTAL
PROJ. ENGR: DK		01/18/17	100% SUBMITTAL
	BY	DATE	DESCRIPTION OF REVISIONS	APP'D

FREYER & LAURETA, INC.
CIVIL ENGINEERS • SURVEYORS • CONSTRUCTION MANAGERS

Thornton Tomasetti
Thornton Tomasetti, Inc.
707 Wilshire Blvd, Suite 4450
Los Angeles, CA 90017-3618
T 213.330.7000 F 213.330.7001

CITY OF PACIFICA
CITY OF PACIFICA
DEPARTMENT OF PUBLIC WORKS, WWTP
170 SANTA MARIA BOULEVARD
PACIFICA CALIFORNIA 94044

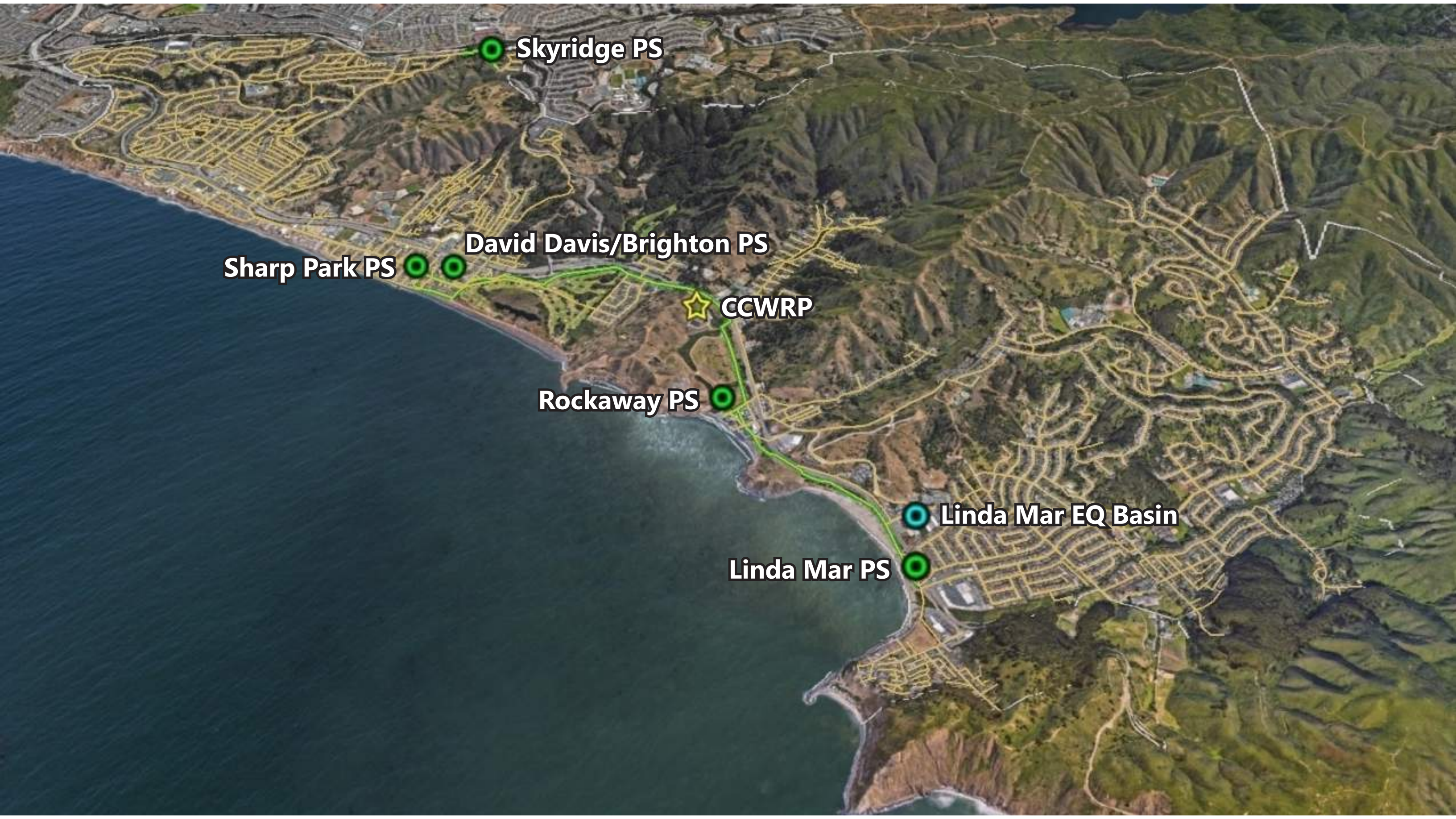
PROFESSIONAL ENGINEER ALBERT CHEN No. S3516 Exp. 03-31-17 STRUCTURAL STATE OF CALIFORNIA

WET WEATHER EQUALIZATION BASIN
TANK SECTIONS
CITY OF PACIFICA, CALIFORNIA

SHEET S-30
JOB NO. 240001

APPENDIX F

Pacifica Collection System Assets Vulnerable to Sea Level Rise (Technical Memorandum)



TECHNICAL MEMORANDUM

TO: Louis Sun, City of Pacifica

PREPARED BY: Stephanie Hubli, Woodard & Curran

REVIEWED BY: Chris van Lienden & Gisa Ju, Woodard & Curran

DATE: August 13, 2021

RE: Pacifica Collection System Assets Vulnerable to Sea Level Rise

This purpose of this Technical Memorandum (TM) is to identify the City of Pacifica's wastewater collection system assets that may be exposed to coastal flooding and erosion in the future due to projected sea-level rise.

1. BACKGROUND

The City of Pacifica encompasses approximately six miles of beaches and bluffs along the California coastline, making it particularly vulnerable to impacts from coastal flooding and erosion. Due to climate change and projected sea-level rise (SLR), the risks associated with coastal flooding and erosion are anticipated to increase significantly over time. To help evaluate and prepare for future impacts, the City recently completed a SLR Vulnerability Assessment (ESA, 2018) in June of 2018 in support of its Local Coastal Plan (LCP) update (Dyett & Bhatia et. al, 2020). The LCP is a planning document that regulates development within the City's Coastal Zone. The City utilized data, guidance, and methodologies from the SLR Vulnerability Assessment for the entire Bayshore and North Coast that was prepared as part of the Sea Change San Mateo County initiative (San Mateo County, 2018) to ensure its SLR Vulnerability Assessment was developed consistent with the County-wide SLR Vulnerability Assessment. Coastal exposure mapping was completed as part of the SLR Vulnerability Assessment to identify City assets that would potentially be exposed to flooding and erosion hazards considering projected sea-level rise. This TM focuses on the wastewater collection system assets (sewer pipelines, manholes, pump stations) that are potentially at risk.

2. SEA-LEVEL RISE VULNERABILITY MAPS

2.1 Data Sources

To evaluate exposure of the City's wastewater assets to coastal flooding and erosion, Woodard & Curran utilized the same hazard data sources that were used for the San Mateo County SLR study and the Pacifica LCP update and associated SLR Vulnerability Assessment, which were downloaded from the City's online, interactive Hazard Exposure Map (Pacifica, 2018). These data sources are described in more detail below and in Section 1.2 of the City's SLR Vulnerability Assessment:

- **Our Coast Our Future (OCOF), 2014**: The OCOF project provides data, online maps, and tools to help users understand, visualize, and anticipate vulnerabilities to various SLR and storm scenarios that were developed by the United States Geological Survey (USGS) using their Coastal Storm Modeling System (CoSMoS 2.0, North-central California (outer coast)). For the City's Vulnerability Assessment and this TM, OCOF data from the online, interactive web map (Ballard, G, et. al.) was used to evaluate existing and future coastal flooding hazards due to projected SLR (for regular tidal inundation) and storm flooding (considering a 100-year coastal event). The OCOF/CoSMoS modeling for the outer coast area does not incorporate long-term erosion of shorelines and bluffs the same way that it does for southern California; and therefore, the flood layers may underestimate flood exposure.

- **Pacific Institute Erosion, 2009**: The Pacific Institute, with the help of the California Climate Action Team, prepared a report titled "Impacts of Sea-Level Rise to the California Coast" (Pacific Institute, 2009) to better understand the potential impacts of climate change to Californians. In the course of this work, future coastal flooding hazards were projected for the entire state based on a review of existing Federal Emergency Management Agency (FEMA) hazard maps and projected future coastal erosion hazard areas for the northern and central California coastline. Erosion impacts from the Pacific Institute do not account for existing coastal armoring structures and are used to identify vulnerabilities under a worst-case scenario. Therefore, they depict the potential extent of erosion in the case that armoring fails or is not maintained.

2.2 Coastal Hazard Exposure Layers

The data sources described in **Section 2.1** were used to develop the attached vulnerability maps. Coastal flooding was evaluated using the OCOF hazard mapping products, while future coastal erosion was evaluated using the Pacific Institute erosion maps. The vulnerability maps overlay the following coastal hazard exposures on top of Pacifica's wastewater collection system, which are described below and in the City's SLR Vulnerability Assessment:

- **Coastal Erosion 2100** (Data Source: Pacific Institute Erosion, 2009) represents long-term shoreline and bluff areas that would be lost entirely by the year 2100 due to rising sea levels, considering 5.5 feet of SLR. Erosion impacts from the Pacific Institute do not account for existing coastal armoring structures and are therefore used to identify vulnerabilities under a worst-case scenario.
- **Storm Flood Area** (Data Source: OCOF, 2014) represents coastal areas of sustained inundation that are hydrologically connected to the Pacific Ocean and would be regularly flooded by wave overtopping and fluvial sources, considering coastal flooding from 5.7 feet of future SLR by the year 2100 combined with flooding from a 100-year coastal storm event. Storm flood areas are based on the OCOF SLR hazard layers, which were modified as part of the SLR Vulnerability Assessment to also include potential flooding extents from fluvial sources for San Pedro Creek and Sanchez Creek. Areas experiencing storm flooding are likely to return to service when floodwaters recede.
- **Flood Prone Area** (Data Source: OCOF, 2014) represents isolated, low-lying areas of sustained inundation that are not hydrologically connected to the Pacific Ocean and would be regularly flooded by wave overtopping and fluvial sources, considering coastal flooding from 5.7 feet of future SLR by the year 2100 combined with flooding from a 100-year coastal storm event. These flood prone areas are below the total water level[1] but are not hydrologically connected to the storm flood areas discussed above due to protection by topographic features or levees (Sea the Future, 2019). Flood prone areas are based on the OCOF SLR hazard layers, which were modified as part of the SLR Vulnerability Assessment to also include potential flooding extents from fluvial sources for San Pedro Creek and Sanchez Creek. Depending on ground elevations and wave exposure, low-lying, flood prone areas could become directly connected to the Pacific Ocean during storms with the potential impacts of SLR.
- **Wave Run-up** (Data Source: OCOF, 2014) represents areas that would likely be damaged by storm waves but could be recoverable, considering 5.7 feet of future SLR by the year 2100. Under maximum wave run-up, water velocities could be great enough to knock over people, move cars, damage buildings, etc. Storm wave impacts are based on the OCOF maximum inland wave run-up points for a 100-year coastal storm that were generated along the shore at regularly spaced transects (points were interpolated along the shore to create polygons and manually edited for anomalies around headlands as needed).

[1] Total water level is the resulting water level considering wave run-up, storm surge, seasonal effects, tides, and sea-level rise (Sea the Future, 2019).

Figure 1 provides a visual example of the coastal hazard exposure areas defined above in an area near the coast that is prone to flooding.

Figure 1: OCOF Coastal Inundation and Storm Flooding Impacts (ESA, 2018)

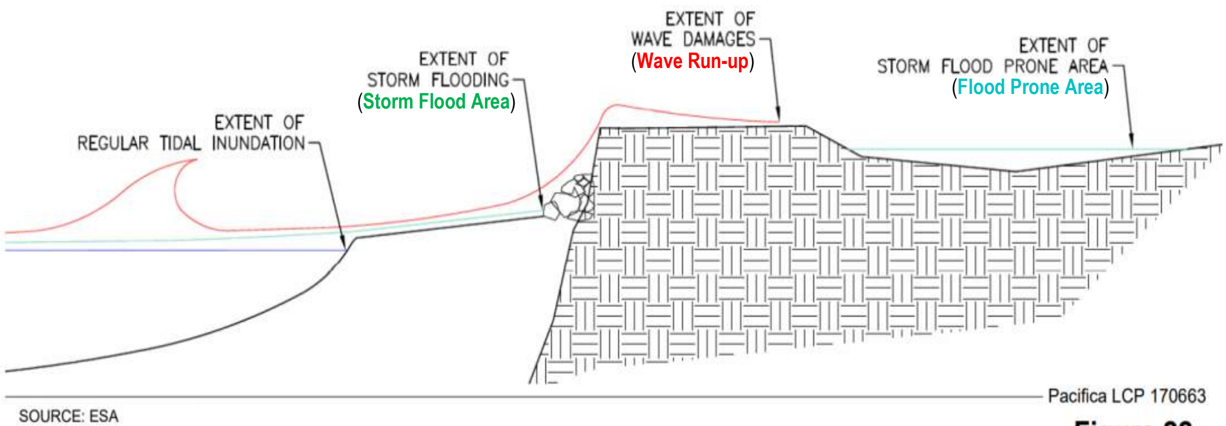


Figure 22
Schematic of OCOF Coastal Inundation and Storm Flooding Impacts

3. VULNERABLE COLLECTION SYSTEM ASSETS

The attached vulnerability maps show that SLR will increase the elevation and inland extents of coastal storm flooding in Pacifica, especially in areas such as Linda Mar, Pacifica State Beach, and Sharp Park that have a low backshore (areas extending from limit of high-water to extreme inland limit which are only affected by waves during exceptional high tides or severe storms). **Table 1** presents a summary of the wastewater collection system assets exposed to coastal erosion and flooding, including gravity pipelines, force mains, pump stations, and the Linda Mar equalization (EQ) basin.

Table 1: Wastewater Assets Exposed to Coastal Erosion and Flooding

Wastewater Asset	Coastal Erosion	Coastal Flooding		
		Storm Flood Area	Wave Run-up	Flood Prone Area
Gravity Pipelines (miles)[1]	6.8	5.1	6.6	0.3
Force Mains (miles)[1]	1.4	0.7	1.1	< 0.1
Pump Stations (# of 5)	4	2	4	0
EQ Basins (# of 1)	0	1	1	0

[1] Pipeline lengths estimated in GIS.

The City's Calera Creek Water Recycling Plant is located outside of the extents of coastal flooding and erosion and therefore would not be impacted by the effects of projected SLR; however, disruptions to vulnerable pump stations could lead to backups in sewer pipes and prevent sewage from reaching the plant. Wastewater pump stations exposed to coastal erosion and flooding include Linda Mar, David Davis/Brighton, Sharp Park, and Rockaway. The Linda Mar EQ Basin is exposed to coastal flooding but not erosion.

As depicted in the vulnerability maps, coastal armoring exists along the shoreline between the ocean and the Rockaway, Sharp Park, and David Davis/Brighton pump stations. Although coastal armoring may provide some protection from erosion if properly maintained, the coastal erosion data used from Pacific Institute (red areas on the vulnerability maps) do not consider the effects of existing coastal armoring structures; and therefore, the vulnerability maps depict the worst-case scenario for coastal erosion assuming that no adaptation strategies are employed.

Approximately 7 percent of the City's 97 miles of gravity pipelines and 30 to 35 percent of its 4 miles of force mains are exposed to coastal erosion and flooding. Surface inflow into manholes and infiltration into leaky sewer pipes in exposed areas could cause a reduction in capacity, which may lead to backups and even overflows of untreated sewage. Sanitary sewer overflows could potentially enter storm drains and the coastal ocean and pose negative impacts to coastal water quality and ecological health.

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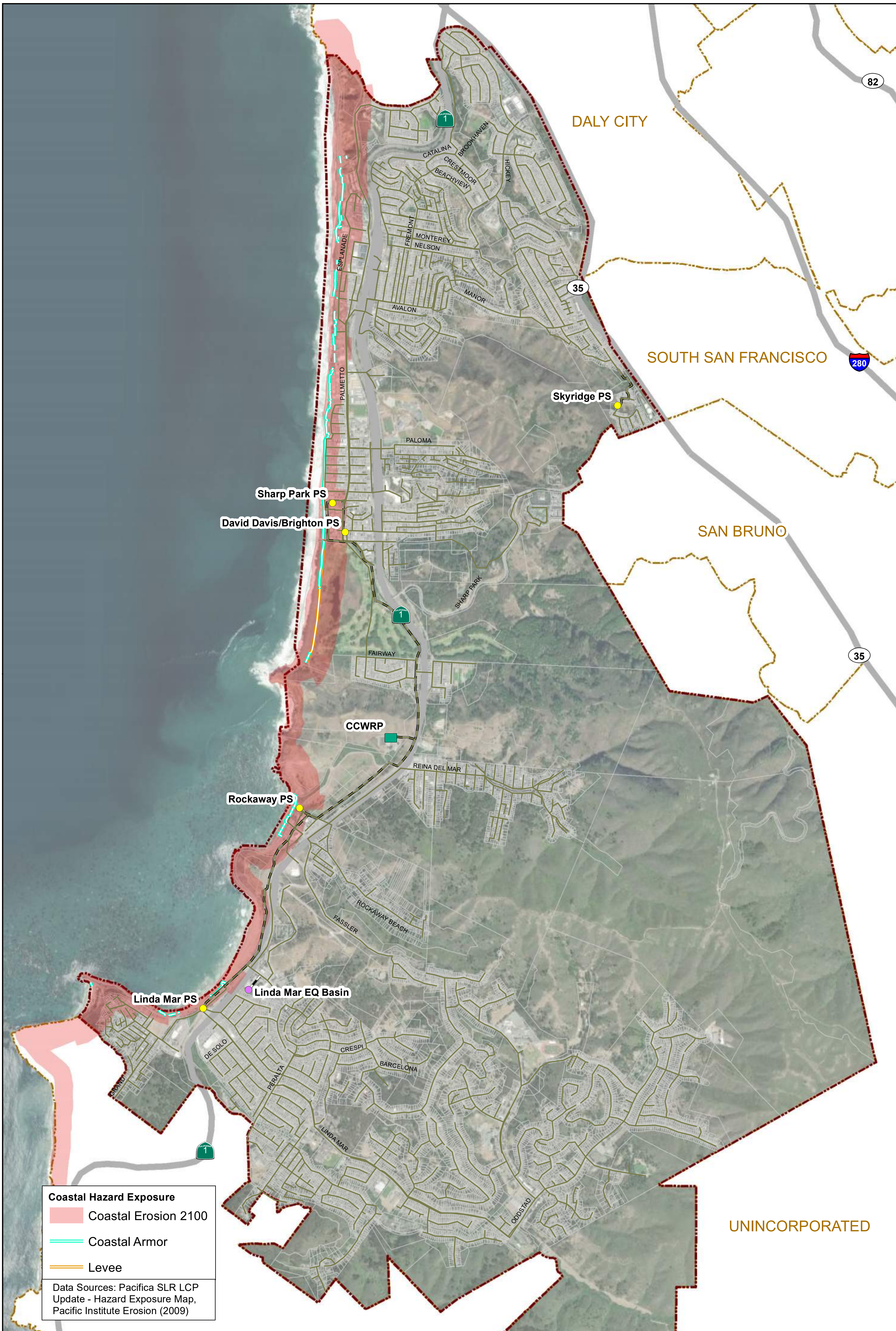
ATTACHMENT A: SEA-LEVEL RISE VULNERABILITY MAPS



Collection System Assets Vulnerable to Coastal Erosion

Wastewater Collection System
Master Plan

Legend

City Sewers
Forcemain
Parcels

Facilities
Pump Station
Water Recycling Plant
Equalization Basin

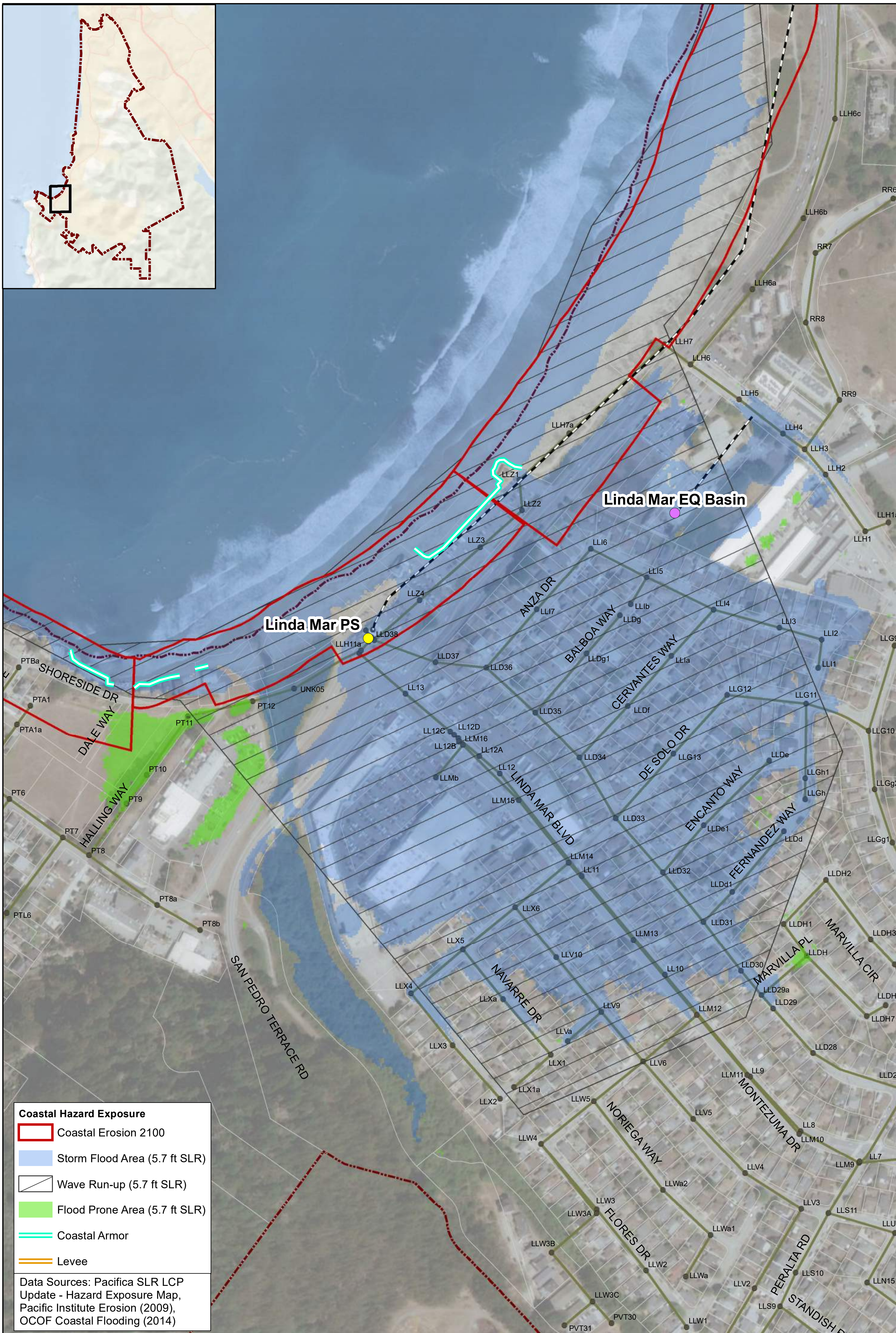
Pacifica City Limits
Other City Boundaries

0 0.125 0.25 0.5 Miles

N

City of Pacifica
WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021



Collection System Assets Vulnerable to Sea Level Rise

Page 1 of 3

Wastewater Collection System Master Plan

Legend

- City Manholes
- City Sewers
- Forcemain

Facilities

- Pump Station
- Equalization Basin

- Parcels
- Pacifica City Limits

0 125 250 500 Feet

N

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01

Map Created: August 2021

Collection System Assets Vulnerable to Sea Level Rise

Page 2 of 3

Wastewater Collection System Master Plan

Legend

- City Manholes
- City Sewers
- Forcemain

Facilities

- Pump Station
- Equalization Basin
- Parcels
- Pacifica City Limits

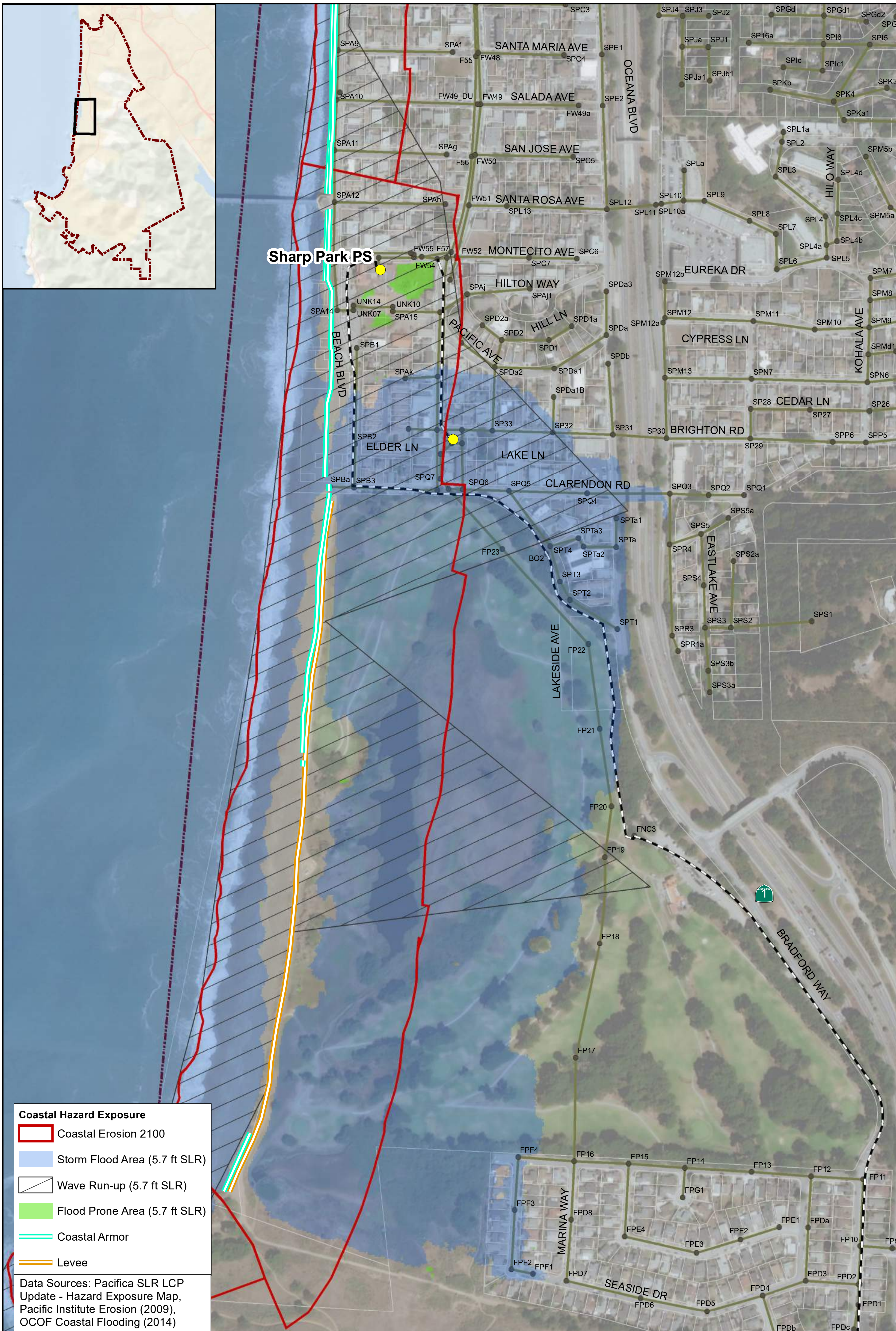
N

0 120 240 480 Feet

City of Pacifica

WOODARD & CURRAN

Project #: 0011180.01
Map Created: August 2021



Collection System Assets Vulnerable to Sea Level Rise

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Wastewater Collection System Master Plan

Legend

- City Manholes
- City Sewers
- Forcemain

Facilities

- Pump Station
- Equalization Basin

- Parcels
- Pacifica City Limits

N

0 145 290 580 Feet

CITY OF PACIFICA

WOODARD & CURRAN

Project #: 0011180.01
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